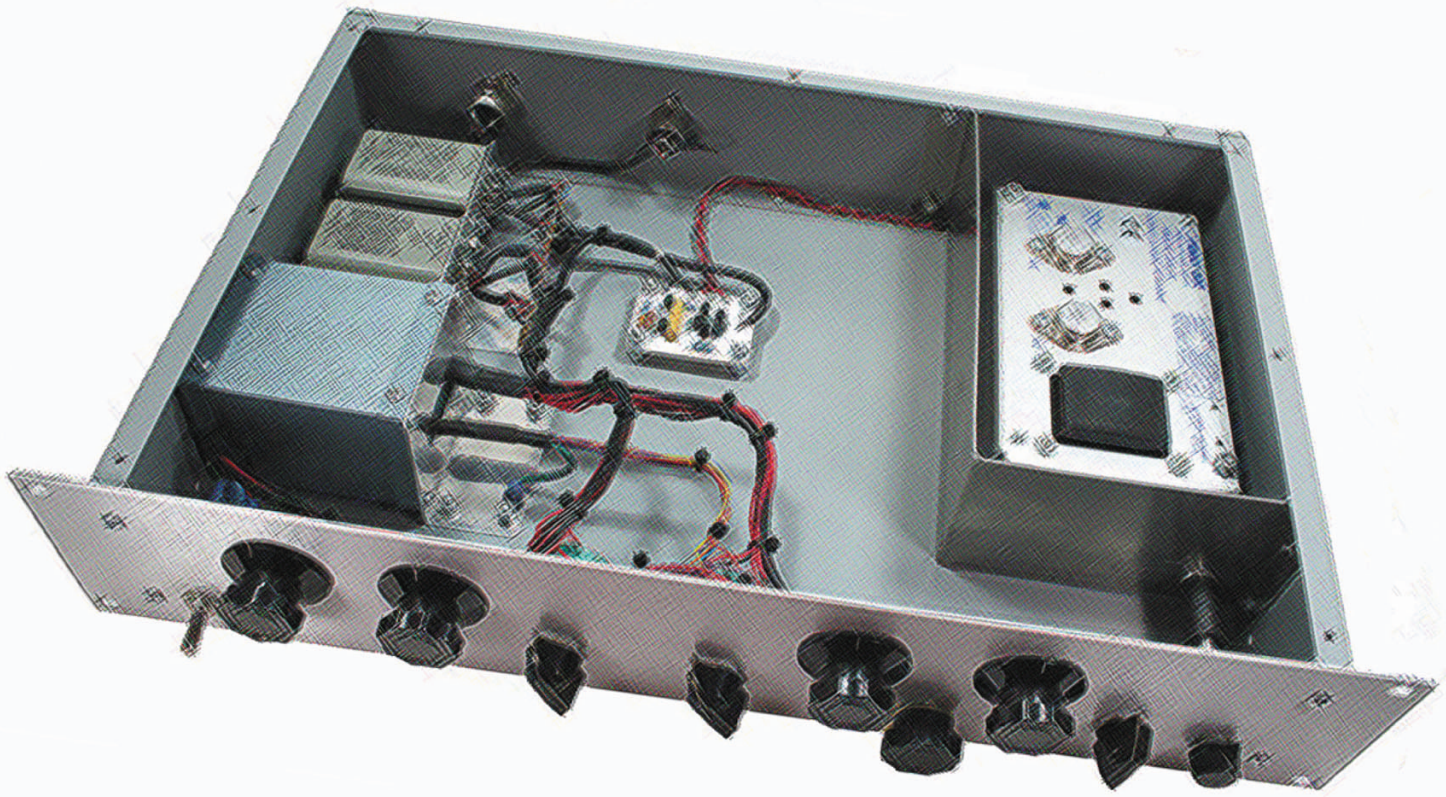
Building a Pultec EQP-1A3 Solid State Equalizer Clone

by C. H. Preston



The reputation of the vacuum tube Pultec EQP-1A is almost universal and it's the tube model that receives the most attention on the internet. That is too bad because the solid state version is just as usable and a much better EQ to consider for DIY. Here are just a few reasons for building a solid state unit: The transformers are cheaper and easier to find, the voltages are not lethal, it's less expensive to build, they sound great!

Vintage Windings

Hard to find stuff for cool gear

A Few Words

The information contained in this paper is offered to help the DIY proaudio enthusiast build a reproduction Pultec type equalizer. It represents the author's current understanding on the subject and is intended for experimenters with some electronics building experience. Although none of the voltages in the actual Pultec EQP-1A3 solid state circuit are high enough to be dangerous, the line voltages are, so care must be taken or serious injury can occur.

This building guide is yours free to download, copy and even pass around to friends. PLEASE do not host the paper on another website without the author's written agreement.

Several brand names are used throughout the text: ***Pultec, Peerless, Jensen, Lundahl, Sony***. They are the trademarks for their associated companies and the author has no affiliation with any of them.

A note from the author:

The information presented here was the best info available to me at the time of writing. I have done my best to insure the accuracy of the text. Much of the history regarding the actual people and companies involved is not a matter of written record. It has been my experience that when obtaining verbal history, the same story is often told with very different recollections depending on who you ask, even when interviewing a principle subject. I urge the reader to contact me at VintageWindings.com with informational challenges and corrections. C.H. Preston

Forward

In the world of DIY proaudio, sometimes it's easy to get in over your head on an audio project. The auction sites are loaded up with parts, once saved for the perfect recreation only to be let go because the project never materialized. The tube Pultec EQP-1A copy is an example of a project that many DIY people want to tackle only to find that it is a huge undertaking to actually complete. In the following text a solid state version of the Pultec EQP-1A3 is presented along with building details. This Pultec type model can be built in much less time and with less cost than it's tube counterpart. It's an easier build as well.

Thanks

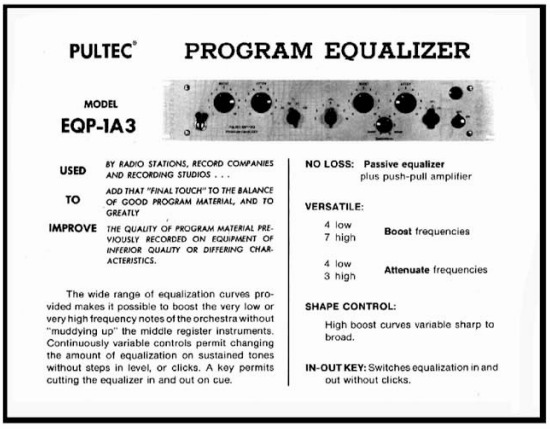
I would be remiss in my duty to not take a brief opportunity to thank the wonderful and unbelievably talented people who have helped me sort through the world of vintage audio. In the interest of space, the thought of forgetting someone, and avoiding gratuitous name dropping, I won't try listing my numerous mentors here. They know who they are and I thank all of them from the bottom of my heart for sharing their lifetimes of knowledge and experience with me. CP

Pultec EQ DIY
Building a EQP-1A3 SS

There is so much information regarding the Pultec EQP-1A equalizer out on the web these days it almost seems pointless to add to the pile. However, much of the info that floats around is no more than regurgitated myths passed and repassed by people who often have an a hidden interest in their perpetuation. While most aspiring Pultec fanciers feel that a tube Pultec is the holy grail, many seasoned audio engineers are just as happy to use one of Pultec's later solid state units.

Only one of the audio transformer types used in the solid state version is the same as the tube version (Triad HS-56V) and there are two of them. The solid state version used an API op-amp instead of a tube gain make-up amp. Both the SS and the tube unit sound great and are highly usable. In the larger picture the sound of these EQ's resides *mostly* in the passive filter circuit. The low end of the filter uses caps and the hi end uses a tapped inductor and caps. The make-up gain amp can be ss or a tube line amp, or, any quality low level amp. The input and output transformers are always important and the ones used here should be high quality. Unlike what you might read on various forums, there are no magic transformers. There are good ones and there are not so good ones. I make my Pultec type EQ's using good quality line transformers because if you're going to go the trouble of seeing a project through to completion, you can't get excellent results with the inferior parts.

What follows is a quick builder's guide to a very useful Pultec solid state EQP-1A3 type EQ. I'll show all of the parts that I use and make other part substitution suggestions along the way. This build uses a VintageWindings EQ-1A Complete Filter Unit (Figs. 1 ab). The VintageWindings EQ-1A has the entire filter circuit for the EQP-1A, including a beefy toroidal core inductor and capacitors enclosed in one Peerless style transformer case. They are very similar to the original units. The nice thing about using the VintageWindings filter unit is that it greatly reduces part sourcing which always adds considerable hidden expense to a building project. The build time is also reduced as all of the capacitors and coil are pre-wired.



PULTEC® PROGRAM EQUALIZER

MODEL EQP-1A3

USED TO IMPROVE

BY RADIO STATIONS, RECORD COMPANIES AND RECORDING STUDIOS . . .

ADD THAT "FINAL TOUCH" TO THE BALANCE OF GOOD PROGRAM MATERIAL, AND TO GREATLY

THE QUALITY OF PROGRAM MATERIAL PREVIOUSLY RECORDED ON EQUIPMENT OF INFERIOR QUALITY OR DIFFERING CHARACTERISTICS.

The wide range of equalization curves provided makes it possible to boost the very low or very high frequency notes of the orchestra without "muddying up" the middle register instruments. Continuously variable controls permit changing the amount of equalization on sustained tones without steps in level, or clicks. A key permits cutting the equalizer in and out on cue.

NO LOSS: Passive equalizer plus push-pull amplifier

VERSATILE:

4 low, 7 high — Boost frequencies

4 low, 3 high — Attenuate frequencies

SHAPE CONTROL: High boost curves variable sharp to broad.

IN-OUT KEY: Switches equalization in and out without clicks.

Pultec EQP-1A3 from 1969 catalog See page 18 for full view.

Fig. 1a The ***VintageWindings EQ-1A*** Complete Filter Unit consists of a shielded tapped toroid inductor along with the caps and resistors needed to complete the passive EQ circuit on page 10.

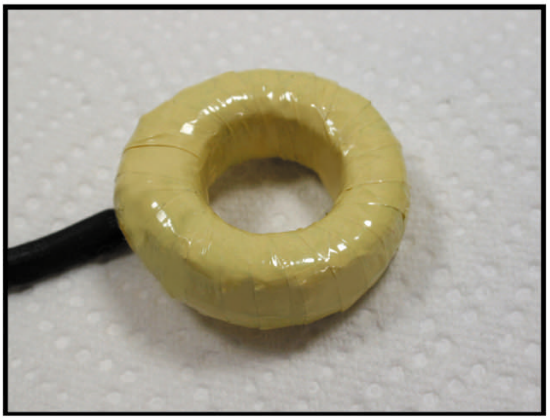
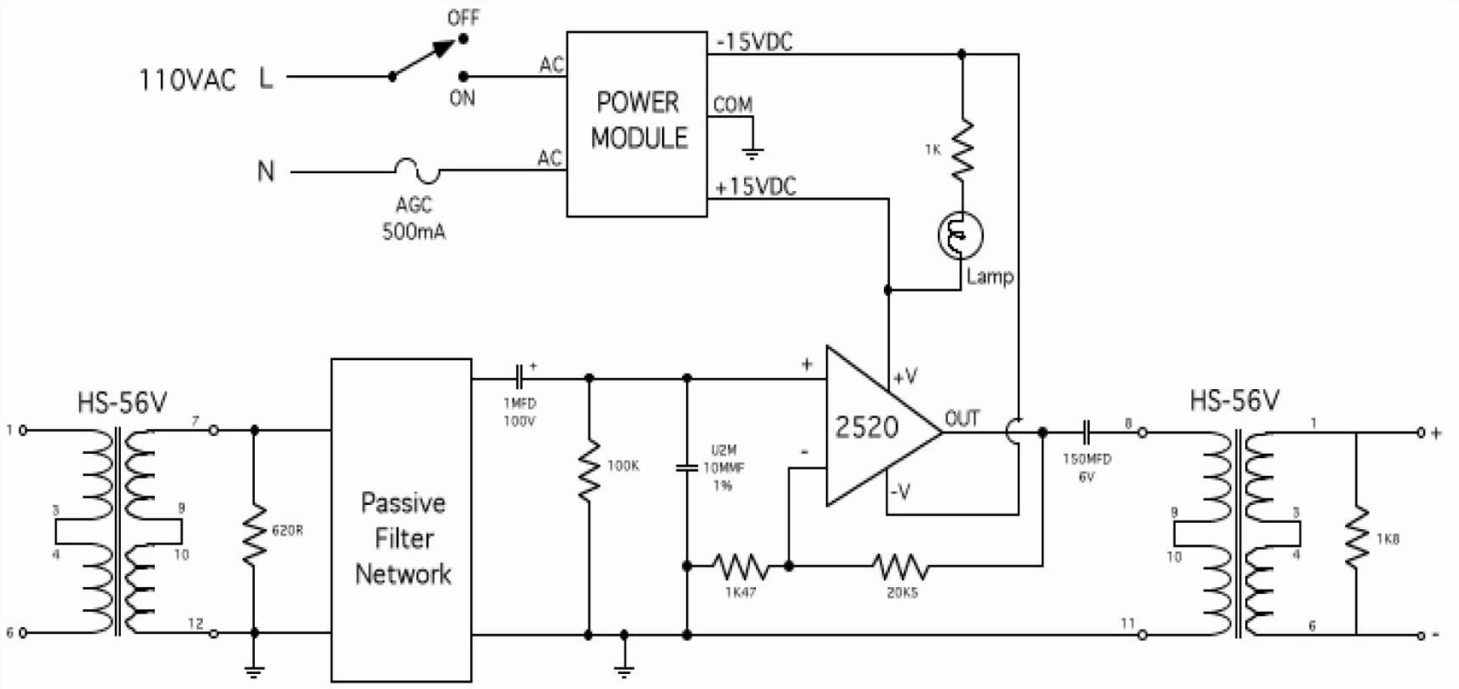


Fig. 1b The heart of the ***VintageWindings EQ-1A*** Complete Filter Unit. This tapped Toroid coil is also available separately.



Pultec EQP-1A3 Solid State - Schematic - The filter schematic is on page 10.

Every proaudio project starts with some choices. After determining what is going to be built, in this case a Pultec copy, you have to decide on what to build it in. Rackmount style cases are standard but that isn't the only option. These EQ's can be used in guitar preamps that can be built into amp heads. A rackmount case was chosen here because they are used universally in the studio and on stage. This solid state version will fit nicely into a two rack space case as original. I usually get my cases from Par-Metal (Fig. 2). I have no affiliation but the case quality is consistently good and the shipping is quick. The case used here is 11" deep because the enclosed filter unit doesn't take up a lot of room. I usually buy primed cases with aluminum faceplates and paint them to requirement. The XLR jack holes can be punched but a Dremel® jig saw can be configured to do a very nice job cutting various chassis holes. The ground pin (PIN 1) on the XLR's should be connected directly to the chassis with as short of lead as possible. After all of the necessary chassis holes and cutouts are complete the case is painted and baked. In this example I'm leaving the case it's original color and only labeling the faceplate. The gray color of the case will make the piece easier to identify from behind the rack it will be mounted in.

Fig. 2 Here is the case as it arrives from Par-Metal. Web forums are cost critical when it comes to rackmount cases. There are many steps needed to produce these and raw metal cost is at a high. This case was a deal at $55.00 + shipping.

There are ways to save money on a rack case. One way is to find an old piece of gear that hasn't retained it's value on one of the auction web sites. There are plenty of vintage audio units that weren't very good back in the day and many times they can be bought today for a song. A trip to the hardware store for a piece of aluminum plate for a new front panel and you have a cheap rack case. There are quite a few knobs and switches used in the EQP-1A circuit so it is probably best to stick with at least a two rack space case.

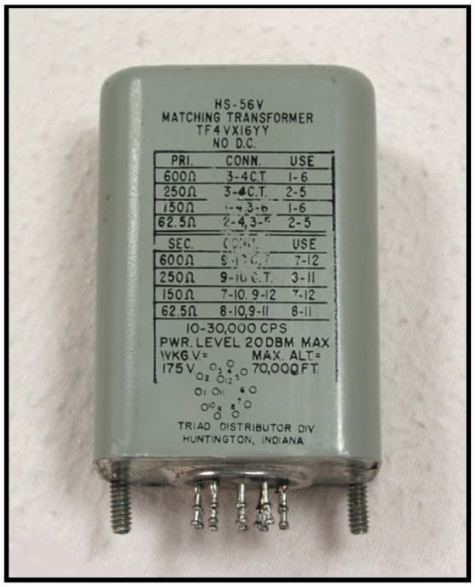


Fig. 3 The Triad HS-56V Used for both input and output in the original EQP-1A3 Solid State.

Fig. 4 The Western Electric 111C toroidal line transformer. Super overkill in this application but these make for a very nice sounding vintage EQ, a very heavy EQ that is.

In order to decide exactly how much room that you might need for a project case you really have to decide on all of the parts that will be used. Different transformers are different sizes. A Beyer peanut transformer is much smaller than a Western Electric 111C. Both will work. The 111C's will sound better and weigh a ton. I have built several of these copies using the original Triad HS-56V's (Fig. 3) for input and output transformers and several other types sound just as good. The 111C's (Fig. 4) sound great, Jensen and Lundahl line transformers are fine too. I like the transformers used in Sony 3000 series recording consoles and usually use a rewound version of those in my Pultec copies. The cores on the Sony transformers (Fig. 5) are large 50% nickel cores that make very high quality transformers when properly wound. One thing to keep in mind on the solid state EQP is that the output HS-56 is reversed and the op-amp is feeding the secondary at it's 250 ohm tap. That means that the output transformer is operating as a step-up transformer in the 1:2 range. Pultec used this arrangement on their stereo panner too. There is also feedback around the op-amp so if you don't use a transformer with a 250 or 300 ohm tap for the output, the gain and the frequency response of the unit will suffer so keep that in mind when choosing a transformer. The input on the EQP-1A3ss is the same as the tube unit using the HS-56 600:600 connections with the input going to the primary and the secondary going to the filter. It doesn't make a difference which direction the HS-56 is put in the line but it is important to make sure that the appropriate taps are used for optimum transfer of signal. The modified Sony transformers (not made by Sony) originally didn't have the proper taps and were only 1:1 transformers. That is one reason I rewind them. Another reason for a rewind is because they were originally wound with Litz wire resulting in many capacitive losses. The transformers are rewound using the early Peerless technique of winding both halves side by side like the primary of a K-241-D and include taps for other hookups. The result of all of the effort is a beefy line transformer with excellent performance.

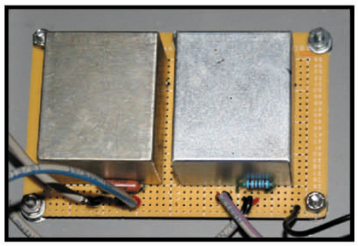


Fig. 5 Sony 3036 type transformers with large 50/50 cores.

Keep in mind that the Triad HS-56V transformer wasn't chosen because it's magic. It was pretty much the industry standard at the time. It used a standard M6 alloy core that wasn't very large. It's just a good quality, reasonably priced (used) transformer that is still relatively available today. The used price for an HS-56V is currently slightly less than they can be properly manufactured for today.

The only other remarks I can make about transformer selection is not to get caught up in the hype that exists on the various web forums regarding the magical nature of a relatively few transformer models. The truth is that some of the best music on the planet has been recorded with the signal going through multiple transformers of varying quality. A "special" transformer in one piece of gear is not going to make or break a recording no matter what the web heads tell you. Don't believe them for a minute. ***If you use quality transformers, modern ones included, and employ reasonable care in your build, you will be rewarded with a vintage style EQ that will bring a smile to your face every time you plug it in***. Don't mortgage the house and remember that you can always switch a transformer if you don't like it or can't afford the one you want. If you're building one of these EQ's into a guitar preamp you don't need any transformers.

Power Supply Considerations

Fig. 6 Power One HAA24-0.6-A power supply. It's fairly bulletproof and has good regulation. The voltages are also adjustable for rail balance.

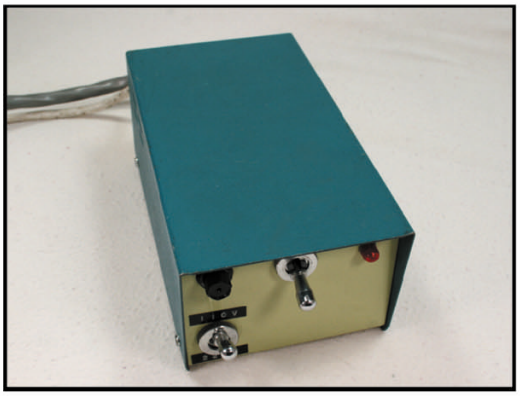


Fig. 7 This Neve +-24V supply would be an excellent external power supply. Other manufacturers made similar units. This model doesn't have as much regulation as the HAA24.

Another consideration when sizing a project case is the power supply requirements. This subject has been covered in a million forum threads so I'm not going the go into many details. My preference is not to place the power supply in the same case with the audio circuitry. Often a separate power supply (Fig. 7) is not feasible of just plain inconvenient. In this project the power supply is only there to supply a voltage to the gain make-up amp so the next decision is what to use for that. Originally the solid state EQP used an API 2520 op-amp. John Hardy 990's are top notch and are much cheaper to buy from him than to source the parts and try to make them as beautifully as he does. On this project I'm using a Fred Forssell designed op-amp that he has kindly posted on his web site. I simply wire these point to point on a little board and they sound great in everything I've used them in. If you dig around his web site you'll find other goodies as well. He has a 3 or 4 page paper posted regarding the building of the op-amp used here that helps greatly when building the amp. Forssell also sells an updated version of his 990 style op-amp.

The Forssell and Hardy type op-amps will operate at various voltages but I like to use +-24V for the response and headroom. The thing to keep in mind when choosing a power supply is that ***an amp or a preamp is only a control device for the power supply***. The power supply should have more output than you need and it should have as low ripple as practical. Again, Fred Forssell has another helpful schematic posted on his site for a +-24V power supply which can be built with added phantom power. However, I have a favorite power supply that I use on anything requiring +-24V which is the Power One HAA-24 (Fig. 6). I'm not sure if these are still in production but they can be found regularly on e-bay. They are fairly bulletproof, have very low ripple and are quiet when mounted inside a rack case. It is overkill in this application but the supply used here was only $30 and couldn't be built for twice that price by the time all of the parts are shipped. The HAA-24 is ready to use so that speeds up the build considerably.

Fig. 8 Here is a shot of the mains entrance. This technique is fully explained in John Atwood's article in VTV vol. 17. Highly recommended reading.

After making the concession of mounting the power supply inside the unit proper it's location and positioning should be considered. I have experimented with the HAA-24 power supplies and have found that when they are mounted as shown in the photos below that they are at their quietest position, so that is where I place them ymmv. When wiring up power to any project I employ the technique illustrated in volume 17 of Vacuum Tube Valley magazine in a nicely written John Atwood article called "A Philosophy of Safety for the Home Constructor". I have not seen that article on-line which is a real shame. It should be required reading for any audio experimenter. See Fig. 8.

In order to keep as much power supply noise as possible from entering the audio it's good practice to wall off the power supply with a shield (Fig. 9) and keep all AC voltage carrying lines away from audio lines. Wires carrying current are twisted. All grounds that enter or exit the case are shunted directly to the case right at the point of entry. A rotary on/off switch is mounted inside the power supply shield. Then a shaft is fabricated that the knob will attach to through the faceplate. Doing this means that no AC from the power lines is introduced into the rest of the audio circuitry as would be the case if a standard AC power switch mounted on the faceplate was used. For power indicators I use two 24V LEDs, one for each rail. In this circuit it's relatively easy to bring all circuit grounds to one location so that is what is done here. Star grounds have come under some forum scrutiny as of late but in this case it works nicely.

I like the HAA-24 0.6 power supplies because the gear in my studio is powered 24/7/365 and so far there have been no failures, ymmv. Whether you build a PS or buy one be sure to use good regulation. Some manufacturers are starting to use switching supplies.... not me. You can also tweek the output voltages on the HAA-24 to get a good match at the rails.

Note: You can use almost any good sounding op-amp as a make-up gain amp, even IC's, so your power supply requirements might be different with different op-amps. I have the same philosophy for op-amps that I have for transformers. A good quality one will work fine. A magical op-amp will not make a crappy song better no matter how magic it is. The reality is that there is not much sonic difference between ***quality*** op-amps, least of all anything that can be quantized into "good" and "bad" categories. As mentioned earlier the sound of these EQ's is derived mostly from the filter circuit so ***build more, worry less***.

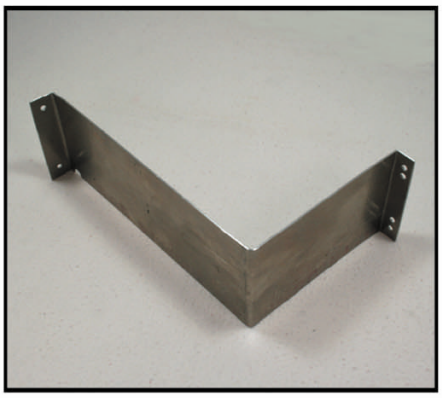


Fig. 9 Power One HAA24-0.6-A power supply. It's fairly bulletproof and has good regulation. The voltages are also adjustable for rail balance. The photo to the left shows the simple hand bent shield that surrounds the power supply. I have used these power supplies without the shield with no problems. The shield is used here to keep the AC to the power switch away from the audio circuit and is overkill. See Figs 18ab Page 15.

One way to keep building costs down is to set up an E-bay search sequence for the type of items you might need for building whatever project(s) you may be considering. For instance, knobs can get very expensive if you only look for them when you need them. You can get a deal on them by searching for them daily and buying the occasional good buys when they happen. It's the same with power supplies. Remember to get as many parts as possible from one source. ***If you have to pay a dozen shipping bills to get parts for a project, you can end up adding $100 to the final cost.*** That's experience talking.

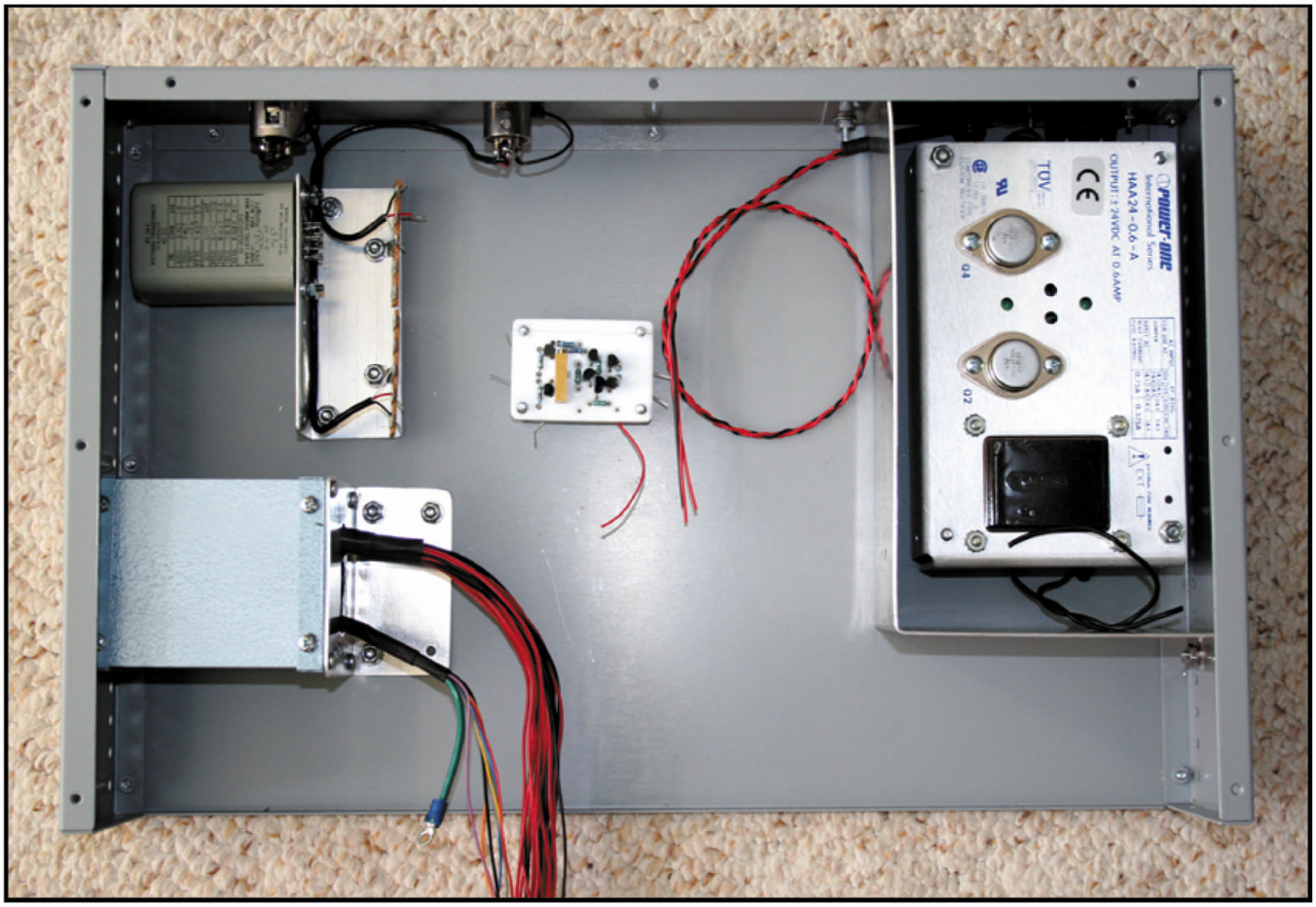
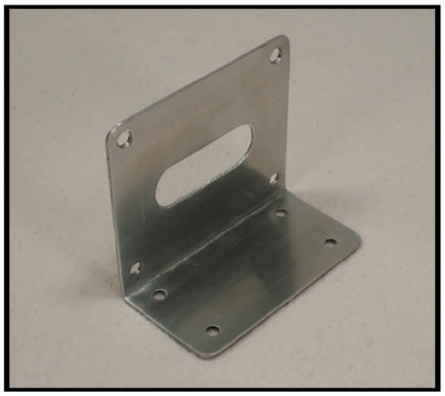


Fig. 10 Here is a photo of the general layout, less one of the transformers and controls. This is basically the whole circuit so as you can see these can be built into a smaller case. Western Electric 111C's would take most of the rest of the space if they were used. The rotary power switch will be mounted on the metal shield surrounding the power supply. That arrangement will keep any stray AC field from the mains out of the main case space. See Figs. 18ab.

The general layout for this build is in Fig. 10. As you can see I have fabricated brackets to mount the coil and transformers (Figs. 11 & 12). The brackets are a personal choice because I tend to over build. My background in live sound has brought me to some serious prejudices of how a product should perform and hold up under industrial use. I try to incorporate the experience gained fixing problems on the fly in live situations. I think a piece of professional gear should be able to take an 8ft. fall to a cement floor and keep working. I also think a piece of old world type gear (pre-surfacemount) should be on-site serviceable. With those requirements in mind components are mounted on simple standoffs and impact absorbing brackets. The power supply standoffs (Fig. 13) hold the PS a few mm's off the bottom plate. They were made with machine screws, locknuts, and ballpoint pen casings. The filter and transformer brackets were scrap pieces of aluminum that I had laying around the shop and bent by hand.

When working with metal, using less than ideal tools, it's best to work to scribed lines. Accuracy to a few thousandths of an inch is possible with hand files as long as you're working to a crisp scribed line. Also, be sure to remove any paint where ground connections are made to the chassis. Another part of my philosophy is that I don't have to make vintage units that look like exact copies. The final unit is my work and I don't mind it looking like my work. ***Worrying too much about matching aesthetics takes time, effort, and money away from the next thing.***



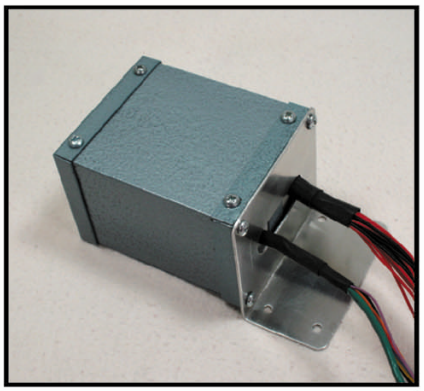
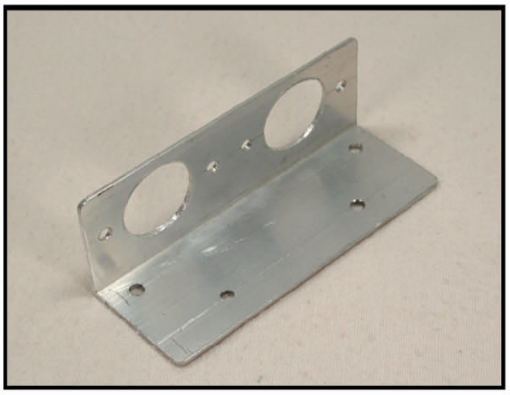


Fig. 11 Here are some shots of the simple metal brackets made from aluminum that was just laying around the shop. They were bent in a bench vise by hand.



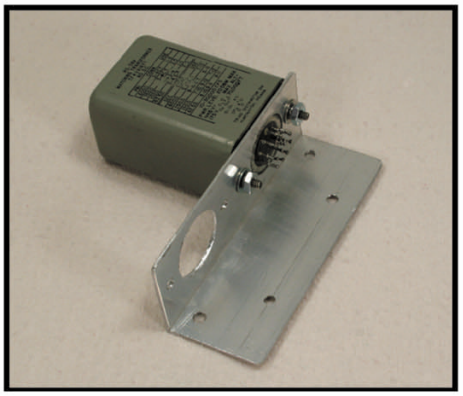
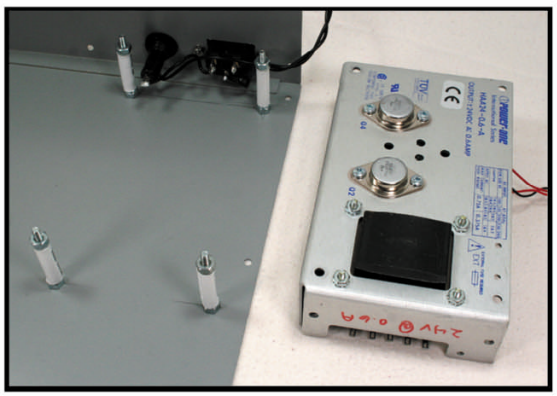


Fig. 12 The transformer bracket with one HS-56V installed. There was no real design intention here and no drawings were made. Form follows function.



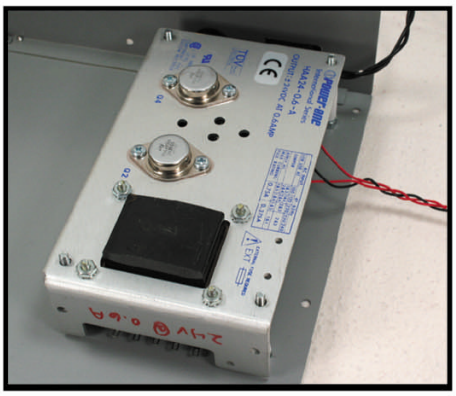


Fig. 13 Standoffs are used to mount the power supply. They were made with locknuts, screws and ballpoint pen casings.

Since I'm using a VintageWindings EQ-1A complete filter unit (Fig. 14) there is no need to source a whole lot of parts to complete the passive portion of the EQ. The switches are Electroswitch brand switches available at Mouser Electronics (details on next page). The models used here are the ones with the user selectable number of positions. The switches used should be of the ***make before break*** variety or there will most likely be audible clicks during frequency switching. Many builders have favorite types for switches and pots, I'll just say that if you go through all of the effort of building a piece of gear, skimping while trying to save a few bucks on the few parts that you need can seriously handicap the results.

If this unit was being built for studio use only I would consider not placing the VintageWindings EQ-1A unit inside the case. It could be mounted on the back of the case like the original. The toroidal coil inside has it's own shield and the case provides more shielding so there is no problem with an exterior mount. This particular EQ may find use in my one of my live racks and I like the back panels of the equipment in the live racks to be as uncluttered as possible. In this build the EQ-1A unit will be mounted inside the case.

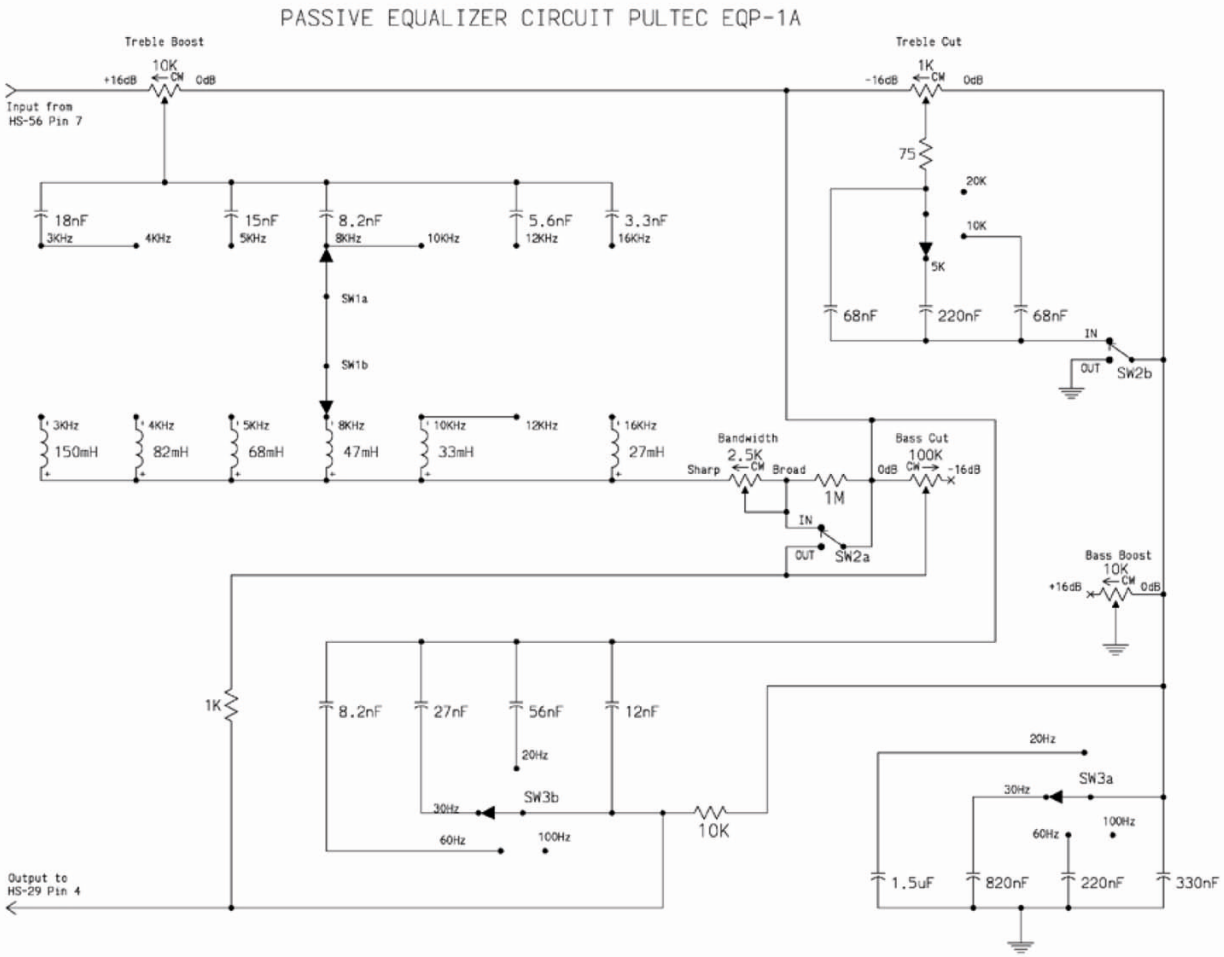


Fig. 14 Here is a schematic of the original EQP-1A filter circuit. The VintageWindings complete filter unit has all of the capacitors and resistors used in the circuit. Only the actual controls (pots and switches) are required to complete the passive portion of the filter. Obviously, the filter unit can also be built up from individual components. There is a great web site with a capacitor parts list for the tube model here: http://www.recproaudio.com/diy_pro_audio/pultec_eqp1a.htm. Remember the filter unit is the same for both models (except for very, very early EQP-1A's). High quality Cornell Dubilier poly caps are used in the VintageWindings EQ-1A unit. Also keep in mind that one wholesaler might not have all the types of caps needed for a complete filter and shipping for multiple parts orders can really add up. The toroidal coil used in the VintageWindings EQ-1A is also available separately.

Parts

Here are the actual part numbers for the switches and pots used on this project. I order from Mouser because it's convenient and they usually have all the parts I'm looking for. These are Mouser part numbers.

Part:	Mouser Part No		Cost (2010)
Rotary Switches 02-12POS/1P/1 DECK	690-C4D0112N-A Mfr. #: C4D0112N-A		$10.30
Rotary Switches 02-12POS/2P/2 DECKS	690-C4D0212N-A Mfr. #: C4D0212N-A	(2) $14.18ea.	$28.36
Panel Mount Potentiometers Linear 2.5K	31VA303-F Mfr. #: RV24AF-10-15R1-B2.5K		$1.40
Panel Mount Potentiometers Linear 1K	31VA301-F Mfr. #: RV24AF-10-15R1-B1K		$1.40
Panel Mount Potentiometers Linear 10K	31VA401-F Mfr. #: RV24AF-10-15R1-B10K		$1.40
Panel Mount Potentiometers Audio 100K	31VJ501-F Mfr. #: RV24AF-10-15R1-A100K		$1.40
Panel Mount Potentiometers Audio 10K	31VJ401-F Mfr. #: RV24AF-10-15R1-A10K		$1.40

There are a few other components needed to complete the makeup gain circuit. One of those parts is a ***10MMF capacitor***. MMF is another way to write ***pico-farad***. The Pultec Panner used a similar output setup that didn't use the 10MMF cap. It can be eliminated but they are not that hard to source.

The input cap is an ***electrolytic 1uF 100V CD*** with the positive terminal going to the op-amp.

Next in the signal chain is a ***100K ohm resistor*** between the input rail and ground.

The ***op-amp*** itself (see text page 12)

The original units used a ***150uF 6V electrolytic cap*** at the output before the transformer. The cap was placed with it's positive terminal going to the output transformer. This cap should be of good quality. I have used a very high quality 10uF non-polarized audio cap here with good results, yrmv.

The input impedance of the passive filter portion of the circuit is set by the ***620 ohm resistor*** between pins 7-12 on the transformer (input to ground).

The feedback ***resistor*** is a ***20.5K ohm*** with a ***1.47K ohm resistor*** going to ground.

There is also a ***1.8K resistor*** loading the output of the output transformer.

As was mentioned previously I use a ***rotary on/off switch*** which is actuated by a rod which protrudes through the faceplate. This setup keeps any AC inside the power supply shield. The rotary switch is a standard appliance switch because they are designed to stand up to thousands of cycles. See page 15.

The resistors can be 1/4 watt but I use 1/2 watt metal film or even wirewounds. Resistors are inexpensive so I don't mind using good ones. Some purists will only use NOS carbon resistors, whatever floats your boat.

The Op-Amp

Op-amp choices were previously covered so I'm just going to touch on some of the details of the Fred Forssell designed gain amp that I'm using here (Fig. 15). It's made from very low noise JFETs and although they are no longer produced by the original manufacturer, they are still readily available. A schematic for this amp is downloadable from Forssell's informative and resource rich web site: www.forsselltech.com . I build the amp on a Teflon board which is more overkill but I have a supply and it's very impact resistant. I think I landed on a PC board layout posted on the internet for this amp so a Goggle search may bring that up. I can point to point wire these in about 30 minutes so I don't bother with a PC board. Using this op-amp for this one off project is fine but if I was considering producing this unit commercially I would not build the amps (unless of course I licensed the design from Forssell). I would use a current John Hardy 990 or a Forssell built 990 (990 being used more as a generic term for the Forssell amp). Both are beautifully made op-amps. Don't forget about API 2520's either. They are available used and new. If you use an op-amp with a standard footprint you can mount it in a socket for auditioning purposes.

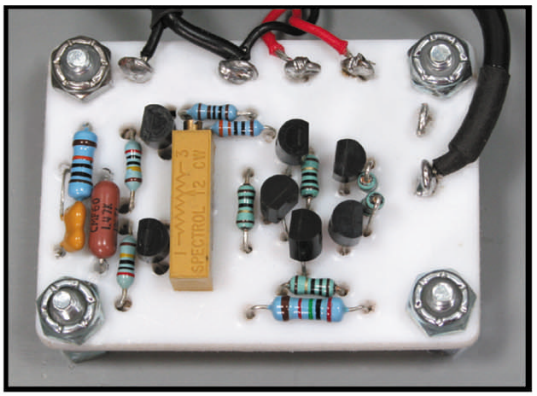
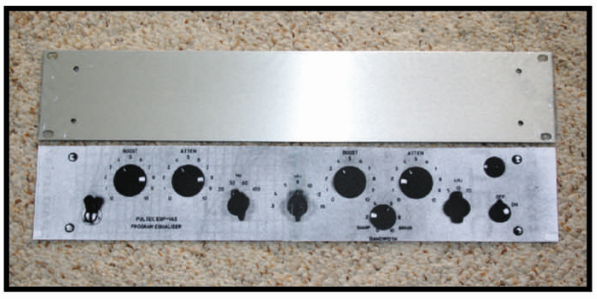


Fig. 15 Here is a closeup of the Forssell designed op-amp built from the schematic and paper posted on his site. The Op-amp schematic is here: www.forsselltech.com/downloads/schematics/Class A JFET Opamp.pdf and the 3 page white paper regarding it's assembly and use is here: www.forsselltech.com/downloads/design_discussions/JFET Opamp.pdf . The paper explains which type of 2SK170's should be used in which position on the schematic among other things and is definitely worth the read. This is a non-inverting op-amp so it will directly replace the 2520. One might consider a Hamptone single ended JFET op-amp which is an inverting type op-amp. In that case a provision should be made to keep the signal polarity consistent input to output. The Hamptone only requires one 24V rail instead of the +-15 to 24V for other op-amps.

The Faceplate

Laying out the faceplate was easier than it looks (Fig. 16). This being the age of technology I simply scanned the catalog page with a photo of the solid state EQP-1A3 at hi-res. I carefully cropped the face of the unit to it's outer edges and sized the remaining photo to 19" (rackmount) wide. Next, I divided the resulting photo in half and cut and pasted both halves side by side on one page. All that was left was to print the page, cut out the halves, tape them together as one panel, and the final template fits the faceplate perfectly. I located the centers using the template and punched/drilled the holes ***noting that some of the control shafts are of varying diameters*** (experience again).



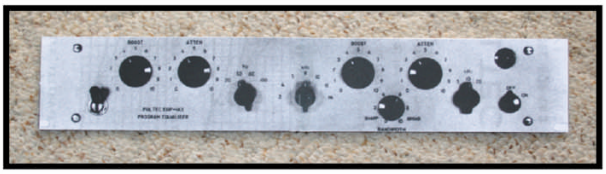


Fig. 16 The faceplate layout obtained from a scan of a photo as described in the text. The result fit the plate perfectly. See last page of this document for template.

Fig. 16 The faceplate during assembly. Here the knobs were being tried for fit. The Daka-ware knobs are slightly large for a two rackspace unit so I decided to use chicken knobs for the switches because they are slightly smaller than the original switch knobs. I haven't installed the power LED's yet because I was waiting for them to arrive. Note: later solid state EQP-1A3's had top hat knobs.

Another benefit to this method of panel layout is that the final template can be scanned via ScanPro into DesignCad and a CNC file can easily produced that an engraver can use to ledger the panel. Professional looking panel labeling is one of the more difficult tasks for the DIYer to pull off successfully. Press type is very difficult to set up properly, especially when trying to create even, circular control scales. Press type also has to be clear-coated so it won't wear off and most clear coats will attack the lettering. Engraving is a fairly common way to ledger a panel. The problem with engraving is that one off projects tend to be very expensive to contract and you're not really sure how it will end up looking in the end. While unlabeled panels might look nice and clean, it's not a very practical solution to the dilemma. After doing a bit of searching on the web, a few other possibilities including printing full panel graphics layovers and the old standby, silkscreening are suggested. Any of these options can end up being the most difficult part of the project to finish.

Here is a suggestion that I have not seen offered in the past. How about a set of rubber stamps? They are cheap to have made and re-usable. One stamp would have a 1-10 semi-circular pattern for the potentiometer scales. This stamp could be used on any project that used knobs of similar size. It would have an indexing plug in the center that would slide into the potentiometer hole and it would also need an indexing line to assure correct centering of the scale. The other needed stamps could be prepared the same way, unfortunately, those would be made specifically for this project (and the tube version). After doing a little price comparison on the net I found that I could get all of the needed stamps for this model for about $80. That sounds a bit high but they should be able to be used on many faceplates if the need arises. Some of the ordered stamps were just text, those were fairly inexpensive and although I probably could have used one of the rollable text rubber stamps, I thought the text might be cleaner with a dedicated stamp. The price was right in the ballpark with engraving. I'm holding off on labeling this unit to see how the stamp idea works before giving up and taking my CAD file to the engraver....

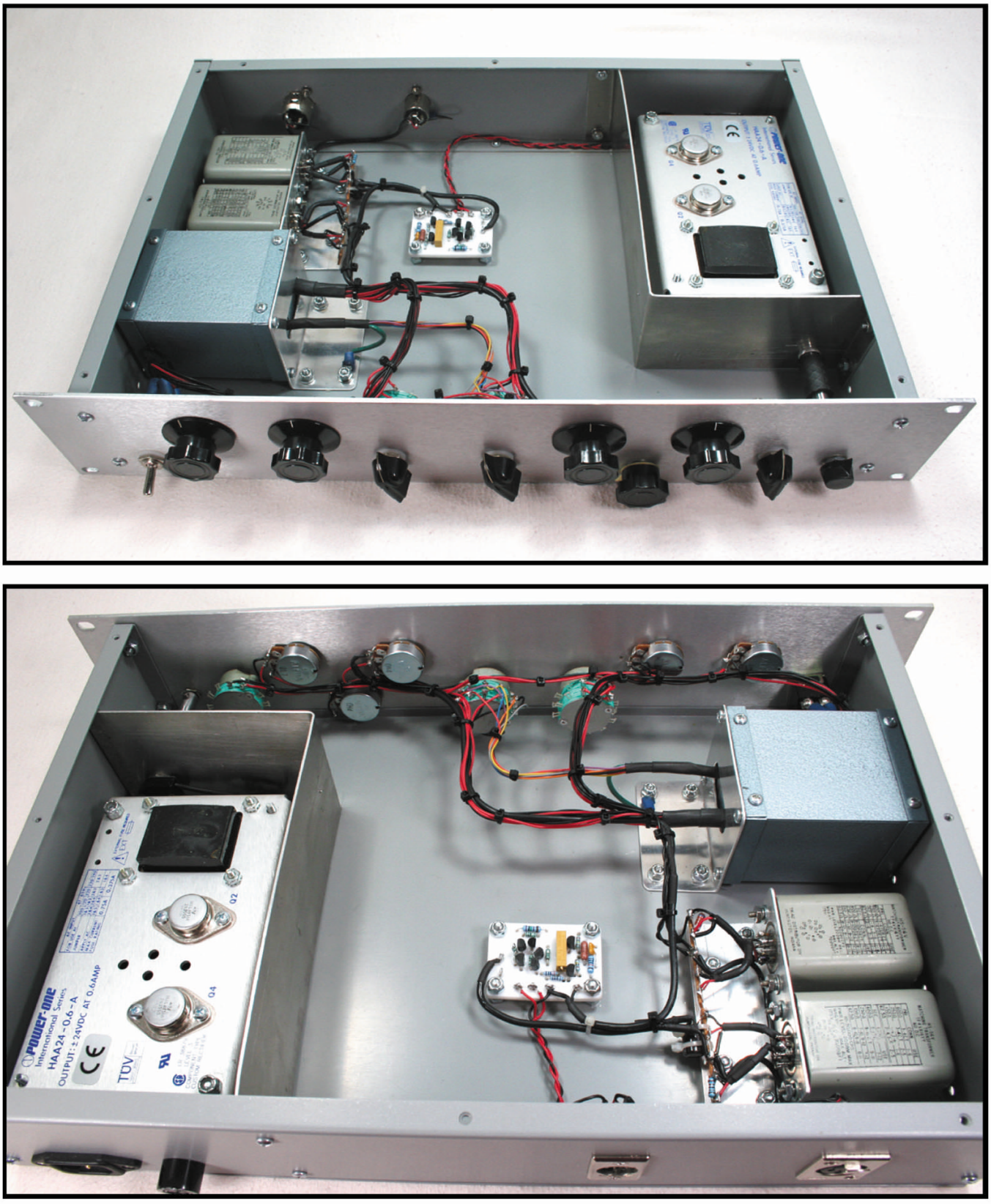
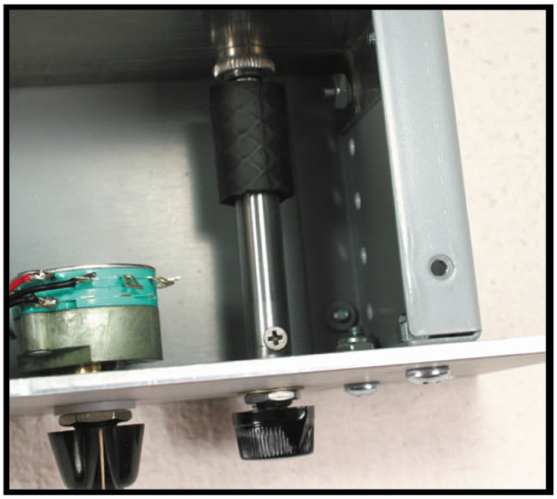


Fig. 17ab Here is the almost completed unit ready to test. At this point I was still waiting for the LED power indicators and the labeling stamps so that work is left to be done. As you can see by the photos the wiring had been kept as short and direct as is reasonably possible. The transformers are wired to terminal strips for easier access. If you leave a tangled mess of wires inside your case finding a problem down the road becomes a nightmare. If you would like to see how a real master EE wires up a rack case you will find some nice photo examples at my good friend Brian Roth's web site: www.brianroth.com. He does some of the cleanest wiring that I've ever seen.

Figs. 17ab show the almost finished unit as it's ready for testing. There are couple of final issues to cover but everything is there that is needed to plug it in and run a signal through it. The VintageWindings EQ-1A unit makes wiring the unit up quite easy. ***The EQ-1A comes with a wiring diagram and all of the leads from the EQ-1A unit are clearly labeled***. Only the few parts supporting the op-amp (see schematic page 4) are needed. I have placed those parts on my op-amp board and at the terminal strips.

At the end of a project nothing is more disturbing than plugging it in, turning it on and hearing absolutely nothing come out of the monitor, until that is, you run a signal, and out of the silence comes beautiful clean sound. This unit is quiet! I have already built several so I already knew they sounded great but it always feels good to build something that works better than something you could buy.



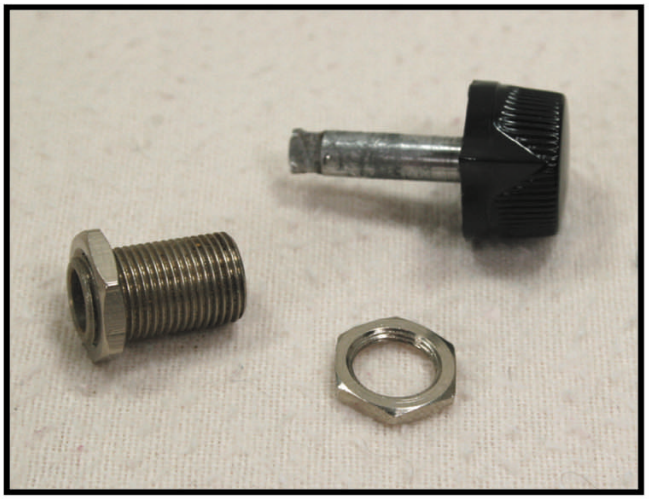


Fig. 18ab Here are a couple of shots of the on-off switch arrangement. This setup keeps the AC that would be going to the power switch, if it were mounted on the face, inside the power supply shield. For the bushing through the plate I used a long neck potentiometer shaft that was cut off from a pot. Then, I yanked a long shaft out of another old pot. Next, a hole was drilled in the end of a 1/2" metal rod to accept the pot shaft, another hole was drilled and tapped for a retainer set screw. I cut the 1/2" rod to length and placed a piece of fuel line at the connection to the switch. This arrangement is solid and effective. When the leads for the LED power indicators are brought out they will not carry AC. They will be run off the +- rails.

Erratum

One thing that you might consider changing on this build is the potentiometer selection. I used rather inexpensive pots that I have had good experience with in the past. If you are intending to use Daka-ware type knobs you may want to choose pots with longer shafts as the ones specified in the text are a little too short for a comfortable fit with Daka-ware knobs. The original manual for the EQP-1A lists the pots as either Allen Bradley or Ohmite types. I should also mention that the EQP-1A3 two space model was first released still using the tube make-up amp. Some early EQP-1A3's used Daka-ware knobs like the EQP-1A but by the time Pultec switched to the solid state model they changed the knobs to top hat style knobs which have that cheap 70's look. In fact, the top hat style knobs are cheaper to source and correct to use. Mouser Electronics stocks top hat knobs. The Daka-ware knobs can cost up to $25 each today so maybe the top hat knobs don't look so bad.

The original tube gain make-up amp was balanced (push-pull). The solid state versions used a single ended type op-amp. An excellent solid state replacement candidate for a balanced amp would be a Langevin AM16. I haven't built one using the Langevin amp but those amps sound very good and I suppose would work nicely in the Pultec circuit.

Pultec EQ DIY
Myths and Mania

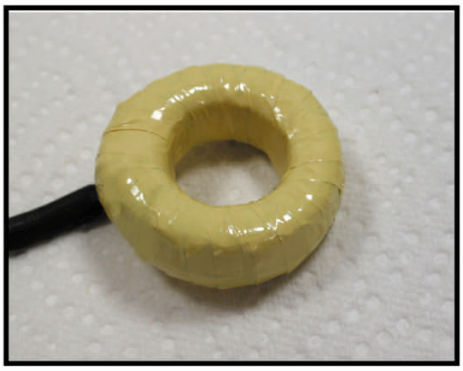
Since there is so much extraneous information out on the web regarding the original EQP, I thought I would conclude with some personal observations. None of the materials used in the Pultec equalizers were chosen by engineers because they had magic. Pultec used many surplus parts. The Peerless S-217-D output transformers were used because Pultec got a deal when they bought a quantity in surplus! I have only been able to closely examine the inside of two filter units, an earlier one, but still a single tapped inductor, and a later one. The early one had a beautifully wound inductor, correctly wound to original Western Electric toroidal protocol. By that I mean that all taps ended at one point on the toroid. In other words, to correctly engineer these inductors the rotation speed of the core changes with the number of turns needed to complete a tap. If there are too many turns on one tap to wind in one 360 degree core rotation, the number of winds is divided evenly on two or more layers. All taps start and stop at one spot on the core. Western Electric pretty much wrote the book on toroids. The idea was that each tap of the coil would evenly charge the full core.

The second Pultec filter that I had an opportunity to examine was a later one and the inductor looked like the cheapest of cheap. It looked as if were wound by monkeys and the taps exited all over the core which has the effect of reducing the Q of the coil. The higher the coil Q, the closer to ideal the filter becomes so reducing the Q is not a good idea. In the interest of disclosure I did not have a chance to 'hear' either dissected filter in a working unit.

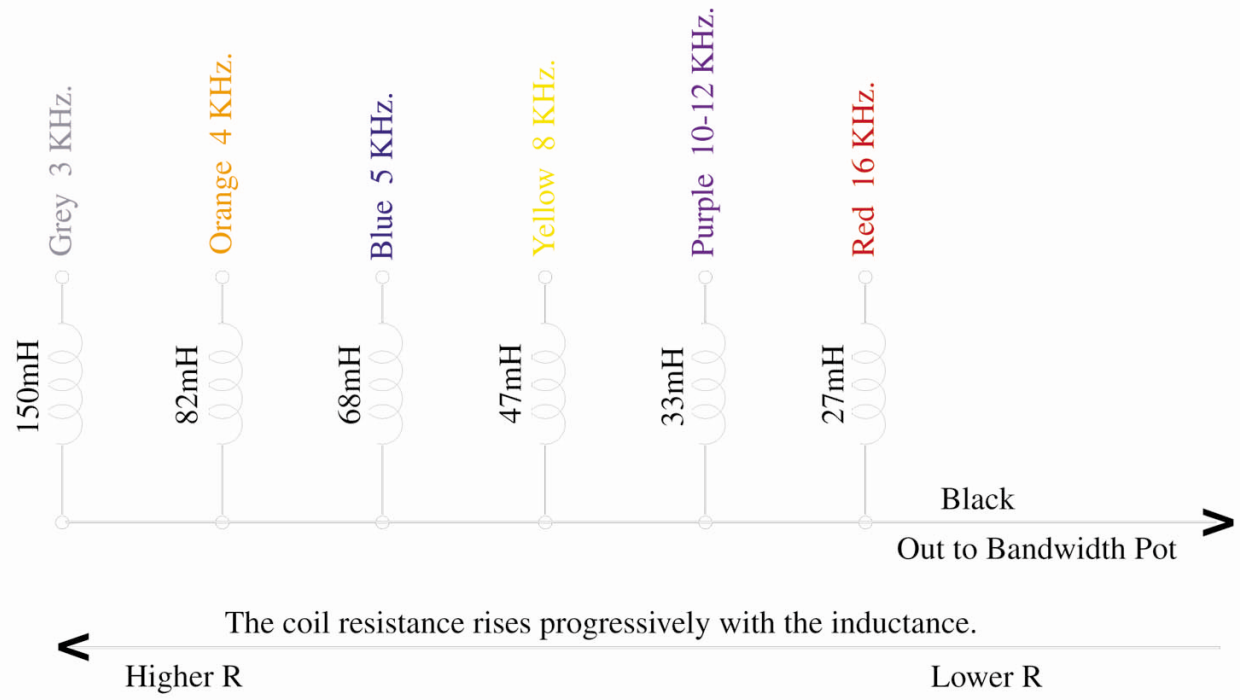
Capacitors - both units that I examined used blue/green Cornell Dubilier poly (I think, except for the name there were no markings) caps. These are the same caps that Peerless used in their telephone equalization units of the same period. (17249 toroid filter). I have been told by some smart people in the know about EQP's that some used paper and oil caps. I see many posts on the web regarding the mythical sound of the Pultecs being *old caps*. More magic hogwash. Sooner or later almost all types of caps deteriorate, and if old caps used in Pultec EQ's have deteriorated into magic, this means that, by definition, they will keep on deteriorating, into what next, heaven? If you start with old caps, they don't have anywhere to go but south. The optimum capacitors for LC filters are polystyrene and polypropylene (Williams, Taylor). I recently built a filter unit using custom made paper in oil caps but have not auditioned it at this writing. I'm simply tingling with anticipation. Capacitor manufacture is one thing that has improved over time so new productions of most types are generally better than their ancestral counterparts. New caps probably aren't magic though...

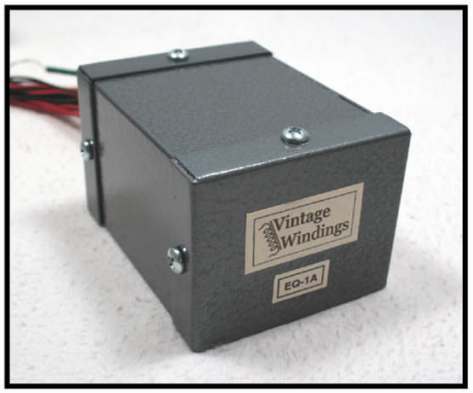
A final thing to keep in mind is that while many of the Pultec's virtues are self evident, some claims should be considered from their source. Myths are often perpetuated by people who have a vested interest. Some manufacturers will claim that their new EQ version is "better than the original" while vintage dealers preach that the "golden era of sound is dead" and "only the old ones can sound good". Then there is the studio owner who spent a fortune on a pair of EQP's in the hope that they would bring customers through the door. ***Many opinions regarding sound have nothing to do with what hits the ears.*** Great sounding gear is still made today and the better it is, the cheaper it isn't! I can't stress enough that no magic box will make bad music good. By using good quality components and reasonably careful building techniques you can produce an equalizing tool that really pays it own ticket. Like any good audio gear, it's sound will get better with age and the more it's used.

Vintage Windings®



Toroid Inductor Replacement for Pultec EQP-1A, EQP-1A3 Equalizers





Also avaialable as complete filter unit including all capacitors housed in an Altec/Peerless style case.

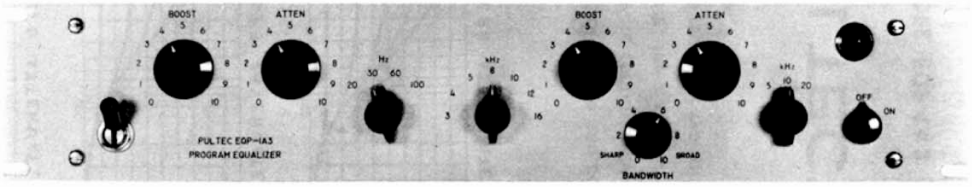
The VintageWindings EQP-1A Toroid Inductor is a replacement for the later original inductor used by Pultec on their famous EQP-1A Equalizers. The first Pultecs used a pair of toroids which were switched in and out of the line to make the proper impedances. Shortly after it's introduction Pultec changed the inductor to a single tapped inductor such as this one.

The shorter bare wire is the μ metal shield ground and it should be connected to the chassis with as little distance between the coil and ground as possible.

PULTEC® PROGRAM EQUALIZER

MODEL

EQP-1A3



USED *BY RADIO STATIONS, RECORD COMPANIES AND RECORDING STUDIOS . . .*

TO *ADD THAT "FINAL TOUCH" TO THE BALANCE OF GOOD PROGRAM MATERIAL, AND TO GREATLY*

IMPROVE *THE QUALITY OF PROGRAM MATERIAL PREVIOUSLY RECORDED ON EQUIPMENT OF INFERIOR QUALITY OR DIFFERING CHARACTERISTICS.*

The wide range of equalization curves provided makes it possible to boost the very low or very high frequency notes of the orchestra without "muddying up" the middle register instruments. Continuously variable controls permit changing the amount of equalization on sustained tones without steps in level, or clicks. A key permits cutting the equalizer in and out on cue.

NO LOSS: **Passive equalizer** plus push-pull amplifier

VERSATILE:

4 low, 7 high — **Boost** frequencies

4 low, 3 high — **Attenuate** frequencies

SHAPE CONTROL:

High boost curves variable sharp to broad.

IN-OUT KEY: Switches equalization in and out without clicks.

Specifications

PEAK BOOST: 3, 4, 5, 8, 10, 12, 16 kHz; 0 to 18 dB.

SHELF ATTENUATE: 5, 10, 20 kHz; 0 to 16 dB.

SHELF BOOST: 20, 30, 60, 100 Hz; 0 to 13.5 dB.

SHELF ATTENUATE: 20, 30, 60, 100 Hz; 0 to 17.5 dB.

NOISE: Below −80 dBm.

DISTORTION: 0.15% at +10 dBm into 600 ohms.

TUBES: One ECC-82/12AU7 and one ECC-83/12AX7.

DIODES: Two 1N1731 silicon diodes.

PANEL SIZE: 3½ x 19 in. Depth behind panel is 7½ in.

PANEL FINISH: Brushed aluminum satintone.

MOUNTING: Standard EIA rack mount.

LOSS: None. Equalizer loss is restored by amplifier. Over-all result is no loss and no gain.

INPUT LEVEL: −20 dBm provides greater than 60 dB signal to noise ratio. +4 dBm allows generously for signal peaks without clipping.

INPUT TRANSFORMER: 600 ohms, matching. Connections can be changed for 250 or 150 ohms.

OUTPUT TRANSFORMER: Feeds a 600 ohm load. Connections can be changed for 250 or 150 ohms.

AMPLIFIER RESPONSE: 20 Hz to 20 kHz; +0, −1 dB from 1000 Hz reference.

POWER REQUIRED: 117 volts, 50/60 Hz, 20 watts. 234 volts, 50/60 Hz available on order.

NET WEIGHT: 12¾ pounds.

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