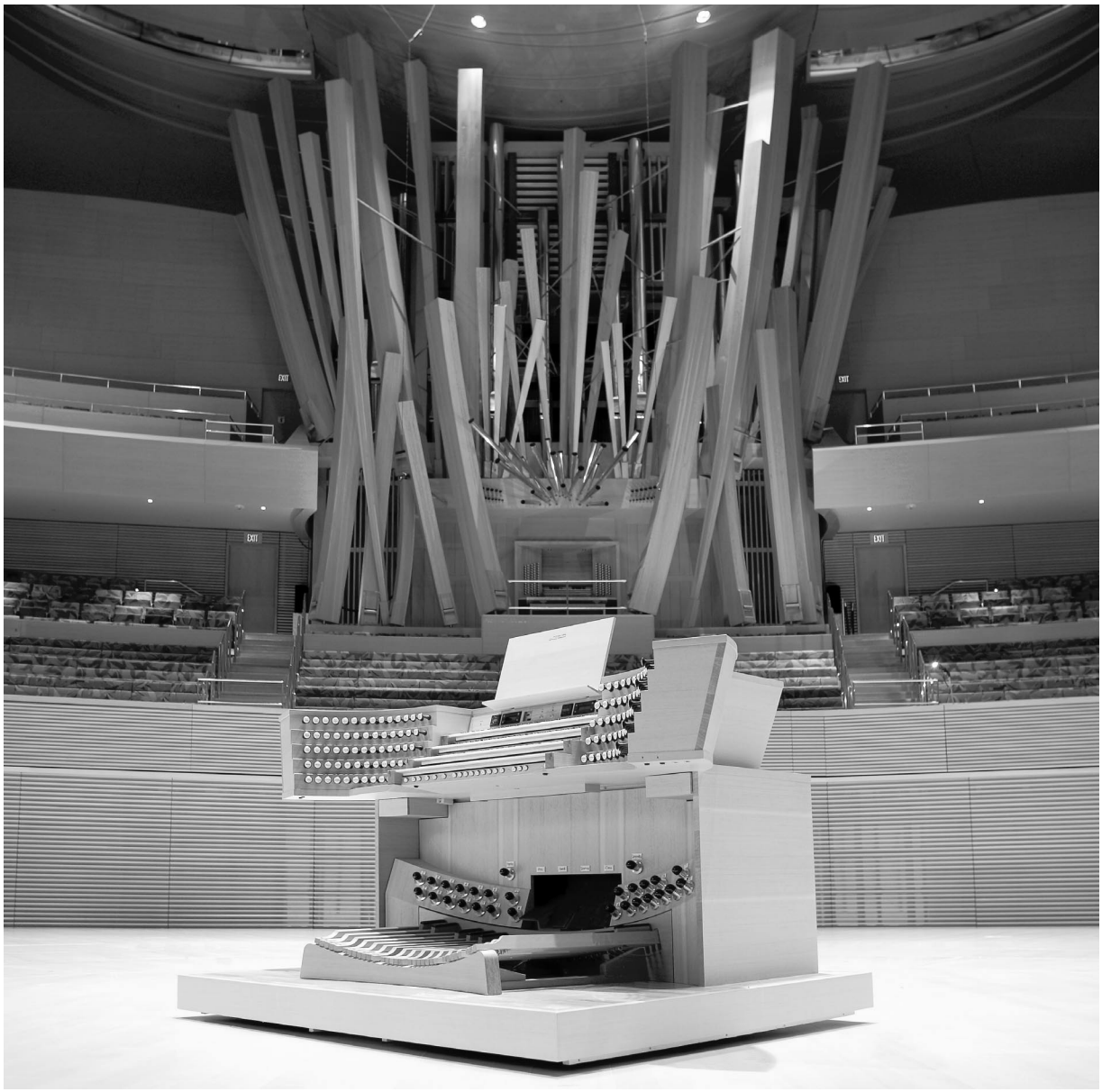
Cover Feature
WALT DISNEY CONCERT HALL
LOS ANGELES, CALIFORNIA
GLATTER-GÖTZ ORGELBAU/ROSALES ORGAN BUILDERS



Founded in 1919, the Los Angeles Philharmonic established its home in downtown Philharmonic Auditorium in 1920. This hall housed Austin Organ Company's Opus 156 (IV/66) of 1906. In 1964, the orchestra moved to the Dorothy Chandler Pavilion in the Los Angeles County Music Center. The Pavilion, a proscenium-type multipurpose theater, forms one of a trio of performance venues grouped around a central plaza, not unlike Lincoln Center in New York City (which opened two years later). For many years after, the idea of an additional symphony hall for Los Angeles seemed unthinkable. While the Chandler's acoustics did not generally meet with wide acclaim, the Pavilion's 3,000+ seating capacity certainly addressed the needs of the symphony- and opera-going public.

In the 25 years following the Chandler's completion, American taste in musical listening experienced a profound transformation. Revolutions in recording and architectural acoustics led to deeper dissatisfaction with the often arid acoustics of the previous generation's symphony spaces. During the same period, the organ's role as orchestral partner underwent similar re-evaluation. Organs of the 1950s and '60s (such as in Detroit's Ford Auditorium, New York's Philharmonic Hall, and Philadelphia's Academy of Music) stressed mobility, versatility, and a lean sound in the style of the times. By 1990, shifting values had produced more favorable acoustical settings and new organs that looked beyond the neo-Baroque and American Classic. A turning point came in 1991 with the opening of the Meyerson Symphony Center in Dallas. Its adjustable acoustics met—and still meet—with a warm reception, and C.B. Fisk Opus 100 redefined the sound of an organ in an orchestral setting.

Since then, virtually every significant new American concert room has included a pipe organ. Just as telling is the fate of the previous generation's halls and organs. The Detroit Symphony has returned to its original 1927 hall; New York's twice-revised Philharmonic Hall of 1962 (now Avery Fisher Hall) is still considered acoustically poor, with the organ removed; and the Philadel-

phia Orchestra has moved one city block to the new Verizon Hall, which will eventually house a large pipe organ.

Los Angeles did not remain aloof from these national trends. Dissatisfaction with the Chandler's acoustics for symphonic music coincided with increasing scheduling demands. With symphony, opera, ballet, and even the Academy Awards presentation all sharing the hall, daily re-configurations were costly and cumbersome. Finally, the Pavilion had neither an organ nor a suitable location for one. By the early 1980s, a new symphony hall no longer seemed so implausible.

When Walt Disney's widow, Lillian, gave $50 million in honor of her husband's love of the arts, the vision for a new hall gained momentum. Largely the brainchild of the Philharmonic's then-executive director Ernest Fleischmann, Walt Disney Concert Hall and its story are as colorful as the building's design. The selection of Nagata Associates of Tokyo as acousticians was followed by an investigation of new concert halls in Japan; almost every one had a significant, centrally located organ. Architect Frank Gehry, chosen by competition in 1988, accepted the organ's visual centrality as part of the brief to create a musical environment unlike any other.

Stimulated by a $1 million gift from the Toyota Motor Car Corporation of America, selection of an organbuilder began in 1989. A committee of Cherry Rhodes, Robert Anderson, and Michael Barone reviewed approximately two dozen proposals from American and European builders. Rosales Organ Builders was selected in the summer of 1990 and engaged on design retainer that fall.

As deliberation commenced, Frank Gehry made clear his starting point: just as the Concert Hall itself bore little relation to traditional architecture, neither should the instrument assume the appearance of a conventional organ case. Thus began a four-year process of gradual philosophical alignment between architect and organbuilder. Rosales proposed various dramatic designs, only to be rebuffed by Gehry with such questions as "Can all the front pipes be mounted upside down?" "Could the organ and organist hang from the ceiling?" and "How about pipe shades of chain-link fence?" Rosales insisted all along that the facade pipes be functional; any "Organ of the Future" still had to be a musical instrument. As Gehry became more aware of the possibilities, he saw that the facade held a unique opportunity: one of his signature shapes—a curvilinear object of straight-grained Douglas fir—could be whimsically fashioned into the functioning entity of an organ pipe.

The design evolved as an array of curved wooden pipes shooting out like an explosion of Roman candle fireworks, some from the case, others from the floor of the hall itself. A burst of brass trumpets directly above the console punctuates the appearance, and a group of vertical tin pipes anchors the design. For variety of shape, two wooden ranks would dominate the facade: a 32' Violonbasse (midway between violone and open wood in nature) and a 32' Contrebasson (a chorus reed of generous but uncommanding output). The tin pipes would form the bass of the Great Prestant, and the brass and tin trumpets would be known as the "Trompeta de Los Angeles."

All in all, it looked unlike anything that had come before. As pictures began circulating through fax machines and across the Internet, the design—dubbed the "French Fry" scheme—gained the status of renegade and spectacle. Having overcome his reluctance, Rosales saw opportunity in the innovative design. To what other pipe organ would apply so readily the public relations dictum, "There is no such thing as bad publicity"? If people were fascinated by the instrument's appearance, they might be equally curious about its sound.

When Manuel Rosales and his longtime associate, Kevin Gilchrist, began preliminary engineering drawings in 1991, an earthquake-resistant structure was assumed. The 1994 Northridge earthquake dramatically confirmed the necessity of such design parameters. By 1995, the certainties were in place: the skeletal steel structure housing the organ and anchoring the facade, the position of the console, and the facade array. Apart from two downward-facing trumpet pipes, every facade pipe would speak. The unfolding design process involved some 20 models. The final version was constructed at 1:10 scale, measuring about five feet tall, inserted into a master model of the building itself. (One of the project's more fascinating aspects is how Nagata Associates employed the building model for acoustical testing. Being accurate to the point of including 2,265 felt-covered lead figures simulating an audience, the structure was sealed, charged with liquid nitrogen, and used as a sound laboratory to forecast acoustical response.)

Through this conceptual stage, the organ's tonal design remained subservient to elements of architectural consequence. What had been established were the facade pipes, the basic locations of three manual departments, and the hanging of a 32' Haskellized open wood outside the steel skeleton (at the rear and sides of the case, mounted upside down, in ironic accord with an early Gehry wish). Beyond that, tonal design and budget remained undefined.

Between 1994 and 1998, the Walt Disney Concert Hall project came close to being shelved, largely because the cost estimates far exceeded initial projections. Several forces combined to put the venture back on track. Under the baton of Esa-Pekka Salonen, the Philharmonic was enjoying unprecedented popularity, appealing to a broader age-range through innovative programming and a commitment to modern music. Frank Gehry's Guggenheim Museum in Bilbao, Spain (designed later than the Concert Hall but finished in 1997), garnered such staggering worldwide acclaim as to lend new credence to his Disney design; moreover, his 1989 Pritzker Prize became a key fund-raising tool. Then-mayor Richard Riordan was determined not to let the Concert Hall die and be seen as yet one more Los Angeles disaster. Riordan, Fortune 500 businessman Eli Broad, and Music Center Chair Andrea van de Kamp revived enthusiasm and engaged in heroic fund-raising.

In the same period, Rosales was involved with a succession of large organs, one in conjunction with Glatter-Götz Orgelbau of Owingen, Germany: Claremont Congregational UCC, Claremont, California. Thus, when the Disney project came alive again in 1998 with a new, tight timetable, Rosales invited Glatter-Götz to build the organ as a collaborative venture. Caspar von Glatter-Götz prides himself on creating organs of high quality that speak a modern architectural language. An organ for Gehry's hall would not only be the young firm's largest to date, but a milestone opportunity, with Gehry's curved facade pipes the pinnacle of irresistible challenge.

Arrangements with Glatter-Götz and Rosales were formalized in mid-1998, and contracts were signed establishing Glatter-Götz as builder and Rosales as tonal director. In addition to building and installing the entire instrument, Glatter-Götz and his chief engineer, Heinz Kremnitzer, would work with Gehry to engineer the spectacular facade. Manuel Rosales and Kevin Gilchrist would supply critical input on stop layout, pipe scales, all details of pipe construction, and carry out voicing and tonal finishing. In due course, Michael Barone was engaged as project consultant, acting as sounding board and mediator, and bringing both an insider's perspective and a worldview from the wider realm of classical music.

From the outset, the organ was envisioned with two consoles, one attached, the other mobile. In the context of a labor-union-run performance space, both are equally necessary. If only the attached console existed, judging balances would be difficult. But if only a mobile unit were provided, a stage call would be required for any and every use. The attached console's first purpose, then, is to secure access to the organ at all times. The mobile console affords easy communication between musician and conductor, and allows the instrument to be heard in good balance. The combination action is common to both consoles, allowing easy migration between the two.

An attached console offered the possibility of mechanical action. It would be inaccurate, however, to regard this instrument as a tracker organ. In reality it is an electric-action instrument with tracker action introduced to the Great, Swell, and Positive. The Pedal, Llamarada, and many bass registers on the other three manuals are entirely electric, as are all couplers. This arrangement affords a sense of connectedness from the attached console, and a different overall experience from the second console. Moreover, the attached console serves a visual role; its perfectly symmetrical stopjambs are of a scale in keeping with the case and the instrument's resources. Conversely, the mobile console is as compact and low in profile as practicable; its radiating terraced jambs grow into fins echoing shapes found in the hall. Both consoles have a crisp, clean appearance, in keeping with Glatter-Götz's own design ethic and the feel of the hall.

At its official opening in October 2003, Walt Disney Concert Hall was hailed as a triumph, the skeptics overwhelmed by the seductive spaces, fantastical vistas, and enveloping gardens. Quite apart from visual design, it was clear that the acoustical research had paid off in a space of exceptional clarity and warmth, reflecting the talents and perseverance of acoustician Yasuhisa Toyota of Nagata Associates. From the organ's perspective, the room may not be overly reverberant, but has excellent resonance. Transmission of tone is direct and clear, with a certain degree of enhancement from multiple early reflections. Bass response is honest and well reinforced. During informal demonstrations of the instrument, it has been found that an organist can speak from the attached console in normal tones and be

heard with perfect ease almost anywhere in the hall.

The playful chaos of the facade is enhanced by the fact that visitors can walk among the forest of pipes. The external appearance stands in contrast to the discipline of the organ's showcase interior: an organ built to last, fully conscious of its place in a world-class venue. The aesthetic of modern appearance extends inward, with elegant oak floors and stairways; large manual chests are divided into four sections, with wide walkboards for ease of tuning access. Other aspects bear in mind the world-class performance venue. Dual blower turbines engage alternately, one always in reserve in case of malfunction. The soundproofed blower room provides wind through silencing baffles. All swell shades are 2½" thick, with distinctive triple-stairstepped edges to promote effective pianissimos and gradual openings. The shades' physical arrangement was determined with Frank Gehry's input, responding equally to visual and tonal criteria. Dedicated pitch pipes allow the orchestra to tune to the organ without an organist present. Finally, the pipes themselves speak of strength and elegance; every principal is tin throughout, and the interior wood pipes are built to the same high standard as those in the facade.

Ultimately, budget and space permitted an organ of 72 speaking stops and 109 ranks. The tonal design culminates 20 years of development that began with the concept for Rosales Opus 11 (1987) for Trinity Cathedral in Portland, Oregon. For Opus 24 in Los Angeles, pressures, scales, and tonal structure are geared not only toward complexity of result but also the specific requirements of use with orchestra. With the inclusion of two 32' and four 16' stops, here could be a Great of uncompromising complexity and magnitude. Twenty-four ranks in the chorus alone—almost a quarter of the organ's pipes—underscores the value placed upon the principal chorus as the instrument's true core. Available depth permitted a broad array of Great foundations, sufficiently spaced to augment each other tonally, and three chorus mixtures, again with enough room to combine meaningfully and to allow stable tuning.

The quartet of unison registers—Principal, Violoncelle, Flûte harmonique, Chimney Flute—continues the Rosales tradition, augmented by the belled Diapason à Pavillon. While a second open in volume, the Diapason possesses an unusual pervading power. The 16' mutations lie midway between principal and flute tone, giving gravity to the chorus while also permitting a *grand jeu de tierce*. The Mixture VIII is a stand-alone register emphasizing the 8' series. The Grand Fourniture and Cymbale together form a second complete mixture, standing on the same toeboard with a near absence of duplicated pitches, separately available for variety in defining the chorus. While the three mixtures are interrelated, and together crown the plenum, it is possible to achieve a slightly more Germanic effect with Mixture alone, and perhaps something more along French classical lines using the other two. "Basson" here denotes a chorus reed of milder tone with moderately closed shallots, allowing for breadth over brilliance.

Directly behind the Great is the Llamarada, or "blazing"—as in a fire, outburst or brilliant flash. Just as the word "Bombarde" is used to name either stop or division, the Spanish words Llamada (as in "call," as in the French word "appel") and Llamarada play upon a homonym in a Hispanic cultural framework. While the Great, Swell, and Positive are viewed as a complete ensemble, the Llamarada augments the tutti for dramatic orchestral climaxes. Placed on eight-inch pressure, the principals of this department are made from flared tin pipes, lending a color distinct from that of the Great. For additional clang and harmonic richness, a second mixture called Compuestas introduces thirds, flat sevenths, and ninths, further differentiating the Llamarada chorus from the Great's, and allowing the two to blend with scintillating effect. The enclosed chorus reeds are the instrument's most powerful. Moments of terrifying grandeur are supplied by a tuba, the Llamada, placed horizontally atop the Swell box. On 17-inch wind pressure and only a few feet from the ceiling, the Llamada readily "calls" attention to itself.

The Swell organ is Rosales's largest to date, combining all the features of its predecessors: a wealth of foundation tone, harmonic flute choir, versatile mutations, major and minor celestes, and a commanding reed chorus with strong mixture. The division's elevated placement lends prominence, with a commanding trumpet chorus that matches in reed tone the Great's dominating plenum. The Positive flanks the console, its location determining much of its tonal character. The principal chorus and flute upperwork respond to the Great, the plenum being the scale of many other instrument's Great divisions. The other foundations relate in romantic character to those of the Great and Swell; the Unda Maris is scaled and located to undulate with either Principal or Gambe in the French tradition. Bearing in mind this department's proximity to the choral terrace and its usefulness for accompaniment, the chorus reeds are the organ's mildest.

The Pedal is both customary and climactic. Its chorus underpins the Great's, with a big mixture based on a 5⅓'. In addition to its customary role, the Pedal supplies the extraordinary qualities expected in the symphonic context. While the facade and various borrows supply milder effects, the Flûte and Grande Bombarde offer a thunderous climax. With four full-length manual 16' chorus reeds, it was felt that the Pedal still needed one unimpeachable stop. The 32' Contre Bombarde, of copper and spotted metal, stands at either side of the Positive and reaches, unmitered, to the ceiling. If some have likened the organ's appearance to the aftermath of an earthquake, the Pedal might as well have the potential to create something similar.

Then there are the astonishing facade pipes. Made entirely in the Glatter-Götz shops, the final design was worked out between the Gehry and Glatter-Götz design staff collaborating on attachment and pipe location. The curving 32' flues and reed resonators are spectacular examples of exacting craftsmanship, built from imported straight-grained Douglas fir (the primary wood finish throughout the hall). Each pipe is anchored with a steel-plated foot. Twin stainless-steel support rods project from the organ's skeletal frame and connect near the top of each pipe to an interior steel plate. In turn, each top connection is hinged, allowing the pipes a limited degree of motion during an earthquake. Nothing quite so daring and unusual has previously existed in organbuilding.

Every great organ is the result of extraordinary collaboration, even when the product of a single firm. This organ represents unusually integrated teamwork among the builders, working together with architect, management, consultant, and voicer. Most particularly, it demonstrates Glatter-Götz's commitment to a vision of 21st-century organbuilding capable of looking beyond the horizon. It bodes well for exciting times to come.

JONATHAN AMBROSINO

The organ installation occurred in stages from October 2002 through October 2003. Voicing commenced in October 2003. The organ will be first heard on July 8 during the AGO National Convention. The Los Angeles Philharmonic's inaugural concert series will take place in the 2004–2005 season, featuring both solo and concerted works. To learn more about the building and the organ, visit:

www.laphil.org/press/imagelibrary.cfm
http://wdch.laphil.org/misc/kcrw_radio_docs.cfm
www.gg-organs.com
www.rosales.com
www.nagata.co.jp

Glatter-Götz Orgelbau, Owingen, Germany; Opus 9
Builders and Installers of the Organ, Facade, and Steel Structure

Caspar v. Glatter-Götz
Heinz Kremnitzer
Stefan Stürzer
Joachim Seifried
Ralf Reichle
Ekki Doll
Gerhard Möhrle
Christoph Meissner
Johannes Hüfken
Eberhard Hilse
Johanna Kessler
Karin Schmelzle
Dominik Mätzler
Markus Burtscher
Roland Opitz

Rosales Organ Builders, Los Angeles; Opus 24
Concept, Visual Design, Tonal Direction, and Voicing

Manuel Rosales
Kevin Gilchrist
Richard Houghten
Vladimir Vaculik
Lawrence Strohm
Jonathan Ambrosino
Robert Coulter
Jonathan Wilson
Russell Schertle
Michael Wong
Albert Nass
Duane Prill
David Chamberlin
Rodney Ford

WIND PRESSURES

Great	5"
Swell	4½"
Positive	4"
Llamarada	8"
Llamada	17"
Pedal Flues, Facade	5½"
Pedal 32' Flute and 32' Bombarde	8"

Cover photo by Jim Lewis
Article photo by Laurence Bartone

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GREAT (Manual II) (unenclosed)
32 Violonbasse (Gehry facade)
32 Grand Bourdon (from 16, 1–12 resultant)
16 Prestant (polished tin facade)
16 Violonbasse (ext.)
16 Bourdon (Pedal Subbass)
8 Principal
8 Diapason à Pavilion
8 Violoncelle (ext. Violonbasse)
8 Flûte harmonique
8 Chimney Flute
5⅓ Grand Nasard
4 Octave
4 Spire Flute
3⅕ Grande Tierce
2⅔ Octave Quinte
2 Super Octave
II–III Grande Fourniture (16)
VIII Mixture (8 series)
IV Cymbale (4 series)
VII Corneta Magna
32 Contre Basson (ext.16) (Gehry facade)
16 Basson
8 Basson
4 Basson

8 Trompeta de Los Angeles (Llamarada)

16 Great to Great (does not affect 32' stops)

POSITIVE (Manual I) (enclosed)
16 Quintaton
8 Principal
8 Unda Maris (CC)
8 Gambe
8 Flûte harmonique
8 Gedackt
4 Octave
4 Hohlflöte
2⅔ Nasard
2 Super Octave
2 Waldflöte
1⅗ Tierce
1⅓ Larigot
IV Mixture (1⅓)
16 Cor anglais
8 Trompette
8 Cromorne
4 Clairon
Tremolo

16 Llamada (Llamarada)
8 Llamada (Llamarada)
4 Llamada (Llamarada)
8 Trompeta de Los Angeles (Llamarada)

16 Positive to Positive

SWELL (Manual III) (enclosed)
16 Bourdon
8 Diapason
8 Flûte traversière
8 Bourdon
8 Viole de gambe
8 Voix céleste (CC)
8 Dulciane doux
8 Voix angèlique (TC)
4 Principal
4 Flûte octaviante
2⅔ Nasard
2 Octavin
1⅗ Tierce
1 Piccolo
III–V Plein jeu harmonique (2⅔)
16 Bombarde
8 Trompette
8 Hautbois
8 Voix humaine
4 Clairon
Fast Tremulant
Slow Tremulant

8 Llamada (Llamarada)
8 Trompeta de Los Angeles (Llamarada)

16 Swell to Swell
4 Swell to Swell

LLAMARADA (Manual IV) (enclosed)
8 Flautado grandiso
4 Octava real
V Compuestas
V Lleno fuerte
16 Bombardon
8 Trompeta armonica
4 Clarín armonico
Tremblante

Unenclosed
16 Llamada (ext.)
8 Llamada (horizontal Tuba)
4 Llamada (ext.)
8 Trompeta de Los Angeles (Gehry facade)

Campanitas (two bell arrays, available independently or together)
Pajaritos (two pairs of birdolas)
Pitch Pipes (3 pipes) D F A (A=442)

PEDAL
32 Flûte
32 Violonbasse (Gehry facade)
16 Flûte (ext.)
16 Prestant (Gt.)
16 Violonbasse (Gt.)
16 Subbass
16 Bourdon (Sw.)
10⅔ Grosse Quinte
8 Octave
8 Flûte (ext.)
8 Violoncelle (Gt.)
8 Bourdon (ext. Subbass)
4 Super Octave
4 Flûte (ext.)
V Mixture (5⅓)
32 Contre Bombarde (ext.)
32 Contre Basson (Gehry facade)
16 Grande Bombarde
16 Bombardon (Llamarada)
16 Basson (Gt. 16)
8 Trompeta (Llamarada)
8 Basson (Gt. 8)
4 Clarín (Llamarada)
4 Basson (Gt. 4)

COUPLERS
8 Great to Pedal
8 Positive to Pedal
8 Swell to Pedal
8 Llamarada to Pedal

16 Positive to Great
8 Positive to Great
16 Swell to Great
8 Swell to Great
4 Swell to Great
16 Llamarada to Great
8 Llamarada to Great
4 Llamarada to Great

8 Swell to Positive
8 Llamarada to Positive

COMBINATIONS

Great	1–8	Thumb reversibles for:
Positive	1–8	Great to Pedal
Swell	1–8	Positive to Pedal
Llamarada	1–6	Swell to Pedal
Pedal	1–6 (toe)	Llamada to Pedal
General	1–24 (1–12 toe)	Swell to Great
		Positive to Great
		Llamada to Great
Restore		Tutti
General Cancel		
Combination Set		Toe reversibles for:
		Great to Pedal
All Pistons Next		Swell to Pedal
Next		Tutti
Previous		Pajaritos

MIXTURE COMPOSITIONS

Llamarada Lleno fuerte V ranks 294 pipes

Notes	1	15	27	39	47	51	61
	2⅔'	4'	4'	4'	4'	8'	8'
	2'	2⅔'	2⅔'	2⅔'	2⅔'	4'	4'
	1⅓'	2'	2'	2'	2'	2⅔'	2⅔'
	1'	1⅓'	1⅓'	1⅓'	1⅓'	2'	2'
	⅔'	1'	1'	1⅓'r	1⅓'r		

Llamarada Compuestas V ranks 290 pipes

Notes	1	15	27	43	47	51	61
	1⅗'	2'	2⅔'	4'	4'	8'	8'
	1⅓'	1⅗'	2'	2⅔'	2⅔'	4'	4'
	1⅓'	1⅓'	1⅗'	2'	2⅔'	2⅔'	2⅔'
	1'	1⅓'	1⅓'	1⅗'	1⅗'	2'	2'
	⅘'	⅘'	⅘'	1⅓'			

Great Grande Fourniture II–III 171 pipes

Notes	1	13	25	31	37	43	51	61
	2⅔'	5⅓'	5⅓'	5⅓'	8'	8'	16'	16'
	2'	2⅔'	4'	4'	5⅓'	5⅓'	8'	8'
		2'	2⅔'	2⅔'	4'	4'	5⅓'	5⅓'

Great Cymbale IV 233 pipes

Notes	1	13	25	31	37	43	51	61
	1'	1⅓'	2'	2'	2⅔'	2⅔'	4'	4'
	⅔'	1'	1⅓'	1⅓'	1⅓'	2'	2⅔'	2⅔'
	½'	⅔'	1'	1'	1'	1⅓'	2'	2'
	⅓'	½'	⅔'	1'r	1'r	1⅓'r		

Great Mixture VIII 362 pipes

Notes	1	13	25	31	37	43	51	61
	2'	2⅔'	4'	4'	8'	8'	8'	8'
	1⅓'	2'	2⅔'	2⅔'	4'	4'	5⅓'	5⅓'
	1'	1⅓'	2'	2'	2⅔'	2⅔'	4'	4'
	⅔'	1'	1⅓'	1⅓'	2⅔'r	2⅔'r	2⅔'	2⅔'
	½'	⅔'	1'	1⅓'r	2'	2'	2'	2'
		⅔'r	1'r	1'	2'r	2'		
				1'r	1⅓'			
					1⅓'r			

Positive Mixture IV 244 pipes

Notes	1	19	31	43	51	61
	1⅓'	2'	4'	4'	8'	8'
	1'	1⅓'	2'	2⅔'	4'	4'
	⅔'	1'	1⅓'	2'	2⅔'	2⅔'
	½'	⅔'	1'	1⅓'	2'	2'

Swell Plein jeu harmonique III–V 269 pipes

Notes	1	13	25	43	51	61
	2'	2⅔'	4'	8'	8'	8'
	1⅓'	2'	2⅔'	4'	5⅓'	5⅓'
	1'	1⅓'	2'	2⅔'	4'	4'
		1'	1⅓'	2'	2⅔'	2⅔'
			1'	1⅓'	2'	2'

Pedal Mixture V 160 pipes

Notes 1 to 32
5⅓'
2⅔'
2'
1⅓'
1'