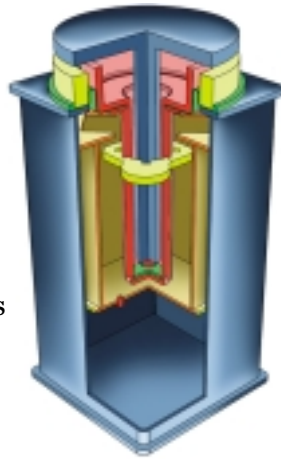


63-500 Series Table with Gimbal Piston™ Vibration Isolation System

The Exploratorium, San Francisco

APPLICATION:

The Exploratorium's Microscope Imaging Station includes several optical microscopes that will ultimately be used by museum visitors to image and manipulate various specimens. The exhibit will feature a time-lapse video, taken under a microscope, of a transparent zebrafish maturing from a single cell to a fully developed hatching egg. The images were captured using a Zeiss Axiocam 200M inverted optical microscope and digital camera. Essential to the experiment was that the image remain completely motionless for the entire 61 hours of the embryo's development. Most imaging applications require only a few seconds of quiescent performance.



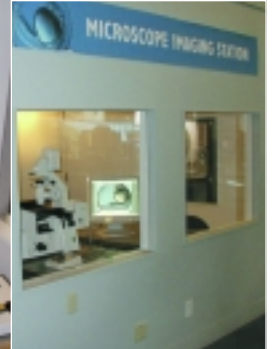
Gimbal Piston Isolator

PRODUCT:

The Exploratorium uses two TMC 63-500 Series Tables in its imaging exhibit. The tables provide extremely efficient vibration isolation of floor noise both vertically and horizontally. In addition to the isotropic nature of the isolation, the Gimbal Piston™ isolator design works well with light mass loads and maintains the efficient isolator performance down to the low amplitude input levels typical of building floor vibrations. The table was specifically designed for use with optical microscopes such as the Zeiss inverted microscope used in the exhibit.

BENEFITS TO USER:

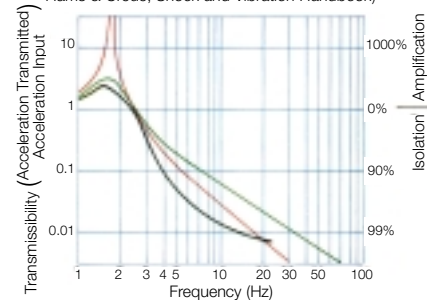
- Vertical and horizontal vibration isolation starting below 2 Hz
- Up to 80% isolation by 5 Hz and 90% isolation at 10 Hz
- Aggressive pneumatic damping quietly settles even gross disturbances
- Desk-style configuration and accessories allow for optimized ergonomics



PERFORMANCE

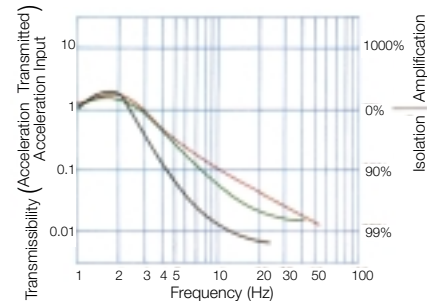
Vibration Isolation vs. Pneumatic Damping

(source for theoretical curves: Harris & Crede, *Shock and Vibration Handbook*)



- Theoretical 1.5 Hz isolator with no damping
- Theoretical 1.5 Hz isolator with 0.2 damping coefficient
- Measured 63-500 Series Table with 40-microinch floor inputs (vertical)

Low-Amplitude Input Response



- Measured 63-500 Series Table with 40-microinch floor inputs (vertical)
- Measured 63-500 Series Table with 4-microinch floor inputs (vertical)
- Measured 63-500 Series Table with 0.1-microinch floor inputs (vertical)

This photo shows the mezzanine level floor (where the exhibit is located) from the floor below and conveys a sense of the vibration problems inherent in the building.



The Palace of Fine Arts Building (1915) was built to celebrate the Pan-Pacific Expo, Panama Canal opening, and rebirth of San Francisco after the 1906 earthquake.

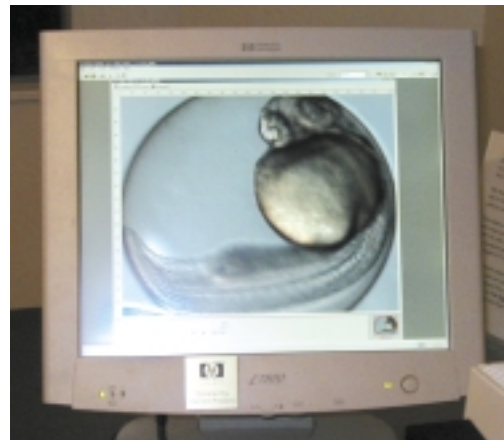
BRIEF:

The time-lapse sequencing is accomplished by outfitting the microscope with a digital CCD camera attachment. The camera is controlled to take a photograph every six minutes. A sequence of 610 images taken over the 61-hour period is then compiled to create the time-lapse sequence that shows the development of the zebrafish embryo from a single cell through hatching.

The exhibit is a particularly challenging vibration isolation problem due to a combination of factors. The Exploratorium is situated in San Francisco's Palace of Fine Arts Building, built in 1915. The Microscope Imaging Station is located on the more recently constructed mezzanine level, a space appropriate for light office space but not at all suited to sensitive time-lapse photography. The corrugated steel floor is supported by lightweight steel beams and steel stanchions. Compounding the problem of a lightweight, resonant, high-ambient-vibration floor is the excessive nature of the surrounding foot traffic. Approximately 600,000 visit The Exploratorium each year. Most visitors are children whose preferred method of touring the facility is to run, jump, fall and bang into every stationary object. This "onboard" source of noise excites the light, resonant floor into a severe vibration environment, hardly suitable for precision microscopy. The vibration isola-

tion provided is a function of frequency and provides up to 80% isolation at 5 Hz and 90% at 10 Hz.

The Gimbal Piston™ isolator design successfully isolated floor vibration to levels which allowed the successful capturing of the time-lapse sequence. The same isolator design is regularly used to successfully isolate some of the most vibration-sensitive applications including AFMs, interferometers and intercellular recording setups. The desk-style configuration allows for optimized ergonomics. A padded front armrest enables the user to lean on the table without disturbing the isolated surface.



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