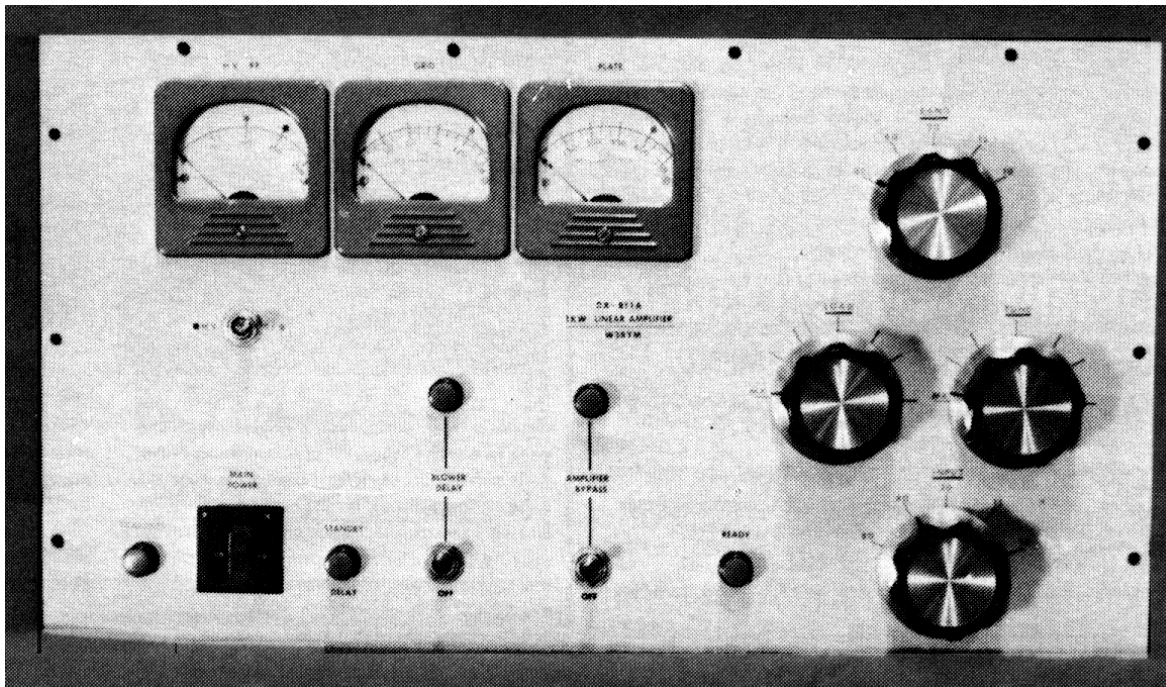


How To Build The DX-811A All-Band Linear Amplifier *CQ Magazine* September 1982

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This project began in the summer of 1981 at a hamfest held at the Howard County Fairgrounds in Maryland. I purchased a real treasure that day for the grand sum of \$15 – a DX-100. The seller, sensing a fish on the hook, quickly loaned me his wheel cart for hauling my 100-pound purchase. For those of you too young to remember, the DX-100 was a real workhorse AM, CW transmitter introduced about 1956 by Heathkit, and featuring 15 tubes, including a pair of 6146's in the final and a welded No. 16 gauge copper-plated steel chassis. The painted steel cabinet used double-lapped joint construction, giving excellent rigidity and RF screening.

I had no intention of restoring the old rig, but the idea of designing another linear amplifier using that enormous chassis, panel, and cabinet was an appealing challenge. Besides these three parts, the old rig contributed many high-quality components to the new project. These included brass panel bushings, shaft couplings, one E.F. Johnson plate tuning capacitor, ceramic tube sockets, and several pre-bent partitions.

Work began immediately by completely stripping the chassis and sorting the useful components. As the hours passed, I often thought of how I would have given my eyeteeth to own this rig in

the mid-50s. But my thoughts soon turned to visions of replacing my trusty SB-220 with another homebrew linear, this being my third.

The new project presented many mind-boggling problems, with the most perplexing being what to do with all those chassis and front-panel holes. The excess chassis holes were simple to deal with. I just discarded the top plate and replaced it with a solid aluminum sheet. The front panel, as you can see in the photos, is original. Many of the holes were retained, some new ones were drilled, and some were filled. Filling of the unused holes was treated like repairing a dent in a car's fender. I first applied pieces of metallized tape to the back of each hole; this provided electrical contact to the chassis front and a base for the Liquid Solder. A flat washer was placed in each hole along with a small amount of solder. Allowing the solder to dry as indicated by the instructions and then sanding and using additional applications as needed produced a very smooth surface. The major goal in the design and construction of this project was to produce a quality 1 KW DC input linear amplifier having good reliability using affordable tubes and components. Early in the design phase I established these minimum requirements:

- One KW DC input using 811A tubes,
- Filament inrush protection,
- Rectifier transient protection,
- Filament warm-up delay,
- Amplifier bypass capability,
- Simultaneous metering of the plate current, grid current, and HV,
- Blower delay and speed option,
- Lamp indicators for all vital functions, and
- Tuned input circuits.

In this project the power transformer (Berkshire 6181) is rated at 600 VA, and when rectified and filtered, it produces a compatible voltage of 1540 VDC for the 811A's.

I would also stress the use of a filament transformer having 25% additional current capacity.

Also, buy a healthy quantity of 0.01 uF disc ceramic bypass capacitors rated at 1 KV. In this project I used 30 of the 1 KV type and another dozen of the 50 VDC variety. If you want to keep power lines clean of RF, bypass capacitors and RF chokes are mandatory.

In my project the power supply shown in Fig. 1 is comprised of three transformers with their primaries connected for 220 VAC operation.

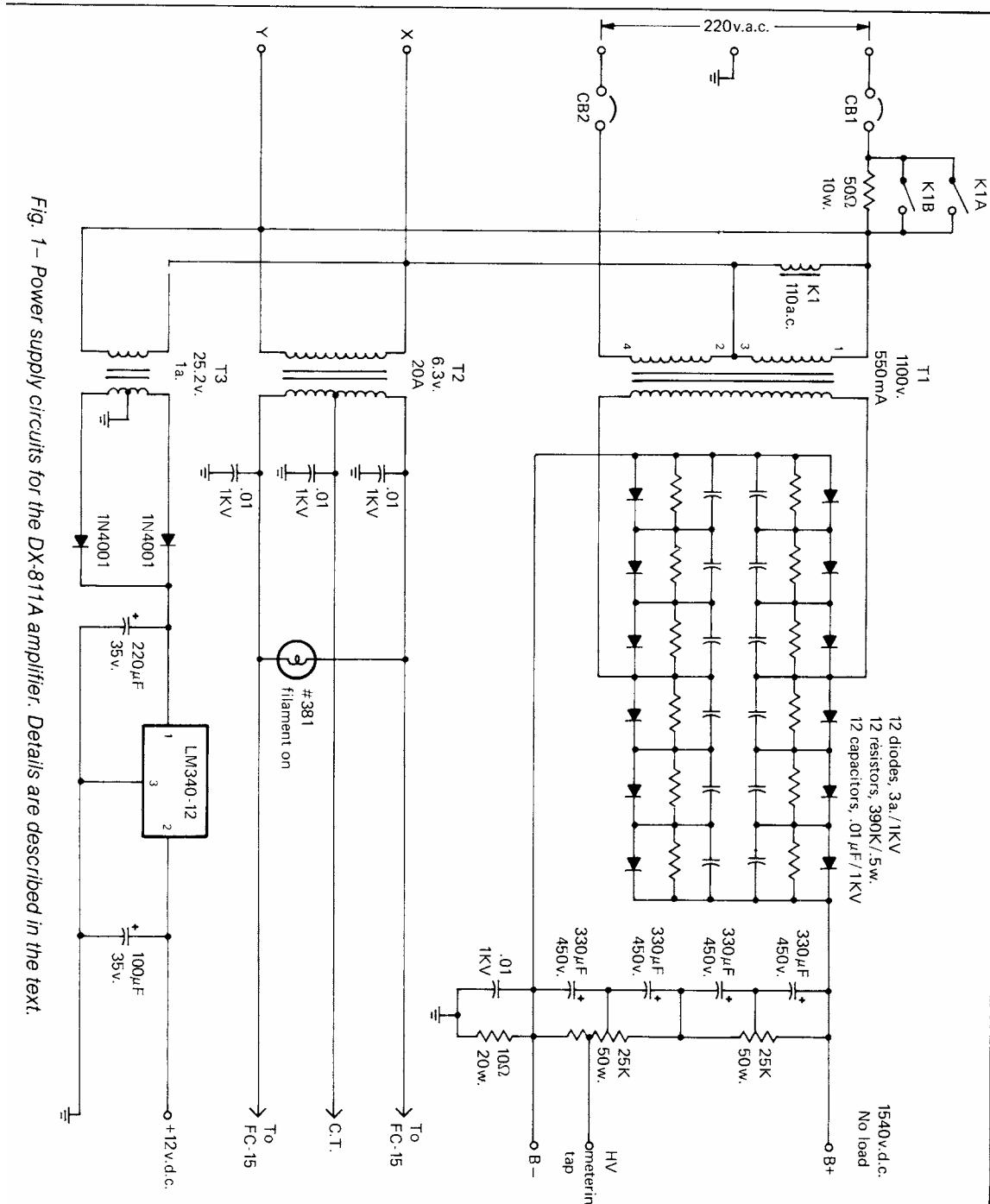


Fig. 1- Power supply circuits for the DX-811A amplifier. Details are described in the text.

All circuitry is protected with the front-panel dual circuit breaker which doubles as the main power switch.

Relay K1 and its contacts in parallel with a 75 ohm 10 watt resistor (*50 ohm resistor on schematic*) form the necessary inrush current protection. All secondary voltages reach full power in about 4 seconds after simultaneous closure of CB1 and CB2.

The rectifier stack is conventional with equalization resistors and transient bypass capacitors. I recommend using the Radio Shack No.276-170 circuit board for mounting all the rectifier components. *This is a full wave bridge rectifier and there is a PCB layout in the back of the 1982 and 1985 ARRL Handbook that could be used also.*

The filters are likewise conventional with a pair of center-tapped 25K ohm 50 watt resistors used for voltage equalization and bleeders. Notice that I mounted these resistors on top of the capacitors. They normally run very warm, producing heat that will escape through the cabinet top and not affect other parts.

One additional tap was added to the bleeder string about 5K ohms above B- for HV metering. The B- is raised above chassis ground by the 10 ohm 10 watt resistor and bypassed with a .01 uF capacitor. This point now becomes the amplifier's high-voltage return via the plate current meter.

The RF amplifier section is shown in the circuit diagram of fig. 2.

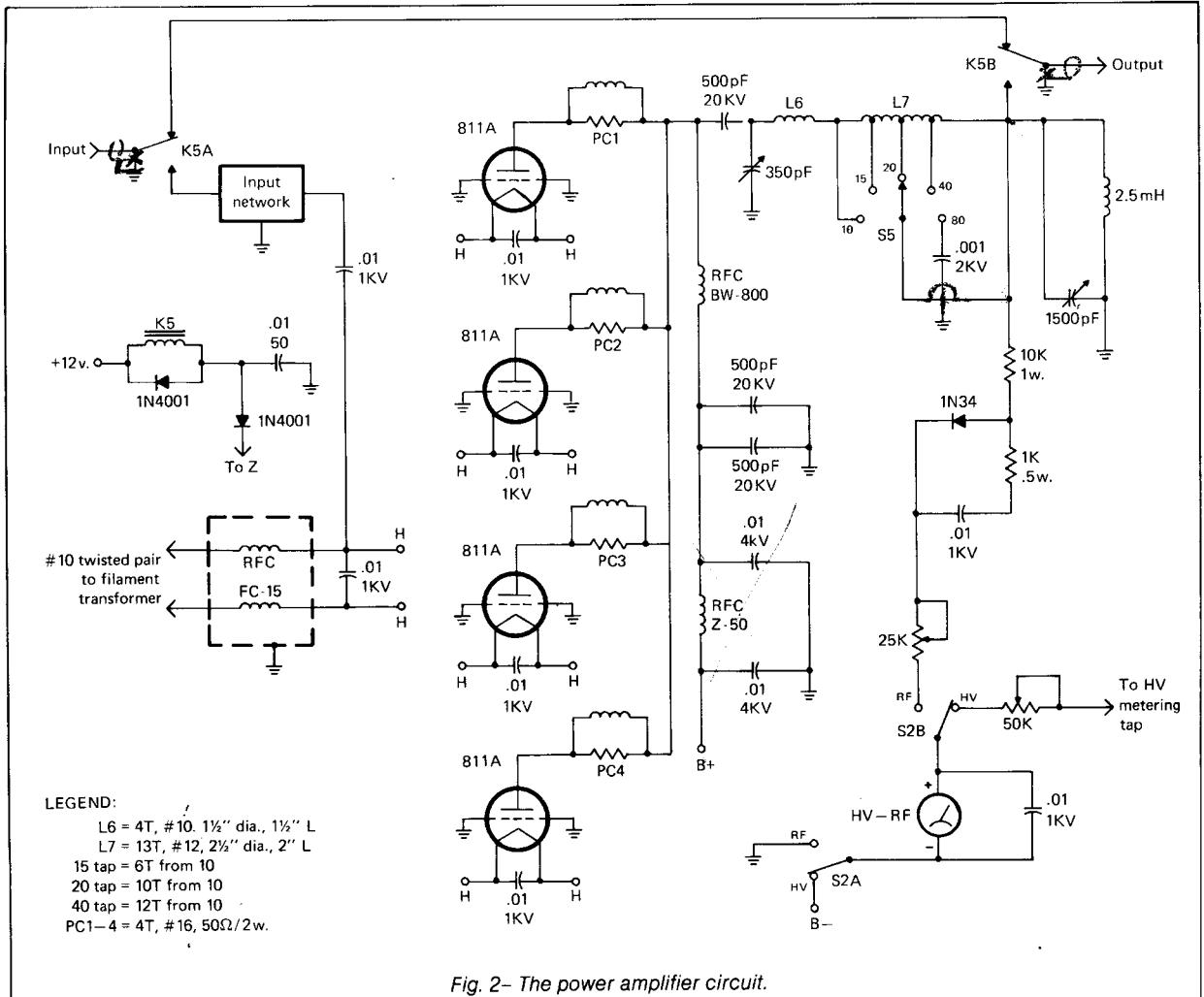


Fig. 2- The power amplifier circuit.

The INPUT from the exciter to K5A is a shielded cable (coax) to the OUTPUT K5B.

Based upon values from other designs, the RFC Z-50 can have a value of 7 microhenries. This is to final filter the power supply from any RF that gets through the B&W 800 plate choke.

Note that in area of L7, the contact on S5 crosses over, and does not connect to, the 0.001 uF 2 KV capacitor from the 80 meter contact.

The grids are hardwired to chassis ground, thus improving plate-to-cathode isolation with true grounded grid operation. Most of the circuits I reviewed use bypass capacitors from grids to ground which lift the grids off DC ground for biasing purposes. This is an acceptable method for RF grounding the

grids and provides a means of supplying external cutoff bias to the tubes.

I selected the Zener diode method of bias because it is easy to install in the center tap circuit of the filament transformer and provides the necessary operating bias, which is again not used on many 811A amplifiers.

Caution: If no bias is used, the resting plate current will be 150 mA for the four tubes.

When the amplifier is keyed up and tuned for full power, the tubes will reach full plate dissipation capability very rapidly, as evidenced by glowing red plates even with maximum blower cooling. Maximum output power will be attainable, but the tube plates will literally deform and eventually fail with repeated use.

My bias circuit uses a 10 watt Zener diode having a value of 4.7 VDC and a 50 Kohm 10 watt resistor for biasing the four tubes.

This circuit is located in fig. 3.

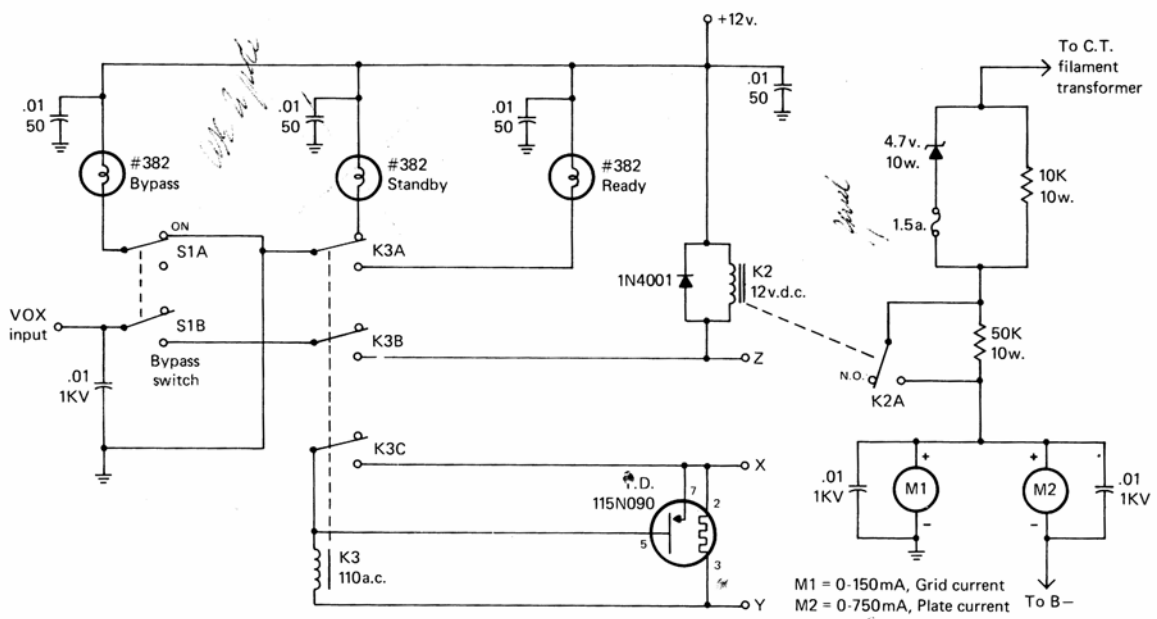
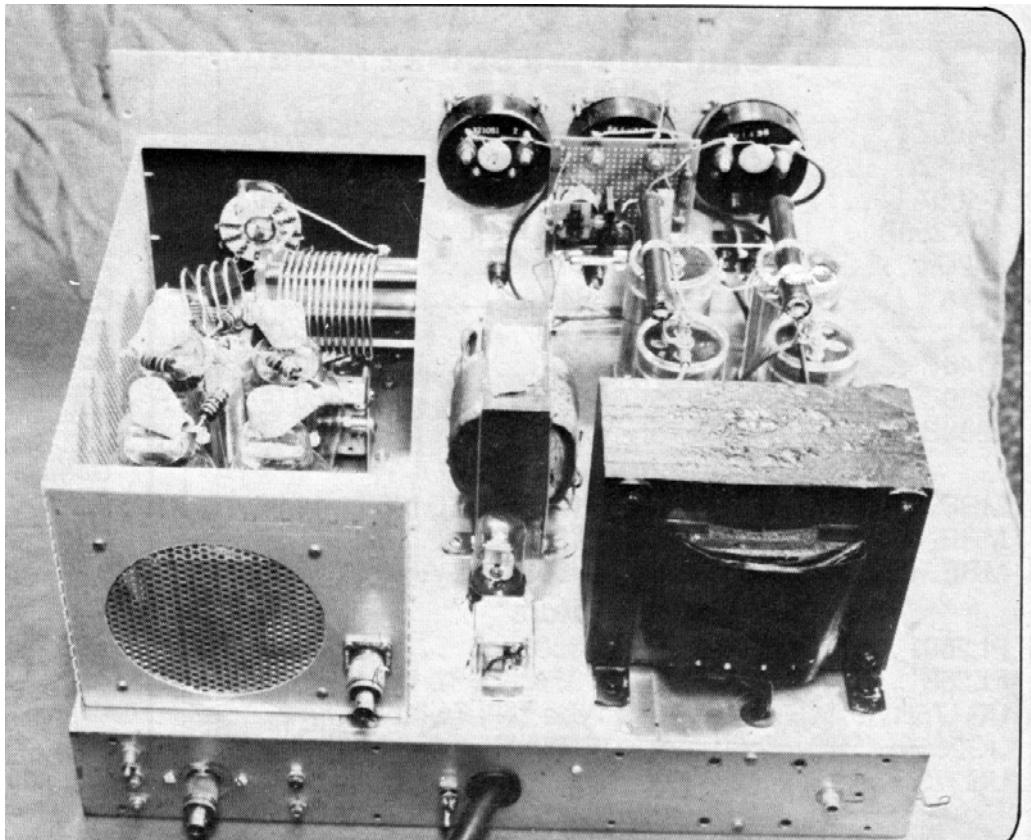


Fig. 3- Bias and control circuitry for the home-brew linear.

The voltage drop across the Zener plus the drop across the 50K ohm resistor provides cutoff bias, frequently called standby bias. This level is reduced to operating Zener bias only when relay K2 is closed by the VOX signal.

As shown in the rear panel photo, the biasing components are attached to a universal PC board supported by the grid meter terminals.



The Zener diode is not mounted on this board, but rather is placed directly underneath on the main chassis using insulating washers.

In the event that abnormally high plate current is allowed to flow, the Zener will be protected by the 1.5 amp series fuse. This could occur if the amplifier is overdriven before the final tank circuit is in resonance. With the fuse blown, the biasing circuit would be open-circuited, allowing plate current to flow through the tubes in their idle state. This condition would not be indicated by the plate current meter because it likewise would be open-circuited by the blown fuse.

To prevent this occurrence, I installed a protective resistor in parallel with the Zener and the 1.5 amp fuse that has a value of 10K ohms and 10 watts. This resistor is ineffective with a working Zener/fuse circuit, but will supply the necessary protective bias in the unlikely event of a blown fuse.

Filament current is fed through a commercial, shielded RF choke rated at 15 amps. Although the four tubes draw a total of

16 amps from the 20 amp transformer, the extra one amp is easily dissipated by the choke.

The dimensions for L6 and L7 were taken directly from the *Radio Handbook* by Bill Orr (21st edition, Editors Engineers, Div. of Howard W. Sams & Co., pp. 22.6–22.8).

The only problem I encountered was with 10 meters and my 350 pF tuning capacitor. To resonate the coil I had to short one turn of L6 using a piece of braid. The reason for this was the additional capacity of the four tubes adding to the large tuning capacitance. *This is more than adequate reasoning to use a roller inductor.*

Placement of the taps on L7 was the last operation performed on the linear. There are several factors which should be considered when this is done. I highly recommend the use of a calibrated dip meter to aid in correct placement of the taps. Although I have stated the number of turns for each band, these values will only hold for this linear. Chances are your layout and/or capacitances will be different, presenting new situations.

- Place all tubes in their sockets with completed plate circuits connected.
- Then connect a 50 ohm dummy load using one of the following methods:
 1. Connect to the output RF connector and close K5A/B by non-electrical means, or
 2. Connect to the top of the 1500 pF loading capacitor.
- Place the input and output band selectors to the same band – say 40 meters.
- Set the loading and tuning capacitors near the center of their ranges.
- Using the dip meter, find the exact tap point. You will have to rotate both capacitors to resonate the inductors.

If your antenna is close to a 50 ohm system, these same settings will also provide maximum RF transfer. The other band taps are located in a similar fashion.

The input circuits should be peaked at this time. The values for L1–L5 and C1–C5 can be found in Fig. 4.

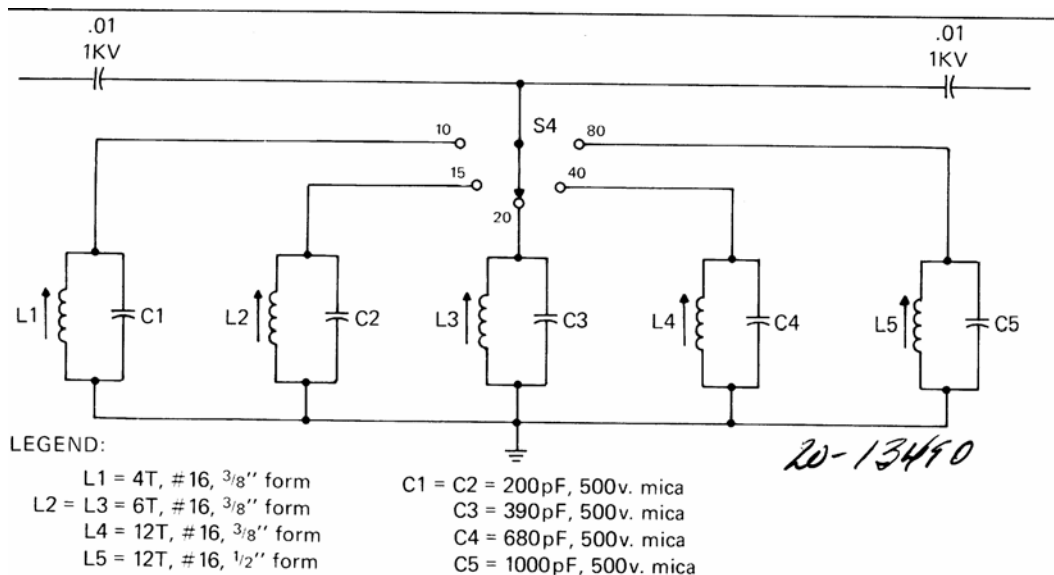


Fig. 4- Tuned input circuitry. Slug-tuned phenolic coil forms are used for L1 through L5.

I used phenolic instead of ceramic forms for all the inductors. The ceramic forms resonated okay, but produced a much smaller notch. All coils are slug tuned and have closely wound inductors using enamel-coated wire.

A solid state rig with a built in antenna tuner could replace this input circuit. Likewise, an older tube rig with broad antenna matching capabilities could match into this amp fairly easily.

The two welded main chassis partitions provided many mounting holes that were used to hold various components, tie strips, and relays. One additional hole had to be drilled for the HV ceramic feed-through. This hole was difficult to install, but by using progressive drill sizes and working from both sides of the partition, it soon became the required 3/8 inch diameter. The HV feed line is brought to one side of the feedthrough and the other side picks up with RFC Z-50 to the second feedthrough.

Notice the use of bypass capacitors on the tube sockets and HV line. In addition, notice the use of solid No. 12 bus wire connecting the filament pins in a symmetrical arrangement.

All components used in the RF output meter circuit, except for the calibration pot, are mounted in the output compartment. The rectified signal is conducted down through a feedthrough located near the rear of the loading capacitor on the chassis top.

The amplifier control circuit is shown along with the previously explained bias circuit in Fig. 3.

Vital functions are initiated by the transceiver's VOX signal. If amplifier bypass is required, S1A/B when switched ON will indicate the event by lighting a lamp and opening the VOX line.

After initial turn-on via CB1 and CB2, the amplifier cannot be placed on line until the time delay relay has closed. This forces a needed warm-up time for the 811A filaments. When time delay contacts 5 and 7 close after the nominal 1 minute waiting period, K3 will close. This event is automatic and will be indicated by the transfer of the standby to ready lamp. The amplifier is now ready to be tuned once the transceiver closes the VOX line to ground.

The blower control circuit that I used has some interesting features. I wanted to eliminate or reduce the annoying blower noise, especially when the linear was sitting at idle with zero plate current. Additionally, I wanted full blower operation to commence automatically with the VOX signal. I did try complete blower elimination during standby, but with such close tube proximity the tube filaments produced undesirable heat concentrations.

After some experimentation I finalized the circuit that is shown in Fig. 5.

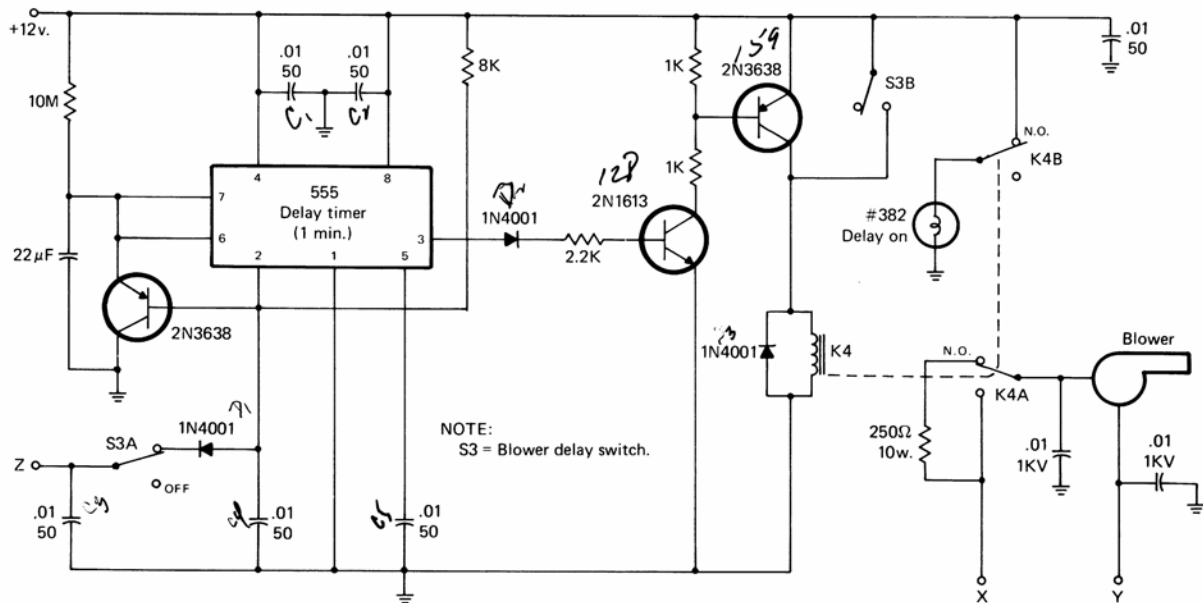


Fig. 5- Blower delay circuitry.

The blower delay circuit is actuated when S3A/B is in the ON position. With this condition set, the blower will turn on at about one-half speed because of the series 250 ohm 10 watt resistor. Yes, the resistor will get warm, so be careful where

you mount it. When the amplifier is initially turned on, the standby delay ON lamp will indicate this event.

When the amplifier's ready lamp comes ON and the VOX signal grounds into Circuit Designator Z, the 555 timer is triggered, closing K4, providing full power to the blower, and turning off the blower delay lamp.

The 555 is wired in a negative trigger mono-stable circuit. Its output will stay in the second state as long as Z is momentarily grounded within the delay period. In other words, the blower will be running at a low, quiet speed until the VOX line is keyed.

Then full blower operation will start and continue for the duration of the transmission, producing maximum cooling when it is most needed. After the last Z grounding or final dot/dash, the 555 will start its last timing cycle. When completed, its output will revert back to the original state, returning the blower to low speed.

I've set the delay time for 1 minute, and this has been adequate to cool the tubes to a safe level before the blower reduces speed. Full blower speed all the time is achieved through S3B's OFF position, which connects K4 directly to the +12 VDC line. With CW mode used 100% of the time, I've never needed to use this position. The 555 delay time can be changed by substituting a different capacitor for the 22 uF unit that is connected to pin No. 7. False triggering is prevented when S3 is OFF by the 8K ohm resistor connected to pin No. 2, keeping that pin high.

The output of this linear compares very favorably with my SB-220 when either is driven by my HW-101. Using the same wattmeter and dummy load, each amplifier will produce 600 watts output at 1 KW DC input. The driving power into each of these amplifiers ranges between 60 and 80 watts, depending upon the band used.

Typical values required to produce 600 watts output from the DX-811A are grid current of 120 ma, plate current of 750 ma, and a loaded plate voltage of about 1450 VDC.

The plate voltage drops about 100 VDC from zero to full load. As with all linears, an RF wattmeter is essential for tuning-up and attaining maximum power transfer into the load.

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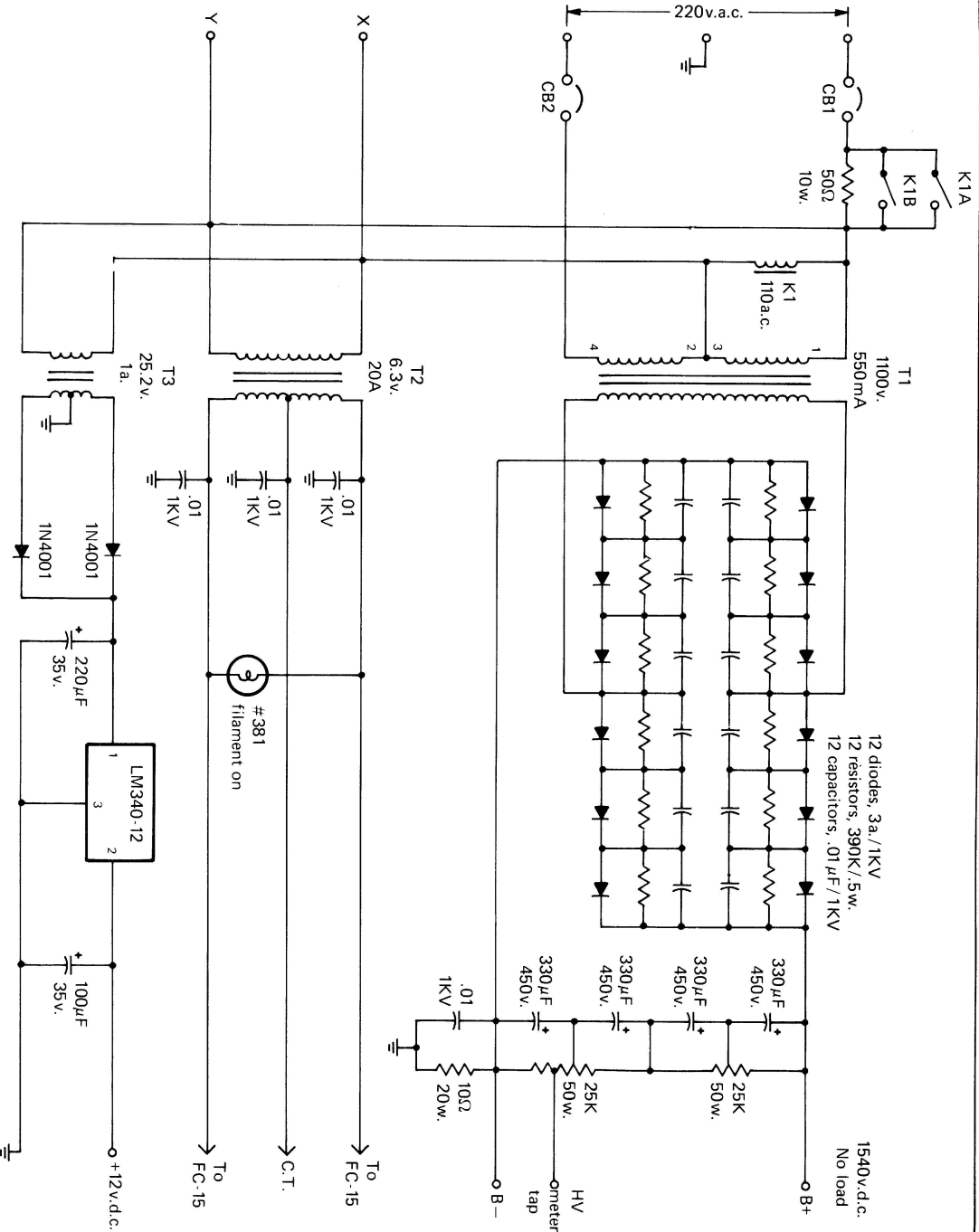


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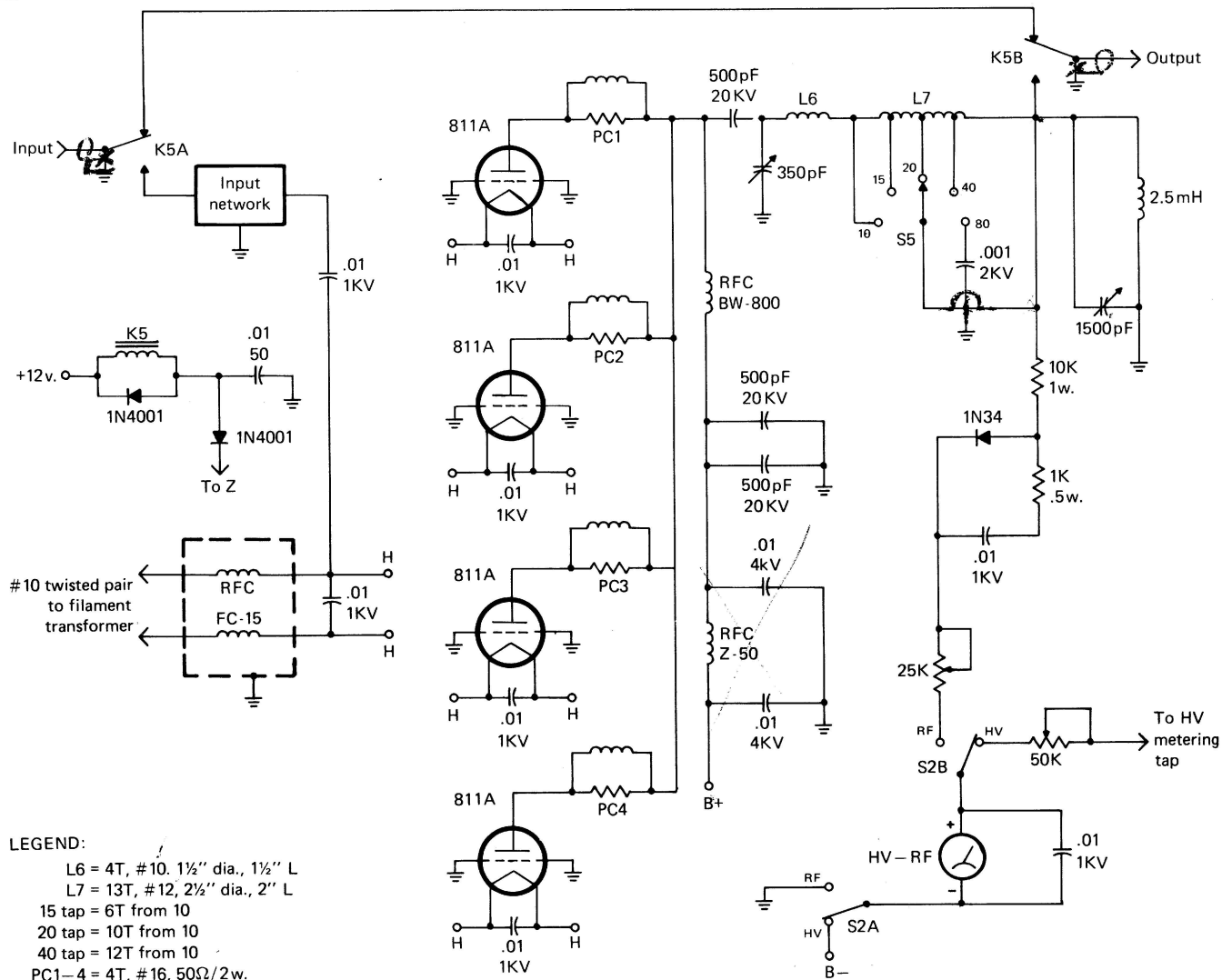


Fig. 2- The power amplifier circuit.

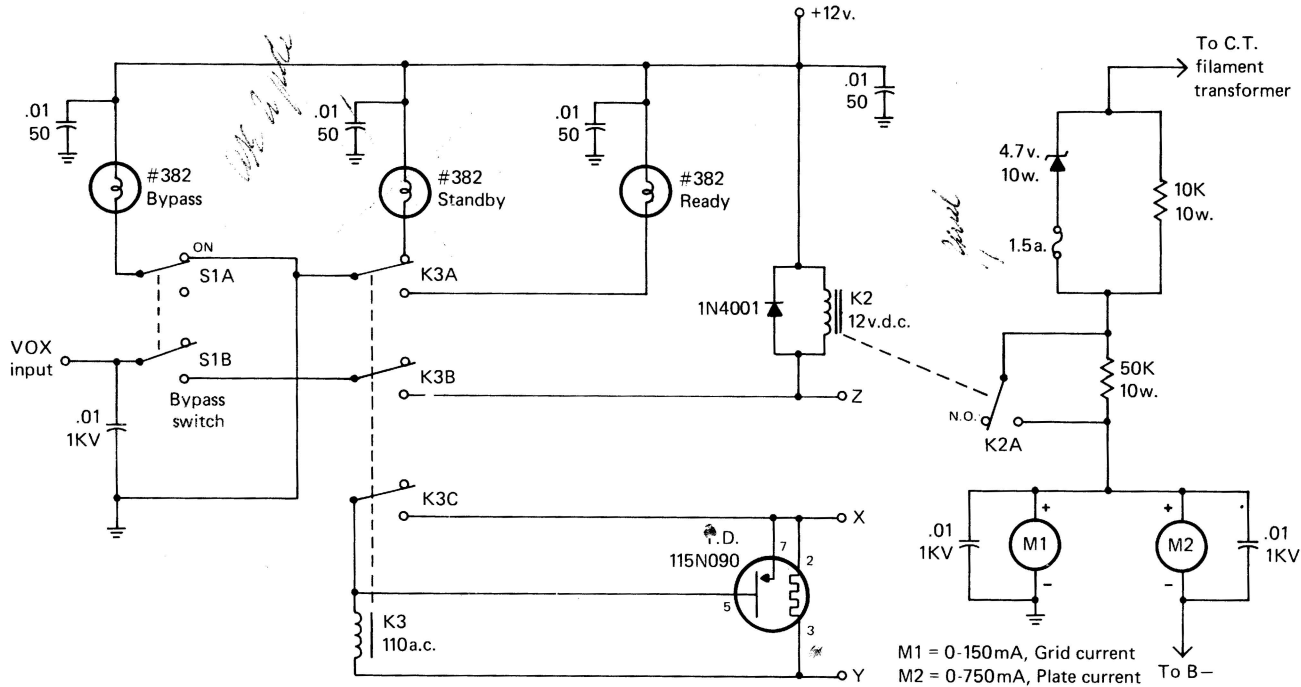


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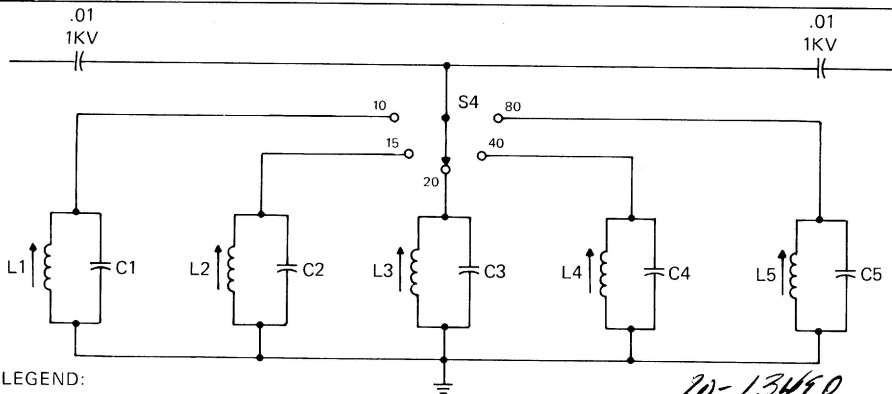


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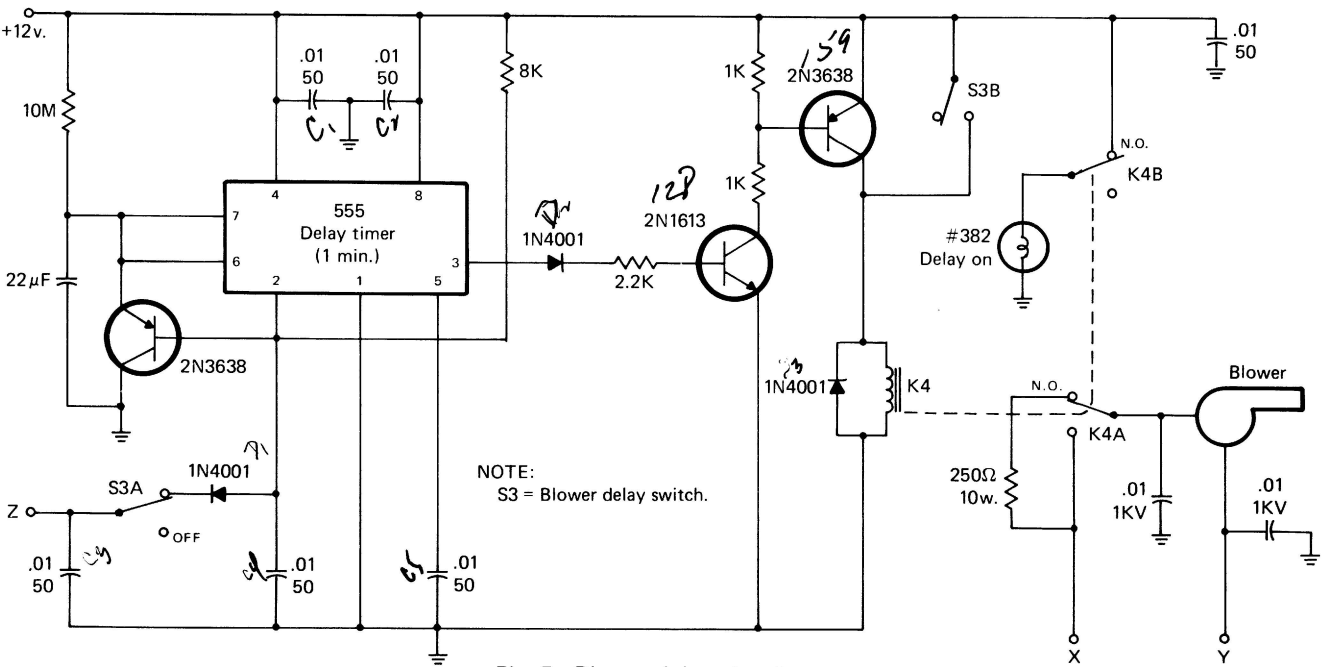
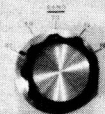
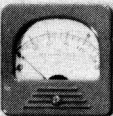
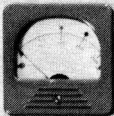


Fig. 5- Blower delay circuitry.

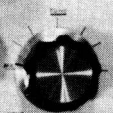
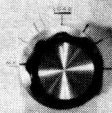
V X 99

GRID

PLATE



DR-8116
1.5W LINEAR AMPLIFIER
W80YM



MAIN
POWER



STANDBY
DELAY

POWER
DELAY
OFF

AMPLIFIER
BYPASS
OFF

READY

