



Photo courtesy of American Watchmakers-Clockmakers Institute

Whether they restore small timepieces or large machinery, these repairers share a fascination of how things work.

Precision instrument and equipment repairers

by Ian Wyatt

Tick-tock, ding-dong, whir-whir—the precise movements of gadgets such as clocks and watches, musical instruments, and industrial measuring devices have fascinated people for decades. Maintaining such small mechanical devices demands a level of skill and attention to detail that borders on an art. Highly skilled repairers keep precision instruments and equipment in working order.

Precision instrument and equipment repairers held more than 70,000 jobs in 1998. These workers compose a diverse group, repairing cameras, medical equipment, musical instruments, watches and clocks, and industrial measuring devices. In this article, you'll learn about their differing duties, working conditions, employment and earnings, job outlook, and skills and training.

Nature of the work

Within the occupation of precision instrument and equipment repairer, there are five groups of workers: camera and photographic equipment repairers, medical equipment repairers,

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musical instrument repairers and tuners, watch repairers, and other precision instrument and equipment repairers. Their jobs all require attention to detail in fixing instruments and equipment, but their tasks vary according to specialty.

Camera and photographic equipment repairers. Camera and photographic equipment repairers perform a series of steps when fixing a camera or photo equipment. First, they diagnose the problem to determine whether a repair is profitable, referring back to the manufacturer the most complicated and expensive problems. Second, they disassemble the camera's or equipment's numerous small parts to reach the source of the problem. Third, they read an electrical schematic to work their way through possible electrical causes of a problem. Finally, they remove and replace broken or worn parts and clean and lubricate gears and springs.

Frequently, older camera and photo equipment parts are no longer available, so camera and photographic equipment repairers strip junked cameras and equipment or build replacement parts using metalworking tools such as a lathe and grinding wheel. Modern camera and photographic equipment repair also requires some knowledge of computer and digital circuitry. For example, most 35-millimeter cameras now have computerized circuit boards and computer programs instead of the many small, moving parts of older cameras. Camera operators must

Precision instrument and equipment repairers are a diverse group: They fix devices ranging from cameras and clocks to medical equipment and musical instruments.

be able to determine whether a circuit board problem requires replacing a simple circuit, a transistor, or the whole board.

Digital cameras and photographic equipment, which are becoming increasingly popular, require repairs similar to those for most other modern cameras and photographic equipment. However, because there is no film to wind in these digital devices, there are fewer moving parts for repairers to fix or replace.

Medical equipment repairers. Medical equipment repair work differs significantly from that of other precision instrument and equipment repair: the larger scale of these repairers' tasks requires less precision. The machines these technicians repair include mechanical lifts, hospital beds, and customized automobiles for disabled users.



Photo courtesy of American Watchmakers-Clockmakers Institute

Repairers' tasks and tools vary by specialty but may include using a lathe to create precision parts.

Medical equipment repairers use a variety of tools, including voltmeters and other measuring devices, to diagnose problems. Repairing the equipment involves both hand tools and machining equipment.

Musical instrument repairers and tuners. Those who repair and tune musical instruments ensure that the first note played is as true as the last. Musical instrument repairers and tuners, often referred to as technicians, specialize in one instrument type: band instruments, pianos and organs, or violins and guitars.

Repairers of band instruments, brass and wind instruments, and percussion instruments focus on damaged woodwind, brass, reed, and percussion instruments. They move mechanical parts or play scales to find problems. They may remove and replace rod pins, keys, worn cork pads, and pistons and remove soldered parts using gas torches. Using filling techniques or a mallet, they repair dents in metal and wood. They also may remove old drumheads and replace them with new ones. In addition to using gas torches and mallets, these repairers use grinding wheels, shears, and small hand tools in their work.

Piano repairers use techniques, skills, and tools similar to those of band instrument repairers. Repairers often earn additional income by tuning pianos, which involves tightening and loosening different strings to achieve the proper tone or pitch. Pipe-organ repair is like piano repair on a larger scale. However, pipe-organ repairers also must contend with large pipes and bellows that force the air through different tubes in an organ. Additionally, organs are too large to transport, so organ repairers must assemble and service them on site. Working in teams or with assistants, repairers assemble an organ over several weeks or months, depending on its size.

Violin repairers and guitar repairers adjust and repair string instruments. These repairers play and inspect the instrument to

find any defects. They replace or repair cracked or broken sections and damaged parts, restring the instruments, and repair damage to their finish.

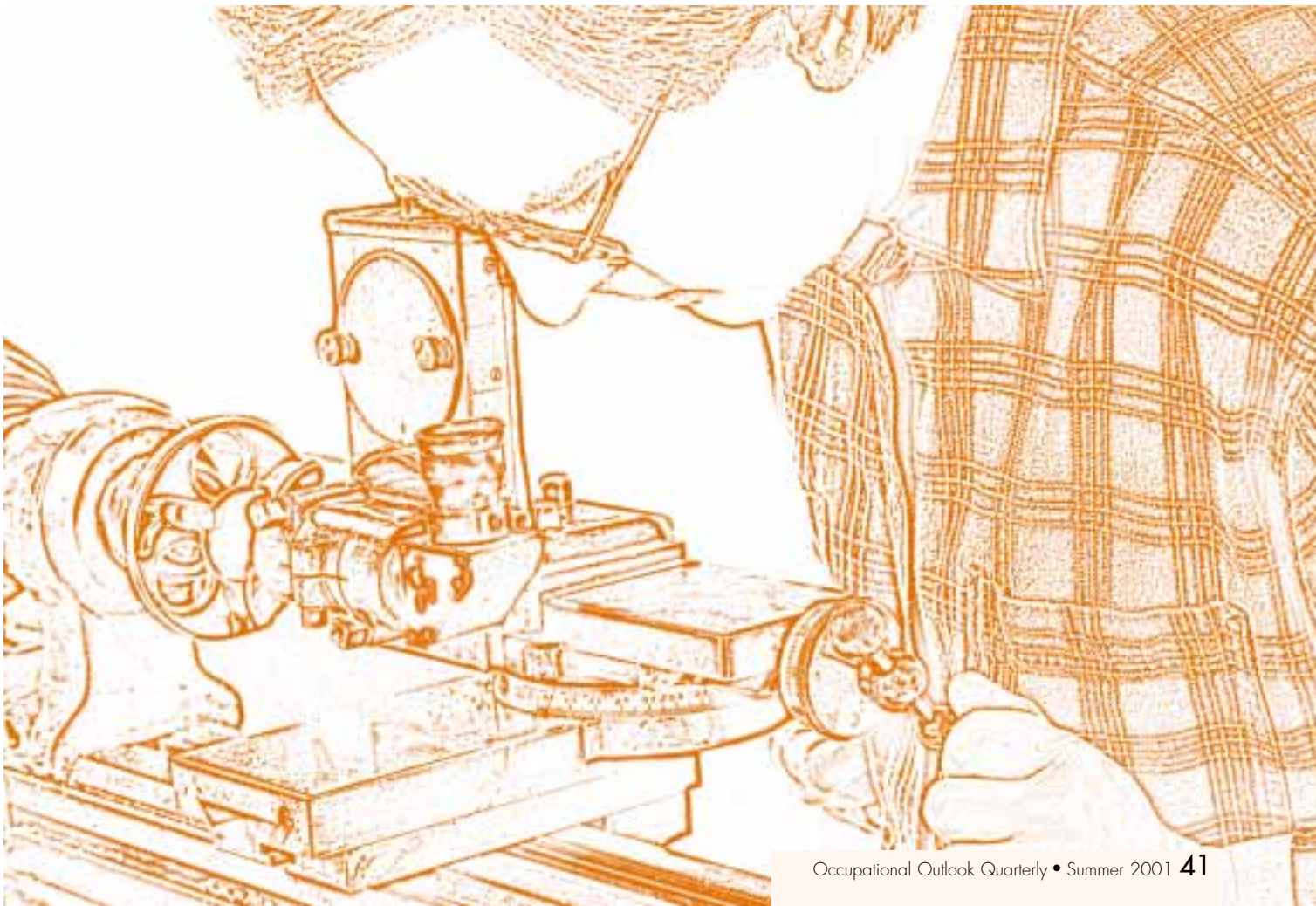
Watch repairers. Moderately priced timepieces are cheaper to replace than to repair, and electrically powered quartz watches and clocks function with almost no moving parts, limiting maintenance to battery replacement. As a result, watch and clock repairers work almost exclusively on expensive timepieces, many of which still have mechanical movements and a manual winding mechanism or spring. These timepieces require regular adjustment and maintenance, which includes disassembling many small gears and components. Each part is inspected for signs of significant wear. Some gears or springs may need to be replaced or machined, and all parts have to be cleaned and oiled.

Replacement parts for antique watches and clocks, like those for older cameras, are frequently unavailable. In such cases, watch and clock repairers construct their own parts. They use small lathes and other machines to create small components.

Other precision instrument and equipment repairers. In addition to the repairers described above, other precision instrument and equipment repairers service, repair, and replace a wide

Some pieces of equipment are cheaper to replace than to repair. For others, repairers may have to create replacement parts that are no longer available.

range of equipment for automated or instrument-controlled manufacturing processes. A precision instrument repairer working at a power plant, for example, might maintain and repair the



gauges that monitor pressure, fuel, and efficiency of a turbine generator.

Repairers diagnose problems when a gauge displays readings outside an acceptable range. They must determine whether the gauge is functioning properly and replace malfunctioning gauges. In other cases, the machinery is not working properly. Repairers often replace malfunctioning parts, but fixing the existing parts may be the least costly or, because replacement parts are not always available, the only option.

Other precision instrument and equipment repairers, like most repairers, perform preventive maintenance, including regularly lubricating, cleaning, and adjusting measuring devices. These workers use many of the same tools medical equipment repairers use.

Working conditions

Precision instrument and equipment repairers work in a variety of conditions—from hot, noisy factories to quiet, air-conditioned workshops to the outdoors. Most work alone, moving through the repair process methodically; the individual nature of their jobs results in minimal supervision. But because their duties may involve dangerous machinery and toxic chemicals, repairers must be concerned with their own safety.

Precision instrument and equipment repairer employment, 1998

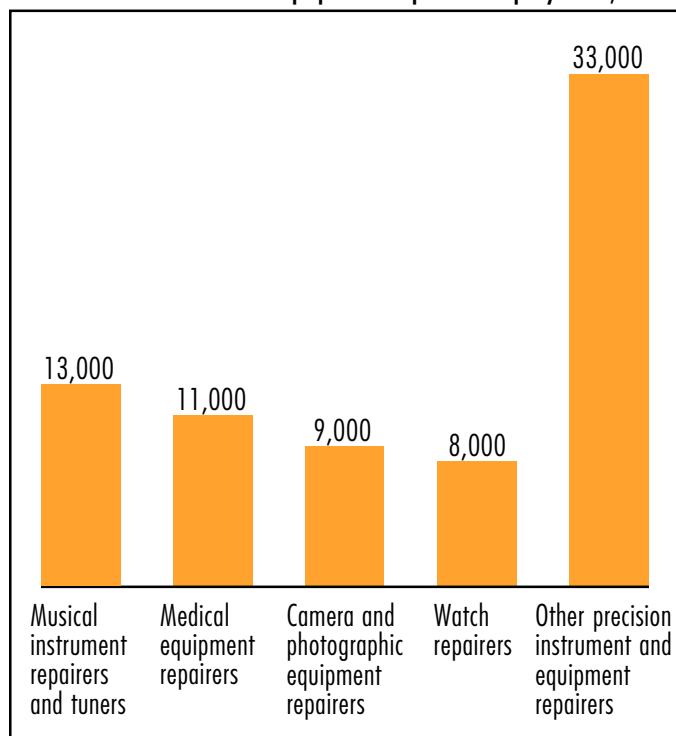


Photo courtesy of Toshiba America Medical Systems

Repairers of large devices, such as medical equipment, often must travel to the equipment site to work.

Camera and watch repairers and musical instrument repairers work under fairly similar conditions. A quiet, well-lighted workshop or office is typical, although some repair jobs for large instruments or equipment—for grandfather clocks, pianos, and organs, for example—require travel to the site. Work schedules vary.

In contrast, medical equipment repairers often work in hospitals or for wholesale equipment suppliers, while most other precision instrument and equipment repairers work in manufacturing plants. Repairers usually work standard daytime hours. But, like other hospital and factory employees, some repairers work irregular shifts.

Employment and earnings

Precision instrument and equipment repairers held 74,000 jobs in 1998. (See chart.) The majority of medical equipment repairers and of other precision instrument and equipment repairers, the largest occupation, were wage and salary workers; most were employed by large companies. But 3 out of 5 camera and photographic equipment repairers, musical instrument repairers, and watch repairers worked as self-employed contractors. Watch repairers are increasingly self-employed, contracting with both jewelry stores and Internet customers.

The table shows earnings for precision instrument and equipment repairers in 1998. Among these repairers, other precision instrument and equipment repairers had the highest earnings, musical instrument repairers and tuners the lowest. However, most earnings differences were less marked at either end of the spectrum than they were at the median. For example, the highest earning 10 percent of camera and photographic equipment

Earnings of precision instrument and equipment repairers, 1998

Occupation	Lowest 10 percent	Median	Highest 10 percent
Camera and photographic equipment repairers	\$15,340	\$28,320	\$50,010
Medical equipment repairers	19,630	34,190	48,890
Musical instrument repairers and tuners	13,230	21,580	38,680
Watch repairers	13,790	24,590	43,230
Other precision instrument and equipment repairers	23,310	39,580	51,820

repairers made close to what the highest earning 10 percent of other precision instrument and equipment repairers did. And the lowest earning watch repairers made slightly more than the lowest earning musical instrument repairers and tuners did.

Job outlook

Overall, employment of precision instrument and equipment repairers is projected to grow more slowly than the average for all occupations over the 1998-2008 decade. But projected growth varies by occupation.

For example, job growth among medical equipment repairers is expected to be about as fast as the average for all occupations over the projections decade. The expanding elderly population should spark strong demand for medical equipment and, in turn, create good employment opportunities in this specialty.

Slower-than-average employment growth is projected for camera and photographic equipment repairers. Camera and photographic equipment repair business is largely immune to downturns in the business cycle because consumers are more likely to repair an expensive camera or equipment than to buy it new. But the popularity of inexpensive cameras, which are cheaper to replace than to repair, adversely affects employment of camera repairers.

Employment of musical instrument repairers also is expected to increase more slowly than average. Replacement needs will provide the most job opportunities as many existing musical repairers and tuners near retirement. An expected increase in the number of school-aged children involved with music should improve the demand for repairers. However, cuts in school music programs, combined with an increasing number of other activities competing for students' interest, is expected to result in a decrease in the number of new musicians who require instrument rentals, purchases, and repairs. Training is limited to a few schools with organized programs, and few experienced workers take on apprentices. Therefore, opportunities should exist for those who receive training.

A slight decline in employment is expected for watch repairers. However, applicants should have very good opportunities as the large proportion of watch and clock repairers approaches retirement age and as fashion trends change. Over the past few decades, changes in technology, including the invention of digital and quartz watches, caused a significant decline in the demand for watch repairers. But shifts in fashion tastes during the 1990's resulted in rapidly growing demand for expensive antique and mechanical watches.

The projected decline in employment of other precision instrument and equipment repairers reflects the lack of employment growth in manufacturing. The decline is offset somewhat, however, by the increasing sophistication of manufacturing equipment and a shortage of applicants due to competition for skilled workers in technical occupations.

Skills and training

Precision instrument and equipment repairers need different skills and training, depending on their specialty. However, some general qualifications usually are required. For example, repairers must pay attention to detail, enjoy solving problems and disassembling machines to see how they work, and be able



Employment, earnings, and job outlook depend on repairers' area of expertise. Other precision instrument and equipment repairers are the largest group and have the highest earnings, but employment is expected to decline.

to work alone with minimal supervision. Because their work involves a great deal of manual dexterity, repairers also need good vision and fine motor skills.

Regarding training, all positions usually require that repairers have at least a high school diploma. Additional training

Training requirements differ according to specialty, but most employers prefer that repairers have some postsecondary education.

takes place on the job, but most employers prefer to hire repairers who have some postsecondary education. The ability to read technical manuals is important.

The qualifications and educational backgrounds of camera and photographic equipment repairers vary. Some background in electronics is necessary, including the ability to read an electrical schematic and comprehend other technical information. New employees are trained on the job in two stages: first, they assist a senior repairer for about 6 months; second, they refine their skills performing repairs on their own for an additional 6 months. Some workers complete postsecondary training, such as an associate degree, in camera and photographic equipment repair. Most repairers in this specialty hone their skills by attending manufacturer-sponsored seminars for specific models.

Medical equipment repair requires less training than precision instrument and equipment repair of other specialties. A background in electronics is helpful but not required. Many medical equipment repairers specialize in a specific model or brand. Learning through hands-on experience and observation, new repairers assist an experienced worker over 3 to 6 months of training. Gradually, trainees begin working independently under close supervision. Following about a year of on-the-job training, medical equipment repairers are considered fully skilled. There are no formal training programs for these repairers.

Most musical instrument repairer and tuners have posthigh school training. According to a 1997 Piano Technicians Guild membership survey, more than 85 percent of respondents had completed some college work; at least 50 percent had a bachelor's or higher degree. A few technical schools and colleges have programs in musical instrument repair. Graduates of these programs usually receive additional training on the job, working with an experienced repairer. Although technical

school training is preferred by employers, some musical instrument repairers and tuners begin learning their trade on the job as assistants. Trainees perform a variety of tasks, with full qualification usually requiring 2 to 5 years of training and practice.

Developing proficiency in watch or clock repair requires several years of education or experience, usually both. Some watch and clock repairers learn on the job, assisting a master watch repairer. A more common training route is through certification available from several associations, including the American Watchmakers-Clockmakers Institute. Some certifications require that applicants pass an examination; other certification programs take a few months to complete. Still others are more demanding, requiring 3,000 hours—over 2 years—of classroom time in technical institutes or colleges. Watch repairers generally need more training than clock repairers because watches have smaller components and require greater precision.

Other precision instrument and equipment repairers must



Most musical instrument repairers and tuners have some posthigh school training. Some begin learning their trade on the job as assistants.

have completed a high school education that includes coursework in mathematics and the sciences. Most employers also require these repairers to take postsecondary courses that help them to understand blueprints, electrical schematics, and electrical, hydraulic, and electromechanical systems. In addition to formal education, the job usually requires 2 years of on-the-job training before a repairer is considered fully qualified. A bachelor's degree is usually required for the most advanced positions.

Sources of additional information

Visit your local library for books and periodicals about the different repairer occupations—camera and photographic equipment, medical equipment, musical instrument, watch, and other precision instrument and equipment—that interest you. For specific details, you also may contact the associations below.

Information about training, mentoring programs, and schools with programs in precision instrument repair is available from:

ISA—Instrumentation, Systems, and Automation Society
67 Alexander Dr.
PO Box 12277
Research Triangle Park, NC 27709
(919) 549-8411
<http://www.isa.org>

For information about careers for camera repairers, contact:
The National Association of Photo Equipment Technicians
3000 Picture Pl.
Jackson, MI 49201
(517) 788-8100

For information about medical equipment repair, contact a medical equipment repair shop or hospital near your home.

For information about musical instrument repair, including schools offering training, contact:

National Association of Professional Band Instrument Technicians
PO Box 51
Normal, IL 61761
(309) 452-4257
<http://www.napbirt.org>

For additional information about piano repair work, contact:
Piano Technicians Guild
3930 Washington St.
Kansas City, MO 64111-2963
(816) 753-7747
<http://www.ptg.org>

For information about watch and clock repair and a list of schools with related programs of study, contact:
American Watchmakers-Clockmakers Institute (AWI)
701 Enterprise Dr.
Harrison, OH 45030-1696
(513) 367-9800
<http://www.awi-net.org>

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