Gibson's *Edwin Wilson* on reissue Bumble Bees

In 2004 the following letter from Edwin Wilson the program manager of the Custom, Art & Historic Division at Gibson which was posted at:

www.gibsoncustom.com/bumblebee/index.htm
(clicking this link will not work, the document was removed long ago)

while the letter is long-gone from Gibson's website, when it was posted it sparked much discussion on the forums as to it's accuracy and the relevant info it communicated some of which is saved here with some additional information from Wesco the manufacturer of the re-issue capacitors.

The Letter...

I am writing this in response to some concerns on both the UNOFFICIAL LES PAUL FORUM and the Gibson Custom Shop Forum about our Bumble Bee capacitors and their authenticity, construction, specifications and the approach to reissuing any hardware on Gibson Historic Products.

First of all, to all those that are experts regarding capacitors just work through the first part of this with me because there are so many people that I have heard toss around descriptions like ceramic, oil filled, foil, mylar,teflon, and paper I feel a little general information is necessary to clarify. The actual definition of a capacitor is: An electronic circuit element used to store charge temporarily, consisting in general of two metallic plates separated by a dielectric. One of the main differences between the various styles of capacitors is the dielectric medium used. In a ceramic capacitor the dielectric is ceramic. The parts used in this style of capacitor consist of the metal plates which have the solder leads attached to them and the dielectric which is ceramic. This is also the most inexpensive capacitor available with the poorest ability to hold a charge. The next one is a mylar capacitor. With this one, it also consists of two metal plates which are the points that you solder and the dielectric which in this case is mylar. The capacitor with the highest quality material and performance is a teflon capacitor.

Original BumbleBee leads

Reissue bumblebee leads

Typically this style is used in higher end custom audio applications where exacting tolerances are necessary. If you go back to the days of antique radios, you will notice some of the first capacitors were oil filled capacitors. With this style capacitor it consists of two conductors which are the metal plates and the dielectric material which is oil. Typically these parts had a metal can around them so that the oil would be contained. There were many materials used as the dielectric material including

paper and foil. As many of you know also on any old electronic part the variations in different tolerances were much greater than now. What was considered a high quality part in the 40's and 50's was a variation of +/- 20%. By today's standard that is totally unacceptable. Once again the bottom line is the metal plates generate a charge when a signal is sent into them and the dielectric material holds the charge and releases it on a constant. So with all of that said let me get into how this project was approached.

So many times when I R & D parts or models for reissues I get assistance both positively and negatively from many sources and all input is appreciated. But in addition to this input I also have access to a vast amount of engineering documents,blueprints, and purchasing records dating back to the '40s, '50s, '60s etc. So many times when it appears that someone at Gibson has not reissued a part or a guitar to a particular individual's idea of what it should be, the closest most realistic information from a manufacturing standpoint is the documentation that we used to make the parts/guitars originally (even though sometimes there are variations between what the blueprint says and what the part ends up looking like).

Original bumblebee foil

Reissue BumbleBee foil

When I started this project I contacted Sprague (the original manufacturer of Bumble bee capacitors), and got as much information from them as I could. Next I went to our purchasing records and searched until I found the vendors that were the distributors and actually sold Gibson the parts. On these documents I found not only the vendors names but also the exact description of the parts and the specifications. Next I went to see if there were any blueprints but I did not have much luck there. Oh one other thing I forgot to mention one of the things I keep in my possession here at the Custom Shop are many original pickup, control assembly, and pickguard sample parts from as far back as the 40's including an original Double 12 wiring harness dated on March 1958 on the inventory/tracking tag.

So once I found a vendor willing to listen to my request I sent him 5 original Bumblebee capacitors to run tests on with the specifications from my purchasing records. Once he ran the tests he informed me that to a degree there was a varied range of the voltage and capacitance. Two of the capacitors read exceptionally high indicating some kind of breakdown within the dielectric material (foil).*
**WESCO*

Three of the capacitors were right on with what I had found in our records and with what the capacitor was supposed to be spec wise according to the color bands on both the original and the new. It was very easy to see but we still ran the test to make sure the color bands were actually what the part was. For those of you who do not know how to read the color bands on a capacitor, (it is different than a resistor), I have attached a sheet explaining. Next I discussed the actual construction, material and dimensions. I wanted the wire size on the leads, shape, color bands, tooling marks,color and all to be as close as possible but most importantly it had to be a foil capacitor with a dielectric at least comparable to the original brown craft paper and the specifications had to match the original bumble bees. On the reissue bumble bees the dielectric material we ended up going with was a poly film that exhibited the same properties as the craft paper did. This decision was made based on numbers and manufacturing issues. It is simple math, if one material conducts at a certain rate then if you find another comparable material and make the necessary adjustments be it in size, thickness, or turns the you end up with the same desired result. On the first

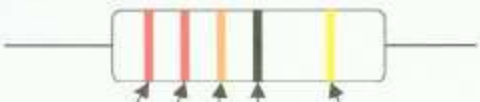
samples they sent me they were plain without the shell just the foil and leads showing so that I could approve the construction. Next came the outside shell with the color bands and tool marks. Finally came the finished part.

I did not take these and x-ray them but as with all good R&D'd projects, there are sacrifices. So attached I have put some of the tech sheets from my vendor for you to read over, along with some detailed pictures and my measurements I took of an original bumble bee I took apart and some other ones of a recent new reissue bumble bee's so that everyone is very clear that this is not a ceramic capacitor in a nice package but truly a foil capacitor, like the original bumble bees, in an injection molded case, like the original bumble bees.

Earlier on in this I said I appreciate all input and I do; it helps all of us at Gibson make better decisions about the product. But I still find it amazing that some people still think that someone is out to get them. I remember '80s Les Pauls that were not even the right shape, had the wrong necks, peghead shapes, routes, made from African Mahogany not even the same species, wrong binding size, wrong hardware and at that time this is what the company offered as a reissue style guitar! Yet now in 2003 when we go through the greatest lengths to make the guitars correct, when we use the highest quality materials ever in the company's history, the body shapes, necks, pegheads, neck tenons, pickups, pots, capacitors, and aluminum stopbars are more accurate and close to an original that ever, there are still individuals that feel we are out to pull one over on them. The things I mentioned above are the most important elements in any guitars sound and playability, except for one thing I left out..... the guy playing it.

Our intent with the bumble bee capacitor was to make a reissue capacitor as authentic as possible using the same basic elements that the original ones used, with the same specifications and performance, to make a part that in 20 or 30 years was still going to perform as well then as it did new, to improve the quality of sound of the guitars and be another contributing factor in making these guitars one step closer in sound and playability to an original, And the greatest guitars that anyone could ever own. And we feel very strongly as do many others that we have accomplished this. If there are any further questions about this or any other parts/guitar issues, before any wrong assumptions are made, please feel free to get in contact with me directly at ewilson@gibson.com, or use the Historic Program Discussion Forum found at http://www.gibsoncustom.com/.

HOW TO READ CAPACITOR VALUES



1st Figure
2nd Figure
Number of Zeros
Cap Tolerance
CAPACITANCE (pf)

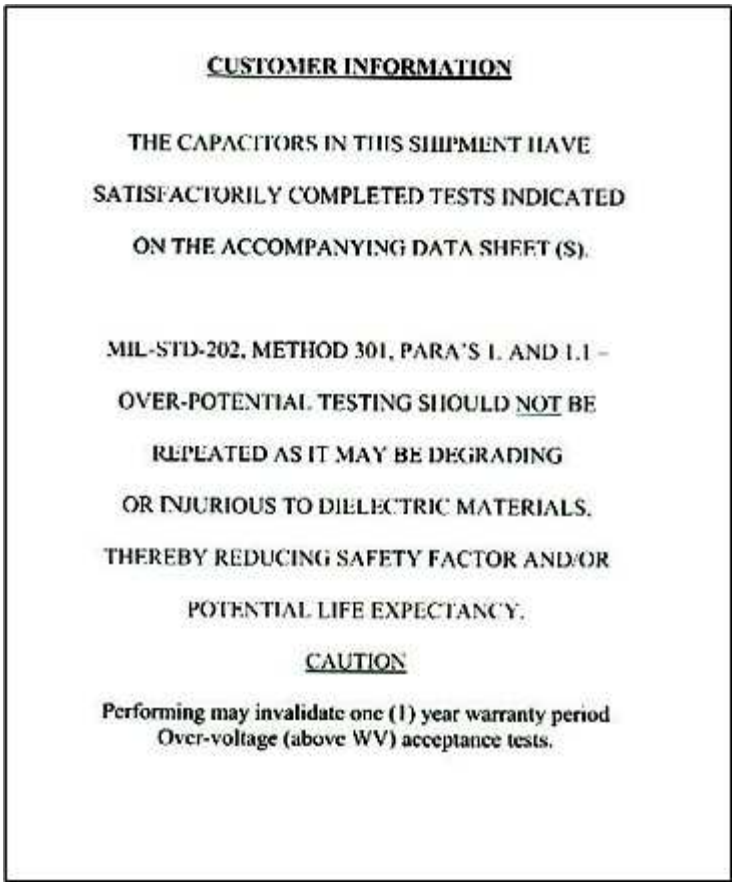
VOLTAGE RATING in Hundreds of Volts
- a second line can be added for 1000 volts and higher

Color	Figure	# of Zeros	Cap Tol.
Black	0		+/-20%
Brown	1	0	
Red	2	00	
Orange	3	000	+/-30%
Yellow	4	0000	+/-40%
Green	5	00000	+/-5%
Blue	6	000000	
Violet	7		
Gray	8		
White	9		+/-10%

Example (shown above): The PF26 we are supplying to you is a 22,000pf +/-20% @ 400 volts

Red, Red = 22 Orange = 000 Black = +/-20% **Capacitance** = 22,000 pf +/-20%
Yellow = 4 (hundreds) **Voltage** = 400 vdc

WARNING FROM THE MANUFACTURER
THAT FURTHER TESTING MAY DAMAGE CAPACITORS



CUSTOMER INFORMATION

THE CAPACITORS IN THIS SHIPMENT HAVE
SATISFACTORILY COMPLETED TESTS INDICATED
ON THE ACCOMPANYING DATA SHEET (S).

MIL-STD-202, METHOD 301, PARA'S 1. AND 1.1 -
OVER-POTENTIAL TESTING SHOULD NOT BE
REPEATED AS IT MAY BE DEGRADING
OR INJURIOUS TO DIELECTRIC MATERIALS,
THEREBY REDUCING SAFETY FACTOR AND/OR
POTENTIAL LIFE EXPECTANCY.

CAUTION

Performing may invalidate one (1) year warranty period
Over-voltage (above WV) acceptance tests.

BUMBLEBEE CAPACITOR COMPARISON:

ORIGINAL BUMBLEBEES
Lead Size: .025" to .035"
Foil Dimensions: height .890" tall, .0005" thick
Paper: Thin, brown craft paper; height .900", thickness .001"
Layers: foil/paper/foil/paper (4-ply)
Ends: lead based metal, 60/40 lead/tin

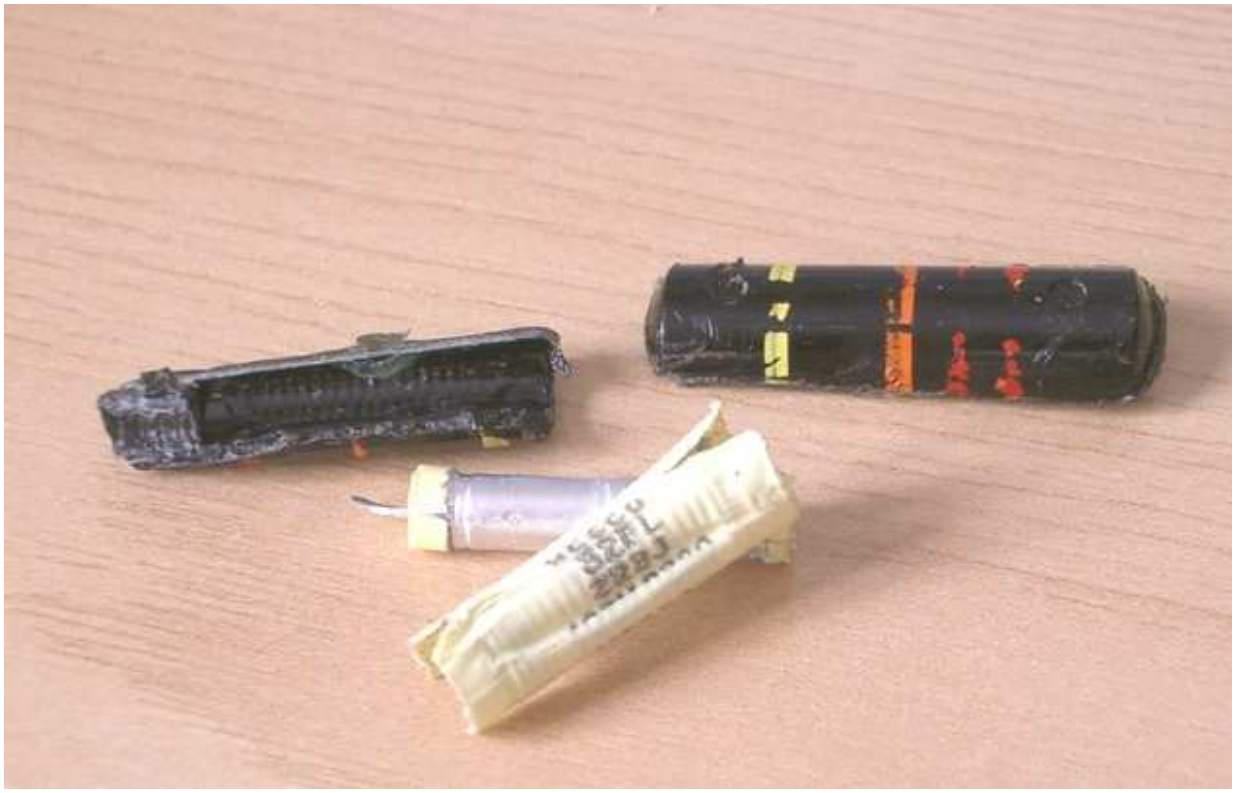
2003 BUMBLEBEES
Lead Size: .025"
Foil Dimensions: height .650" tall, .0015" thick
Poly (separator/dialectric): height .750" tall, .0015" thick
Layers: foil/poly/foil/poly (4-ply)
Ends: lead based

Edwin Wilson
Historic Program Manager
Gibson Custom, Art & Historic Division

The Facts...

Disecting a *Re-issue Bumblebee* Capacitor...Surprise!, these are pictures of a disected Gibson *Re-issue Bumblebee* capacitor posted January-2005 on the Les Paul Forum
courtesy of *pepejara*:

With the cover removed:



the markings **WESCO 32PL 223J** can be seen:

with the material unrolled:

clearly a poly-film type

Is this the same film+foil cap shown in Edwin's picture?

The Specs...

The following is the actual spec sheet from WESCO for these **32PL 223J** capacitors:

WESCO POLYPROPYLENE CAPACITORS

Type 32PL

SPECIFICATIONS

DIELECTRIC WITHSTANDING VOLTAGE

200% of rated voltage applied through a minimum limiting resistance of 100 Ohms/Volt. Duration of voltage stress shall be 15 seconds minimum and 1 minute maximum at 25°C.

INSULATION RESISTANCE

At 25°C after 2 minutes of electrification at rated voltage or 500 VDC, whichever is less, the minimum product of Insulation Resistance and Capacitance shall be 250,000 megohms-microfarads, but need not exceed 250,000 megohms.

DISSIPATION FACTOR

Shall not exceed .05% when measured at 25°C and 1000 Hz, ±20 Hz. See characteristic curves for D.F. ratings at other temperatures.

FEATURES

- Wrap and fill construction
- Excellent long-term stability
- Superior "Q" for tuned circuits
- High insulation resistance
- Linear temperature coefficient (-55°C to +85°C)
- Quality control procedures per Mil-Q-9858
- Extended foil design

APPLICATIONS

- Computers
- Data Processing Equipment
- Aircraft and Missile Systems
- Industrial Instrumentation
- Navigation and Distance Measuring Equipment

CAPACITANCE AND TOLERANCE

Shall be measured within the tolerance limits specified. Measurements will be made at 25°C and 1000 Hz, ±20 Hz.

LIFE TEST

Shall withstand 140% of rated voltage at 105°C for 250 hours. One failure in twelve shall be permitted.

TEMPERATURE COEFFICIENT

Capacitance shall change linearly over operating temperature range range of -55° C to +85°C at rate of -290, ±75 parts per million/°C.

CAPACITANCE STABILITY (DRIFT)

Less than .2% when measured in the following manner: three capacitance readings at 25°C, each made prior to and after temperature cycling from room to 105°C, and room to -55°C. The mathematical difference between the two extremes, divided by the intermediate value, and then multiplied by 100, yields the stability expressed in percent.

- Communications Equipment
- Timing and Retrace Circuits
- Integrating Networks
- High "Q" Low Loss Filters
- Peripheral Equipment

HUMIDITY RESISTANCE

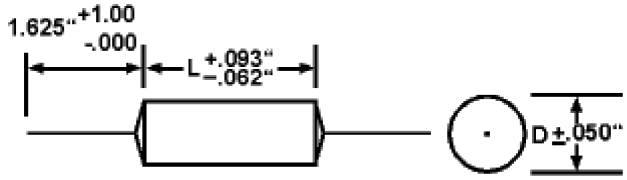
Meets requirements of Mil-C-27287, Para. 3.12 when tested in accordance with Mil-STD.-202, Method 103 B, Condition B.

LEAD PULL AND BEND TEST

Steady pull of 5 pounds applied axially to leads for one minute. Bend test shall consist of one bend from the point of egress, first 90° in one direction, back to the original axial position, and then 90° in the opposite direction with no evidence of breakage.

TEMPERATURE RANGE

-55°C to +105°C with full rated voltage applied.

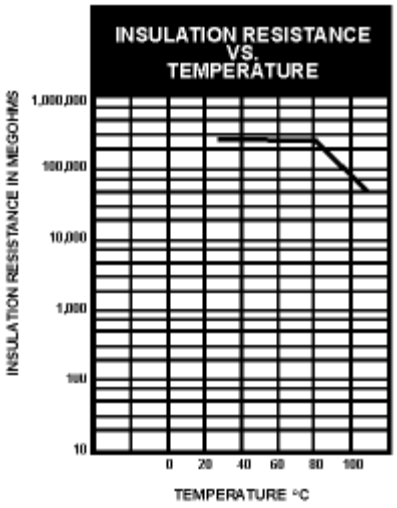


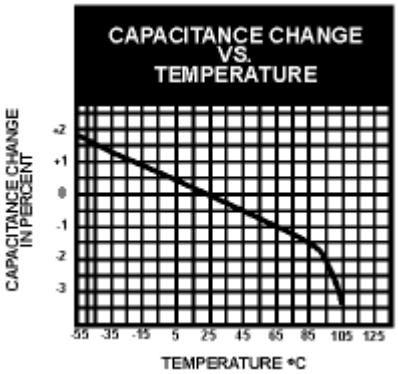
32PL
RATINGS and DIMENSIONS

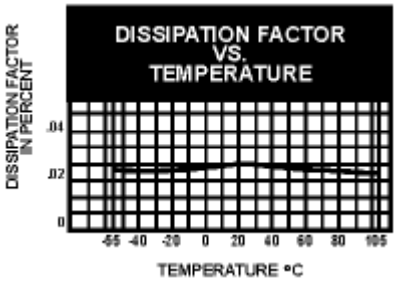
CAPACITY IN MFDS.	100 VOLTS	200 VOLTS	400 VOLTS

TEMPERATURE CHARACTERISTIC CURVES

	D	L	CAT. No. 32PL---K-1	D	L	CAT. No. 32PL---K-2	D	L	CAT. No. 32PL---K-4
.0010	.187	.406	1001	.187	.406	1001	.187	.406	1001
.0015	.187	.406	1501	.187	.406	1501	.203	.406	1501
.0022	.187	.406	2201	.187	.406	2201	.234	.406	2201
.0033	.187	.406	3301	.187	.406	3301	.187	531	3301
.0039	.187	.406	3901	.203	.406	3901	.187	.531	3901
.0047	.187	.406	4701	.187	.531	4701	.203	.531	4701
.0056	.187	.406	5601	.187	.531	5601	.218	.531	5601
.0068	.187	.406	6801	.187	.531	6801	.234	.531	6801
.0082	.187	.406	8201	.187	.531	8201	.203	.656	8201
.0100	.203	.406	1002	.203	.531	1002	.218	.656	1002
.015	.219	.531	1502	.203	.656	1502	.265	.656	1502
.022	.250	.531	2202	.234	.656	2202	.312	.656	2202
.027	.265	.531	2702	.265	.656	2702	.328	.656	2702
.033	.234	.656	3302	.281	.656	3302	.328	.781	3302
.039	.250	.656	3902	.312	.656	3902	.359	.781	3902
.047	.281	.656	4702	.296	.781	4702	.390	.781	4702
.056	.281	.656	5602	.312	.781	5602	.421	.781	5602
.068	.296	.656	6802	.343	.781	6802	.406	.906	6802
.082	.312	.781	8202	.375	.781	8202	.437	.906	8202
.10	.344	.781	1003	.375	.906	1003	.484	.906	1003
.12	.375	.781	1203	.406	.906	1203	.453	1.156	1203
.15	.375	.906	1503	.453	.906	1503	.500	1.156	1503
.18	.406	.906	1803	.484	.906	1803	.546	1.156	1803
.22	.437	.906	2203	.484	1.031	2203	.687	1.156	2203
.27	.437	1.031	2703	.531	1.031	2703	.578	1.406	2703
.33	.500	1.031	3303	.593	1.031	3303	.640	1.406	3303
.39	.531	1.031	3903	.593	1.156	3903	.687	1.406	3903
.47	.531	1.156	4703	.656	1.156	4703	.750	1.406	4703
.56	.578	1.156	5603	.625	1.406	5603	.825	1.406	5603
.68	.625	1.156	6803	.687	1.406	6803	.825	1.656	6803
.82	.625	1.406	8203	.687	1.656	8203	.906	1.656	8203
1.0	.687	1.406	1004	.734	1.656	1004	1.000	1.656	1004







LEAD MATERIAL: TINNED COPPER SOLID WIRE

STANDARD LEAD SIZES: # 24 AWG: Up to and including .203" Dia.
22 AWG: from .204" thru .312" Dia.
20 AWG: .313" Dia. and over

CAPACITY TOLERANCE: STANDARD…± 10%
OTHER…from ± 20% to ± 1%

OTHER VALUES AS WELL AS VOLTAGE RATINGS ARE AVAILABLE ON REQUEST

MARKING: WESCO Logo, Capacity, Tolerance, VDC Rating and Date Code. (Note: On smaller units, (7) trademark will be substituted for WESCO logo.)

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This information provides insight into the development of the re-issue bumblebee capacitors and is not a critque of Gibson products or policy's or people, it is of interest regarding the views and processes which occurred at Gibson while finding a suitable capacitor for the custom shop historic line of instruments.

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