Organ Pipe Metallurgy

Featuring local organ builder **Richard Bond** Assisted by Lou Paff & Joe O'Donnell

Portland Section ACS

December 12, 2002
First Unitarian Church
Portland, OR

1873 Hutchings-Plaisted tracker action organ rebuilt & enlarged by **Richard Bond** at the First Unitarian Church, Portland, Or.

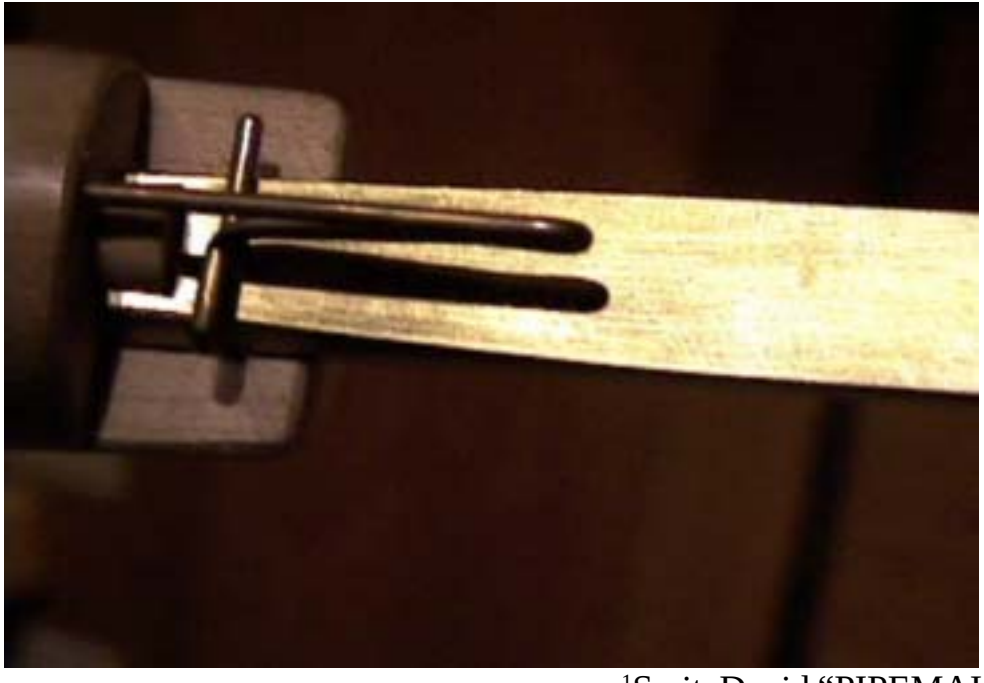
Photo: http://www.bondorgans.com/gallery_first_unitarian.html

Slide Presentation by Martha Dibblee

METALS used in casting organ pipes[1]

Tin, Lead, Copper, Aluminum, Zinc

Chemical mixtures of Tin & Lead ("spotted metal", "pipe metal")



Brass for reed tongues; trace elements Antimony, Bismuth; Silver

Brass tongue of reed pipe

Photo: Dibblee

[1]Smit, David "PIPEMAKING Metal Pipes Part I Metallurgy" (http://www.albany.edu/piporg-l/pipemet.html#introduction)

PHYSICAL PROPERTIES OF METALS[2] used for casting organ-pipe metal[3]

	Aluminum	Copper	Zinc	Silver	Tin	Antimony	Lead	Bismuth
Symbol	Al	Cu	Zn	Ag	Sn	Sb	Pb	Bi
Atomic number	13	29	30	47	50	51	82	83
Atomic weight	27.0	63.5	63.4	108	119	122	207	209
Sp. gr. (g/cm^3)	2.70	8.69	7.04	10.46	7.36	6.70	11.35	9.79
Melting point ^oC	660.37	1083.0	419.6	961.9	232.0	630.7	327.5	271.3
Melting point ^oF	1220.7	1981	787	1761	449	1169	621	520

[2]CRC Handbook of Chemistry and Physics 64th Edition 1984

[3]Smit, David "PIPEMAKING Metal Pipes Part I Metallurgy" (http://www.albany.edu/piporg-l/pipemet.html#introduction)

“SPOTTED METAL” pipes

“Spotted Metal” is a chemical mixture of lead and tin. It is not an alloy.[4]

Spots appear when tin:lead concentration is between 45-55%; spots are more prominent at higher tin concentration

Photo: Dibblee

[4]http://panther.bsc.edu/~jhcook/OrgHist/begin.htm

SPOTTED METAL METALLURGY

Spots develop on cooling because of " ... molten lead and tin having different melting temperatures. As the liquid ... passes through its eutectic point and begins to solidify, the metals separate and crystallize in small regions or "pools" on the casting table."[5]

[5]piporg-l Samuel McKeon 24 July 1995 week 4 #323

COMMON METAL PIPES

Mixture of tin and lead where tin:lead ratio is below 45% and does not form “spots”[6]

Less expensive metal costs; used where visual or tonal effect is less important

[6]piporg-l July 1995, week 4 (#366) McKeon quoting from ISO Journal Feb. 1974 article “The metallurty of Tin-Lead Alloys for Organ Builders”

Photo: Dibblee

Photo: Dibblee

TIN PIPES

melting point of tin:
232° C/450° F

Pure tin (99.97%) may used for display or façade locations[7]

"Tin Pest", in which tin metal changes to the powdery "grey tin", may occur at temperatures below -13° C[8,9,10,11]

[7] www.metals26.freeserve.co.uk/tin/tin.html
[8] Smit, David "PIPEMAKING Metal Pipes Part I Metallurgy" (http://www.albany.edu/piporg-l/pipemet.html#introduction)
[9] http://members.aol.com/pewtrsocty/glossary.htm
[10] http://corrosion-club.com/tinplague.htm
[11] Jack Harris: Material Matters, *Materials World*, May 2002

ZINC PIPES

melting point: 420° C; 687° F

Less costly than tin, spotted metal, or common metal

Used where visual and sound effects are less important such as large bass pipes

Photo: Dibblee

Photo: Dibblee

LEAD PIPES

melting point: 328^{o} F; 622^{o} F

Common in Bach-era organs in Europe

Recent discoveries by Brombaugh, Fisk, & others using modern analytic tools made successful casting possible nowdays.[12]

[12]Smit, David “PIPEMAKING Metal Pipes Part I Metallurgy” (http://www.albany.edu/piporg-l/pipemet.html#introduction)

LEAD METALLURGY

Modern-day lead pipes collapse if today's pure lead is used for casting

Recently discovered impurities[13] in 17th-century lead kept pipes from collapsing:

Sb	0.75%
Cu	0.06%
Bi	0.05%
Sn	1.0%

Impurities were determined using Electron Microprobe Analysis, which measured Auger electrons. Analyses were done on 300- year old pipes to recreate the tonal qualities.[13]

[13]Smit, David "PIPEMAKING Metal Pipes Part I Metallurgy" quoting Charles Fisk (AGO Magazine 1978) (http://www.albany.edu/piporg-l/pipemet.html#introduction)

POURING MOLTEN LEAD INTO CASTING TROUGH TO CAST LEAD SHEET

Photo: Dibblee

FRESHLY CAST LEAD SHEET

Photo: Dibblee

PYROMETER USED TO MEASURE TEMPERATURE OF LEAD MELT BEFORE CASTING

Photo: Dibblee

BUCKET FLOATING IN MOLTEN LEAD

Photo: Dibblee

OSHA ISSUES

Tests conducted by OSHA in organ shops that cast lead confirmed that lead is not an occupational hazard, as long as lead melt is kept below 800^{o} F[14], areas are kept clean, and there is no grinding or sanding of lead surfaces.

One shop's data documented that the "average YEARLY output of lead into the atmosphere ... [was] 0.56 grams."[15]

[14]Excerpt from piporg-l archives September 1994, week 5 (#54)

[15]Excerpt from piporg-l Wednesday 3 October 2001 (list440@earthlink.net)