Industry & Trade Summary

Measuring, Testing, Controlling, and Analyzing Instruments

USITC Publication 2648
July 1993

OFFICE OF INDUSTRIES
U.S. International Trade Commission
Washington, DC 20436

UNITED STATES INTERNATIONAL TRADE COMMISSION

COMMISSIONERS

Don E. Newquist, Chairman
Peter S. Watson, Vice Chairman
David B. Rohr
Anne E. Brunsdale
Carol T. Crawford
Janet A. Nuzum

Office of Operations
Robert A. Rogowsky, Director

Office of Industries
Vern Simpson, Director

This report was prepared principally by

Ruben H. Moller

Instruments and Precision Manufactures Branch
Services and Electronics Division

Address all communications to
Secretary to the Commission
United States International Trade Commission
Washington, DC 20436

PREFACE

In 1991 the United States International Trade Commission initiated its current *Industry and Trade Summary* series of informational reports on the thousands of products imported into and exported from the United States. Each summary addresses a different commodity/industry area and contains information on product uses, U.S. and foreign producers, and customs treatment. Also included is an analysis of the basic factors affecting trends in consumption, production, and trade of the commodity, as well as those bearing on the competitiveness of U.S. industries in domestic and foreign markets.[1]

This report on measuring, testing, controlling, and analyzing instruments covers the period 1987 through 1991 and represents one of approximately 250 to 300 individual reports to be produced in this series during the first half of the 1990s. Listed below are the individual summary reports published to date on the electronic technology sector.

USITC publication number	*Publication date*	*Title*
2445	November 1991	Television Receivers and Video Monitors
2648	July 1993	Measuring, Testing, Controlling, and Analyzing Instruments

[1] The information and analysis provided in this report are for the purpose of the report only. Nothing in this report should be construed to indicate how the Commission would find in an investigation conducted under statutory authority covering the same or similar subject matter.

CONTENTS

CONTENTS—*Continued*

CONTENTS—*Continued*

INTRODUCTION

This report provides information on the domestic and foreign industries primarily engaged in the manufacture of measuring, testing, controlling, and analyzing instruments and system (instruments and systems),[1] and covers the period 1987 through 1991. The report is organized into three major sections: U.S. and foreign industry profiles; tariff and nontariff measures; and U.S. industry performance in domestic and foreign markets. In addition, appendixes include explanations of tariff and trade agreement terms and statistical tables.

An instrument is a device that makes a calibrated measurement of a physical, electrical, or chemical quantity, which it may display, transmit, and/or automatically control. An instrument system combines one or more instruments with auxiliary or associated devices for detection, observation, measurement, automatic control, automatic computation, communication, or data processing.[2] These instruments and systems operate mechanically, pneumatically, electronically, or electrically. Often the name of an instrument or system describes the function for which it is designed, such as hardness tester, flowmeter, revolution counter, speedometer, voltage meter, process control system, and thermal analysis instrument.

This summary covers many instruments and systems with a wide range of applications. The instruments and systems range from low- to high-technology products with various capabilities and accuracy ranges. A sizable share of the products manufactured by this industry consists of advanced-technology products. Based on 1991 data, 4 of the 11 product groups covered in this summary accounted for almost 86 percent of the value of total U.S. producers' shipments, 85 percent of U.S. exports, and 86 percent of U.S. imports. Each of the four major product groups include a high percentage of technology-intensive instruments and systems.

The largest product group is instruments for measuring, checking and controlling the flow, level, pressure or other variables of liquids or gasses (measuring and controlling instruments), which accounted for about 30 percent of total U.S. shipments, 26 percent of total U.S. exports, and 33 percent of total U.S. imports in 1991 (table B-2). The principal products manufactured by producers of measuring and controlling instruments include process control computers,[3] programmable logic controllers (PLC),[4] sensors,[5] flowmeters,[6] level indicators, and pressure gauges. Approximately 70 percent of the measuring and controlling instruments are industrial instruments and related products for measuring, displaying, transmitting, and controlling process variables.[7] The principal end users of these instruments are the manufacturing and process industries and public utilities. The remaining 30 percent of the measuring and controlling instruments are designed for monitoring and controlling residential and commercial environments, such as heating and air-conditioning installations, and household appliances. The primary producers and users of these instruments are the cooking appliances, refrigerators, and air conditioners manufacturers.

The second-largest product group is instruments and apparatus for measuring or checking electrical quantities (instruments for measuring electrical quantities), which accounted for about 29 percent of total U.S. shipments, 27 percent of total U.S. exports, and 14 percent of total U.S. imports (table B-3). Instruments for measuring electrical quantities include electrical indicating instruments, electrical recording instruments, and instruments and apparatus for testing electrical circuits of products such as radios, televisions, communication systems, motors, and appliances. The primary end users of these instruments are producers and installers of electrical and electronic equipment, inspection and maintenance facilities, and research and development (R&D) facilities.

The third-largest product group is instruments and apparatus for physical or chemical analysis (analytical instruments), which accounted for almost 20 percent of total U.S. shipments, 22 percent of total U.S. exports, and 19 percent of total U.S. imports (table B-4). The analytical instruments have laboratory and industrial applications, and include, in part, electrochemical, chromatographic,[8] spectrophotometric,[9] thermal analysis, and on-stream gas and liquid analysis instruments,[10] as well as clinical laboratory

[1] Not included are products covered in Standard Industrial Classification (SIC) code 3812, 3821, and certain products covered in SICs 3827 and 3829. In addition, data provided in this summary does not include proprietary instruments and systems produced by firms solely for internal consumption.

[2] McGraw-Hill, *Dictionary of Scientific and Technical Terms*, 1974, p. 758.

[3] A process control computer provides supervisory control over an entire process control system, and may have computation, data collection, and report generation capabilities.

[4] A PLC performs the function of an automatic controller, and collects and communicates information.

[5] A sensor is a device that senses either the absolute value or a change in a physical quantity such as temperature, pressure, flow rate, or pH and converts that change into a useful input signal.

[6] A flowmeter is an instrument used to measure flow rate, pressure and discharge rate of a liquid, vapor, or gas flowing in a pipe.

[7] Process control systems continually monitor the critical physical variables in an industrial process and keep them within predetermined limits. In a manufacturing plant, a control system may control a single process, a number of processes, or all the processes in a plant.

[8] Chromatography uses the method of separating and analyzing chemical substances by chromatographic absorption; the separation processes may be by partition, absorption, permeation, exclusion, or ion exchange.

[9] Spectrophotometry measures photometrically the wavelength range of radiant energy, such as visible light, ultraviolet light, or x-rays absorbed by a sample under analysis.

[10] On-stream gas and liquid analysis instruments and systems are used in such areas as oil refining process or chemical manufacturing process.

instruments for measuring, analyzing, and processing clinical specimens. The leading end users of analytical instruments are life science, clinical, industrial, educational, government, and nonprofit research laboratories.

The fourth-largest product group is measuring or checking instruments, appliances, and machines not specified elsewhere (measuring instruments not specified elsewhere), which accounted for about 7 percent of total U.S. shipments, 10 percent of total U.S. exports, and 20 percent of total U.S. imports (table B-5). Measuring instruments not included elsewhere encompass many unrelated products such as profile projectors, machines for balancing mechanical parts, test benches, equipment for inspecting photomasks[11] and semiconductor wafers,[12] and equipment for testing the characteristics of internal combustion engines. The primary end users of these products include machine and repair shops, manufacturing enterprises, and quality control facilities.

The remaining seven product groups accounted for 14 percent of U.S. shipments, 15 percent of U.S. exports, and 14 percent of U.S. imports of instruments and systems.

Gas, liquid, or electricity supply or production meters are meters that measure, total, and register the quantity of gas, liquid, or electricity produced, supplied or consumed over a period of time (table B-6). The largest markets for these meters are public utilities, oil refineries, gas and oil storage and distribution facilities, and pipeline operators.

Revolution counters, production counters,[13] taximeters, odometers, pedometers and the like;[14] speedometers and tachometers;[15] and stroboscopes[16] perform various measuring functions (table B-7). Manufacturing enterprises, testing facilities, and laboratories are the primary users of counting devices, tachometers, and stroboscopes. Motor vehicle manufacturers are the principal producers and end users of speedometers and odometers.

[11] A photomask is a glass plate on which single integrated circuit layers are patterned.

[12] A semiconductor wafer is a thin disk, from 2 to 8 inches in diameter, cut from silicon or other semiconductor material. The wafer is the base material on which integrated circuits are fabricated.

[13] Counters are devices for detecting, totaling, and indicating a sequence of events.

[14] Taximeters automatically show the fare payable in relation to time and to distance traveled. Pedometers are carried by people and determine the distance traversed while walking or jogging. Odometers are essentially revolution counters graduated in linear units, such as miles or kilometers, and register the distance traveled by a vehicle.

[15] Speedometers measure and indicate the speed of travel of motor vehicles, bicycles, locomotives, ships, and other forms of conveyance, in miles or kilometers per hour or knots. Tachometers indicate speed, the number of revolutions, output, and so forth, per unit of time, and are widely used to measure the movement of motors, gears, engines, conveyors, drill presses, mixers, and fans.

[16] Stroboscopes are used to observe machines in operation as though they are stationary or moving slowly.

Instruments and apparatus for measuring or detecting alpha, beta, gamma, X-ray, cosmic or other ionizing radiations include, in part, ionizing chambers,[17] Geiger-Muller counters,[18] scintillation counters,[19] and semiconductor detectors[20] (table B-8). These instruments are used primarily for radiation dose and exposure measurements in nuclear power plants, uranium- and fuel-processing and reprocessing plants, hospitals, laboratories, and other facilities that may be exposed to radiation.

Machines and appliances for testing the hardness, strength, compressibility, elasticity or other mechanical properties of metal, wood, textile, paper, and plastics are instruments for testing articles or materials to determine their physical strength, their service life, their weaknesses and possible points of failure, and their reaction to different external conditions (table B-9). These machines and appliances have wide applications in almost all sectors of industry, and are mostly used for fundamental and basic research, and quality control functions.

Hydrometers and similar floating instruments,[21] thermometers, pyrometers,[22] barometers, hygrometers and psychrometers,[23] recording or not, and any combination of these instruments perform measuring functions for which they are designed (table B-10). These instruments have a wide range of uses for household, laboratory, scientific, and industrial applications.

The remaining two product groups are instruments, apparatus and models, designed for demonstrational purposes, unsuitable for other uses (table B-11), and parts and accessories, not specified or included elsewhere in this chapter, for machines, appliances, instruments or apparatus of chapter 90 of the Harmonized Tariff Schedule of the United States (HTS) (table B-12).[24]

[17] An ionizing chamber is an ion particle detector.

[18] A Geiger-Muller counter is an instrument for detecting the presence and intensity of cosmic rays or radioactive substances.

[19] A scintillation counter is a device that operates on the principle that radiation can be detected or measured by scintillation produced in a fluorescent material by ionizing radiation.

[20] A semiconductor detector is a device in which semiconductor compound detects radiation.

[21] Hydrometers are floating instruments for measuring and indicating density, specific gravity, or similar characteristics of liquids.

[22] Pyrometers are temperature measuring instruments which measure beyond the range of thermometers.

[23] Hygrometers and psychrometers measure the moisture content of air or gases.

[24] Parts and accessories classifiable under HTS 9033.00.00 include parts and accessories not specifically dedicated to a particular end use. For example, these goods include (1) a digital strip chart recorder that is not a stand-alone printer, and may be integrated into different types of instruments; or, (2) a strain gauge that may be integrated into scales, certain analytical instruments, hardness pressure gauges, etc. Other parts and accessories classifiable under HTS 9033.00.00 include electric gauges and other types of gauges for measuring temperature, pressure etc., that do not have an output display or are not calibrated for specific measurements.

U.S. INDUSTRY PROFILE

Industry Structure

The instruments and systems covered in this summary correspond to the following Standard Industrial Classification (SIC) codes: SIC 3822, Automatic Controls for Regulating Residential and Commercial Environments and Appliances; SIC 3823, Industrial Instruments for Measurement, Display, and Control of Process Variables; and Related Products; SIC 3824, Totalizing Fluid Meters and Counting Devices; SIC 3825, Instruments for Measuring and Testing of Electricity and Electrical Signals; SIC 3826, Laboratory Analytical Instruments; SIC 3827 (pt.), Optical Instruments and Lenses; and SIC 3829 (pt.), Measuring and Controlling Devices, Not Elsewhere Classified..

The United States is the world's single largest producer and user of the instruments and systems covered in this summary. During 1987-1991,[25] the estimated number of U.S. establishments primarily engaged in the manufacture of instruments and systems declined from 3,240 to 3,200. During the same period, approximately 2,740 establishments employed less than 100 workers; 260 employed 100 to 249 people; 120 employed 250 to 499 workers, and 80 employed 500 workers or more. About 75 percent of total U.S. shipments was produced by 460 establishments with 100 or more employees.

Based on the value of U.S. producers' shipments during 1987-91, the leading States producing instruments and systems were California, with 20 percent, Massachusetts, with 9 percent, Pennsylvania, with 7 percent, Illinois and Ohio, with 5 percent, each, and New Jersey and Washington, with 4 percent, each.

During 1987-91, total employment declined from about 230,000 to 228,800. The decline in the labor force was primarily due to improved production efficiencies; also, some highly labor-intensive parts and components, especially electronic types, are assembled increasingly in low labor cost countries. The ratio of production workers to all employees averaged about 52 percent during 1987-91.

Because the instrument industry is technology-intensive, skilled workers and professionals make up a large share of the work force. Most of these employees are primarily engaged in R&D, engineering, operating high-technology capital equipment, performing extensive quality-control functions, and providing after-sales services. U.S. shipments per worker grew steadily from $91,300 in 1987 to $103,600 in 1991. The average hourly earnings of the production workers increased from $10.75 in 1987 to $11.75 in 1991.[26]

The instrument industry as a whole did not experience unusual problems relating to production cost, material shortage, environmental restraints, or product liability during 1987-91. However, the semiconductor automatic test equipment (ATE) manufacturers were hurt by the high cost of capital. These firms probably produce the most costly and technology-intensive equipment manufactured by the instrument industry.[27] To design, develop, and build a next-generation tester generally takes several years, and it may require spending $45 million or more in R&D, engineering, material, and human resources before the equipment is placed on the market.[28]

The instrument manufacturers, especially those producing advanced- to high-technology products, devote considerable effort to sales, engineering, and after-sales services. Most of the medium and large-sized U.S. producers market the bulk of their instruments and systems in the United States by direct sales, and provide engineering and after-sales service through their own facilities. The small-sized companies generally market a large portion of their products through independent distributors, and the remainder by direct sales or through factory representatives. U.S. firms that have production facilities overseas generally market and service their U.S.-made products through these subsidiaries. Other U.S. producers with large foreign markets have wholly owned sales, engineering, and after-sales servicing facilities overseas. U.S. producers with small overseas markets generally have their sale, engineering, and after-sales service handled by independent local firms.

The instrument and system market is highly competitive, with hundreds of U.S. and foreign companies competing for a segment of the market. Consequently, the prices charged for instruments and systems are primarily determined in the marketplace. At a minimum, the price of a product must cover the cost of R&D, engineering, designing, producing, and selling the equipment, as well as earning a reasonable return on the investment. Generally, the instrument industry gives quantity discounts for products purchased in large quantities, which are mostly low- to medium-technology instruments with relatively large

[25] Unless otherwise indicated, the 1987 data provided in this section are based on U.S. Department of Commerce, 1987 Census of Manufactures, Industry Series, "Search and Navigation Equipment and Engineering, Measuring, Controlling, and Optical Instruments," April 1990; the 1988 and 1989 data are based on U.S. Department of Commerce, 1989 Annual Survey of Manufactures, "Statistics for Industry Groups and Industries (Including Capital Expenditures, Inventories, and Supplemental Labor, Fuel, and Electric Energy Costs)", June 1991. The remainder of the data provided are estimated by the staff of the USITC, based on data extracted from 10 K reports and/or annual reports of fifty of the leading U.S. instrument manufacturers, and other sources.

[26] The average hourly earnings of production workers for 1987-90, is based on data of the U.S. Department of Commerce, International Trade Administration, "1992 U.S.Industrial Outlook 1992", Industrial and Analytical Instruments, p. 23-1-23-5; 1991 earnings were estimated by the staff of the USITC.

[27] The selling price of automatic semiconductor test equipment can range from several hundred thousand dollars to more than five million dollars.

[28] *Electronic Business*, Sept. 1992, p. 95.

and repetitive demands. Another factor that influences the price of a product is the relationship between the instrument producer and the purchaser of the products. In recent years, as the instruments and systems have become increasingly more sophisticated, complex, and dedicated, many instrument manufactures have established strategic relationships with their primary customers.[29] Industry sources have stated that such interaction between the producers and purchasers of instruments and systems is advantageous to both parties.

The instrument industry, like most other technology-intensive industries, invests heavily in R&D. During 1987-91, the U.S. instrument industry's composite R&D expenditure as percent of sales decreased from 7.8 percent to 7.2 percent.[30] The rapid technological advances experienced in many technology-intensive industries, especially in the electronic industries, is one of the primary factor influencing the relatively high level of R&D expenditure of the U.S. instrument industry. These technological advances are fueling the ongoing need for increasingly complex, sophisticated, and technology-intensive instruments and systems. To meet the changing needs of the end users of instrument and systems, the U.S. instrument industry is compelled to continually conduct extensive R&d efforts in order to design, develop, and produce instruments and systems of the highest quality, and reliability, and have the fasted possible throughput at the lowest possible cost. Most of the R&D efforts undertaken by the instrument industry is directed towards improving and refining existing products, expanding their use and applications, and developing new instruments and systems. Firms producing advanced- to high-technology equipment generally invest more in R&D activities than those with low- to medium-technology products. For example, during 1987-91, the composite R&D expenditure as a percent of sales of the semiconductor ATE manufacturers ranged from 14 percent to 15. Reportedly, the composite U.S. instrument industry's composite R&D expenditure is higher than the composite R&D expenditure of the foreign instrument industry.[31] However, it is believed that R&D expenditure by some of the leading foreign instrument manufacturers is equal to or higher than their U.S. competitors.

[29] In the instrument manufacturing industry, a strategic relationship implies that the instrument manufacturer and the purchaser of the product collaborate in such areas as preliminary engineering, detailed system design, fabrication and construction, training and start-up, and maintenance.

[30] R&D expenditures for 1987-91 are based on data extracted from 10 K reports and/or annual reports of fifty of the leading U.S. instrument manufacturers.

[31] The information on foreign composite R&D expenditure is based on data provided in Survey of Science Resources Series, National Science Foundation, *International Science and Technology Data Update: 1991*, Special Report, NSF 91-309, as well as contacts in industry.

According to industry sources, a number of factors have contributed to the decline in the level of R&D expenditure by the U.S. scientific instruments industry in recent years. One of the primary factors has been increased competition, especially from foreign instrument producers, which forced the U.S. instrument manufacturers to sell their products at a lower margin of profit. Hence, as the profit margins declined, the U.S. instrument manufacturers' R&D expenditure also contracted. As a result, R&D projects undertaken by the instruments industry in recent years have become more selective and have focused on essential and priority R&D projects. In addition, in recent years, a large number of U.S. instrument manufactures have been acquired by foreign entities, and some of these foreign-owned, U.S-based enterprises may have shifted selected R&D activities to their home countries. Instrument manufacturers generally prefer to perform their most advanced and sensitive R&D activities in the home countries.

Because the instrument industry is technology driven, the U.S. instrument manufacturers are continually integrating into their products the latest advances in solid-state and digital technology, as well as laser, fiber optics, microwave and other technologies in order to improve the performance capabilities of the existing products or to develop new improved products. However, most of the improvements to the products are incremental. In recent years, an increasing number of instruments have built-in microprocessors to improve the speed, measurement process, or analytical capabilities of the instruments. Also, computer hardware and software technologies have become key elements in improving the accuracy, reliability, and versatility of the instruments and systems produced by this industry. Some of the leading U.S. instrument manufacturers produce their own industrial computers and software. Others that do not have the capabilities have teamed up with leading hardware and software firms to supply them with customized computers and software.

Historically, the United States has been and remains the world's leading producer and supplier of many advanced- to high-technology instruments and systems. Most of the leading U.S. producers have production capabilities in many industrialized countries. A large portion of the instruments and systems produced in Canada are made by U.S.-owned companies. In Western Europe and Latin America, wholly owned U.S. companies, joint ventures, and licensing agreements account for a substantial part of total instrument and system shipments in these countries. In Japan and Korea, American manufacturers generally have established joint ventures, or have licensing agreements with local firms. A few wholly owned U.S. companies are located in low-labor-cost Pacific Rim countries for assembling highly labor-intensive electronic parts and components.

In recent years, foreign investment in the U.S. instrument industry has increased sharply. During 1987-90, direct foreign investment in the instrument

industry in the United States doubled to $7.2 billion. U.S. direct investment abroad in the instrument industry during the same period declined by 8 percent, to $1.7 billion.[32] Within the last 4 years, a number of the leading U.S. companies were acquired by or entered into partnership with foreign entities. These U.S. companies are producing highly advanced industrial instruments and control systems for such industries as the petrochemical industry, petroleum-refining industry, paper and pulp industry, food-processing and packaging industry, and the manufacturing industry. The Foxboro Co., believed to be the second-largest U.S. manufacturer of advanced technology industrial instruments and control systems, was taken over by Siebe, PLC of the United Kingdom. The Industrial System Division of Texas Instruments, Inc. was purchased by Siemens AG of Germany. Combustion Engineering, Inc. was purchased by Asea Brown Boveri (ABB) Ltd., a company headquartered in Zurich, Switzerland. Bailey Controls was acquired by Instituto Riconstruzione Industiale (IRI), an Italian holding company.

The division of Johnson Controls, Inc. producing industrial instruments and process control systems is now jointly owned by Johnson Controls and Yokogawa Electric Corp. of Japan; the division of Johnson Control manufacturing controls for monitoring residential and commercial environments remained independent of Johnson/Yokogawa. In 1990, Sumitomo Metal Industries Ltd. of Japan acquired a 15-percent interest of the LTX Corp., plus 49.5 percent of LTX's Japanese operations. LTX is the second-largest U.S. producer of sophisticated semiconductor ATE. As part of this agreement, LTX licensed some of its test technologies to the joint venture. The acquisition of these U.S. companies and their technology by foreign entities will undoubtedly enhance the foreign manufacturers' competitive strength in the U.S. and foreign markets.

Consumer Characteristics and Factors Affecting Demand

The principal end users of instruments and systems are the manufacturing and process industries, public utilities, and laboratories. The end users are located nationwide, but the primary markets are in the heavily industrialized States. The principal consumers of control instruments and systems are the manufacturing and process industries, including producers of machinery, motor vehicles, appliances, and other products, processors of food and kindred products, primary metals, chemicals, petroleum, pulp and paper, and rubber and plastics, as well as electric power utilities, and water purification facilities. The primary end-users of laboratory instruments and systems are industrial, institutional and commercial laboratories.

Instruments and systems have evolved as the primary tools that can make manufacturing and process industries, utilities, and laboratories more productive and to enhance the quality of their products or service. Consequently, the demand for instruments and systems is heavily influenced by the level of capital expenditure by the end users of these products. The demand for industrial measuring and controlling instruments is affected chiefly by the level of capital expenditure by the manufacturers of consumer, commercial, and industrial products for upgrading their manufacturing and process capabilities. The market for controls designed for monitoring and controlling residential and commercial environments, including comfort heating, ventilation, and air conditioning installation, is influenced by the level of construction of commercial buildings and residential housings. The demand for controls for major appliances, such as heating and air-conditioning units, cooking appliances, and refrigerators, is dependent on the level of consumer spending for these products. The demand for instruments for measuring electrical quantities is mostly contingent on the level of production and sales of electrical and electronic products. The market for analytical instruments is determined by the level of funding for medical research, by the amount of R&D expenditures by the biotechnology and pharmaceutical companies and the U.S. Government, and by level of test and evaluation activities of industrial, institutional, and commercial laboratories, and quality control facilities. Other factors that influence the increased demand for analytical instruments are availability of a growing number of highly sophisticated computerized laboratory systems with automated sample handling, data storage and files, as well as providing status reports on samples and analysis, trend analysis, and report writing.

The instrument industry is highly competitive. For a manufacturer of instruments and systems to remain competitive, the producers must (1) be price competitive, (2) make products that are user-friendly, and meet the needs of the end users, (3) incorporate the most up-to-date, state-of-the-art technology into the instruments and systems, (4) provide effective engineering assistance, and (5) furnish prompt and competent after-sales service.

FOREIGN INDUSTRY PROFILE

The primary foreign producers of instruments and systems are located in Germany, the United Kingdom, Japan, and France. Other countries with viable instrument industries are Switzerland, the Netherlands, Italy, and Sweden. During 1987-91, foreign-made instruments and systems are estimated to have accounted for about 60 percent of total world shipments. Germany is believed to have averaged about 30 percent of total foreign shipments, followed by Japan and the United Kingdom with 20 percent each, France with 9 percent, and the rest of the world with 19 percent.[33]

[32] U.S. Department of Commerce, Bureau of Economic Analysis, "Survey of Current Business", August 1991, p. 77 and p. 106.

[33] The estimated total world's shipments of instruments and systems reached $51 billion in 1987 and $60 billion in 1991. These estimates are based on the following: U.S. Department of Commerce, International

The foreign instrument industry consists of several thousand manufacturers, but the bulk of the instruments and systems are produced by a relatively small number of medium and large manufacturers, and they are mostly in Germany, Japan, the United Kingdom, and France. Probably the single largest foreign producer of instruments and systems is Siemens AG of Germany. Some of the other leading foreign manufactures are Rohde & Schwarz GmbH, Carl Zeiss AG, Kloeckner-Moeller GmbH, and Krauss-Maffei Automationstechnik GmbH of Germany; Siebe, PLC, Marconi Instruments Ltd., Oxford Instruments Ltd., and Negretti Aviation Ltd. of the United Kingdom; and Schlumberger Ltd., Cafes Massilia S.A., and Desgranges et Huot S.A. of France. All of these instrument manufacturers are multinational corporations, and virtually all have subsidiaries in the United States. The subsidiaries of many of the leading U.S. instrument manufacturers are also prominent producers of instruments and systems in these countries, and also act as distributors of U.S.-made products, and they include such companies as Honeywell, Inc., Hewlett-Packard Co., Inc., Perkin-Elmer Corp., Beckman Instruments, Inc., Varian Associates, Inc., and Bio-Rad Laboratories, Inc. It is estimated that more than 50 percent of the instruments and systems manufactured in the United Kingdom are produced by subsidiaries of U.S. instrument manufacturers. In Japan, some of the leading Japanese instrument manufacturers are Yokogawa Electric Corp., Ono Sokki Co., Ltd., Advantest Corp., Ando Electric Co., Ltd, Toshiba Corp., and Hitachi Ltd. Virtually all of these Japanese companies have subsidiaries in the United States to distribute and service their products.

Germany, followed by Japan, and the United Kingdom are the United States' primary competitors in the world market. All three countries produce certain instruments and systems that are in some cases equal or superior to U.S.-made products. Overall, foreign producers of instruments and systems do not appear to have a competitive advantage over their American competitors as a result of lower production costs or government policies.

---

[33]—*Continued*
Trade Administration, "Analytical and Scientific Instruments" Industry Sector Analysis, Germany, May 1990; U.S. Department of Commerce, International Trade Administration, "Industrial Controls" Industry Sector Analysis, Germany, June 1990; U.S. Department of Commerce, International Trade Administration, "Electrical Test and Measuring Instruments" Industry Subsector Analysis, Japan, May 31, 1991; U.S. Department of Commerce, International Trade Administration, "Analytical Instruments" Industry Subsector Analysis, Sept. 30, 1991; U.S. Department of Commerce, International Trade Administration, "Scientific and Laboratory Instruments", United Kingdom, April 1989; U.S. Department of Commerce, International Trade Administration, "Analytical and Scientific Instruments", CMP Industry Subsector Analysis, Feb. 1990; and Japan External Trade Organization, *Your Market in Japan*, Analytical Instruments, March 1990.

U.S. TRADE MEASURES

Tariff Measures

Table B-1 shows the rates of duty (as of January 1, 1992), applicable to imports of instruments and systems under the HTS. The table shows the column 1 general duty rates for countries designated for most-favored-nation (MFN) treatment, as well as duty rates under column 1 for countries qualifying under special tariff programs. (See appendix A for an explanation of tariff and trade agreement terms.)

The 1991 U.S. general rate of duty ranges from free to 17 percent. The trade-weighted, average rate of duty for all instruments and systems covered in this summary was 4 percent in 1991.

Nontariff Measures

There are no known nontariff barriers to U.S. imports of instruments and systems.

U.S. Government Trade-Related Investigations

During 1987-92, the Commission conducted 11 investigations related to imports of instruments and systems—7 under the countervailing duty and antidumping laws, 1 under section 332 of the Tariff Act of 1930, and 4 under section 337 of the Tariff Act of 1930. Table 1 shows U.S. Government trade-related investigations conducted during 1987-92.

Table 1
U.S. International Trade Commission investigations related to trade in mesuring, testing, controlling, and analyzing instruments, 1987-92

Date	Type of investigation	Product	Petitioner	Respondent/ source country	Final outcome
1986[1]	Unfair practices in import trade (337-TA-251)	Electronic chromatogram analyzers	Biscan Inc.	Isomess, Isotopenmess-gerate, GmbH, Germany; Aloka, Co. Japan; IN/US Service Corp. of Fairfield, NJ; and Radiomatic Instrument and Chemical Co., Inc., of Tampa, Florida	Negative vote[2]
1986[3]	Unfair practices in import trade (337-TA-256)	Cryogenic ultramicrotome apparatus	Research Manufacturing Co., Inc.	Reichert A.G., Austria; Reichert-Jung, Inc., Buffalo, NY; and Cambridge Instruments, Buffalo, NY	Terminated because of the imminent expiration of the patent
1987	Unfair practices in import trade (337-TA-278)	Programmable digital clock thermostats	White-Roger Division, Emerson Electric Co.	Computime Ltd., Hong Kong; Hunter-Melnor, Inc., Memphis, TN; and Jameson Home products, Downers, Grove IL.	Terminated as a result of settlement and consent order.
1988	Countervailing duty (701-TA-290-272), and antidumping (731-TA-400 and 402-404)	Thermostatically controlled appliance plugs and internal probe thermostats therefor	Triplex Inter Control (USA) Inc.	Canada, Japan Malaysia, and Taiwan	Negative vote[4]
1988	Antidumping (731-TA-390)	Digital readout systems and subassemblies thereof	Anilam Electronic Corp.	Japan	Negative vote[5]
1989	Antidumping (Preliminary) (731-TA-453)	Electromechanical digital counters	ENM, Co.	Brazil	Negative vote; terminated[6]
1990	Antidumping (731-TA-455)	Certain laser lightscattering instruments and parts	logy, Corp.		tive vote[7]

See footnotes at end of table.

Table 1
U.S. International Trade Commission investigations related to trade in mesuring, testing, controlling, and analyzing instruments, 1987-92—Continued

Date	Type of invest	Product	Petitioner	Respondent/ source country	Final outcome
1990	Unfair practices of import trade (337-TA-304)	Certain pressure transmitters	Rosemount Inc.	SMAR Equipment, Brazil and SMAR International Ronkonkoma, N.Y.	Affirmative[8]
1990	General factfinding	Semiconductor manufacturing and testing equipment and materials (SEM)	Senate Committee on Finance	Not applicable	The report concluded that the U.S. industry lost a significant share of the global SEM market during 1980-90.[9]

[1] Investigation was completed in 1987.

[2] U.S. International Trade Commission, *Certain Electronic Chromatogram Analyzers*, investigation No. 337-TA-251, USITC publication 2012, Aug. 1987.

[3] Investigation was completed in 1989.

[4] U.S. International Trade Commission, *Thermostatically Controlled Appliance Plugs and Internal Probe Thermostats Therefor from Canada, Japan, Malaysia, and Taiwan*, Determination in Investigation No. 701-TA-292 (Final) Under the Tariff Act of 1930, and Determinations of the Commission Investigations Nos. 731-TA-400 and 402-404 (Final) Under the Tariff Act of 1930, USITC publication 2152, Jan. 1989.

[5] U.S. International Trade Commission, *Digital Readout Systems and Subassemblies Thereof from Japan*, Determination of the Commission in Investigation No. 731-TA-390 (Final) Under the Tariff Act of 1930, Together With the Information Obtained in Investigation, USITC publication 2150, Jan. 1989.

[6] U.S. International Trade Commission *Electromechanical Digital Counters from Brazil*, Determination of the Commission in Investigation No. 731-TA-453 (Preliminary) Under the Tariff Act of 1930, Together with the Information Obtained in the Investigation, USITC publication 2273, Apr. 1990.

[7] U.S. International Trade Commission, *Certain Laser Light-scattering Instruments and Parts Thereof From Japan*, Determination of the Commission in Investigation No. 731-TA-455 (Final) Under the Tariff Act of 1930, Together with the Information Obtained in the Investigation. USITC publication 2328, Nov. 1990. Antidumping duty order, Federal Register, vol. 55, No. 223, Nov. 1990, notices. Certain light-scattering instruments and parts are still subject to dumping duties, as of Jan. 1993.

[8] U.S. International Trade Commission, *Certain Pressure Transmitters*, investigation No. 337-TA-304 (Commission Decision of Oct. 22,1990), USITC publication 2417, Aug. 1991.

[9] U.S. International Trade Commission, *Global Competitiveness of U.S. Advanced-Technology Manufacturing Industries: Semiconductor Manufacturing and Testing Equipment*, Report to the Committee on Finance, U.S. Senate, on Investigation No. 332-303 Under Section 332(g) of the Tariff Act of 1930. USITC publication 2434, Sept. 1991.

FOREIGN TRADE MEASURES

Tariff Measures

The leading markets for U.S.-made instruments and systems are Canada, the European Community (EC), Japan, Mexico, and Korea, and their duty rates range from free to 20 percent (see below). The duty rates of some of the Latin American countries have reached up to 25 percent.

Nation	Rate of duty on instruments and systems
	(Percent)
Canada	Free - 8.2
EC	Free - 11[1]
Japan	Free - 4.9
Mexico	Free - 20[2]
Korea	10 - 13[3]

[1] The rate of duty for most product groups ranged between 4.6 percent to 7.2 percent in 1991.

[2] The rate of duty for most products was 10 percent in 1991.

[3] The rate of duty for nearly all product groups was 13 percent in 1991.

Nontariff Measures

The Brazilian "Informatics Law" of 1984, and the "Law of Similars" were nontariff barriers that affected Brazilian imports of instruments and systems.[34] The Brazilian Informatics Law provided that the Brazilian market for products incorporating digital technology were reserved for Brazilian-owned and Brazilian-controlled companies. At times, this law limited imports of instruments and systems incorporating digital technologies. The Informatics Law expired on October 29, 1992. The Law of Similars prohibited the importation of goods which were similar to products already manufactured in Brazil. This law often limited the importation of instruments and systems already produced or capable of being produced in Brazil.[35] In 1990, the prohibitions contained in the Law of Similars were lifted for most products except those covered by the 1984 Informatics Law. Other nontariff trade barriers that reportedly hurt imports of instruments and systems are widely differing standards, testing, and certification requirements, and inadequate patent, trademark, and intellectual property protection.

U.S. MARKET

Consumption

The United States is the world's single largest market for instruments and systems. During 1987-91, U.S. consumption of instruments and systems grew at an average annual rate of 3 percent, from $17.0 billion to $19.4 billion (figure 1, and table 2), and in 1992 increased by 1 percent, to $19.5 billion. During 1987-91, U.S. consumption of measuring and controlling instruments rose annually by 4 percent, from $5.3 billion to $6.1 billion; of instruments for measuring electrical quantities increased annually by 1.7 percent, from $5.0 billion to $5.4 billion; and of analytical instruments grew annually by 12 percent, from $2.3 billion to $3.6 billion (tables B-2 - B-4). The marked rise in U.S. consumption of analytical instruments was mostly due to a growing demand for technologically advanced analytical instruments and systems to facilitate faster and more accurate testing by laboratories, testing facilities, and by the manufacturing and process industries.

The ratio of U.S. imports to U.S. consumption for instruments and systems increased from 15 percent in 1987 to 19 percent in 1991. During the same period, the ratio of U.S.imports to U.S. consumption for measuring and controlling instruments rose from 15 percent to 20 percent; for instruments for measuring electrical quantities grew from 7 percent to 10 percent; for analytical instruments increased from 13 percent to 19 percent; and for measuring instruments not specified elsewhere rose from 39 percent to 49 percent. The high ratio of U.S. imports to U.S. consumption for measuring instruments not specified elsewhere occurred chiefly because this product group contains a relatively large percentage of low- to medium-technology instruments and systems. The growth in the ratio of U.S. imports to consumption is attributable, in part, to the growing availability of state-of-the-art and competitively priced foreign-made instruments, an increase in related party transactions, the United States-Canada Free Trade Agreement (U.S.-Canada FTA), and a rise in U.S. imports under HTS subheading 9802.0080.

Production

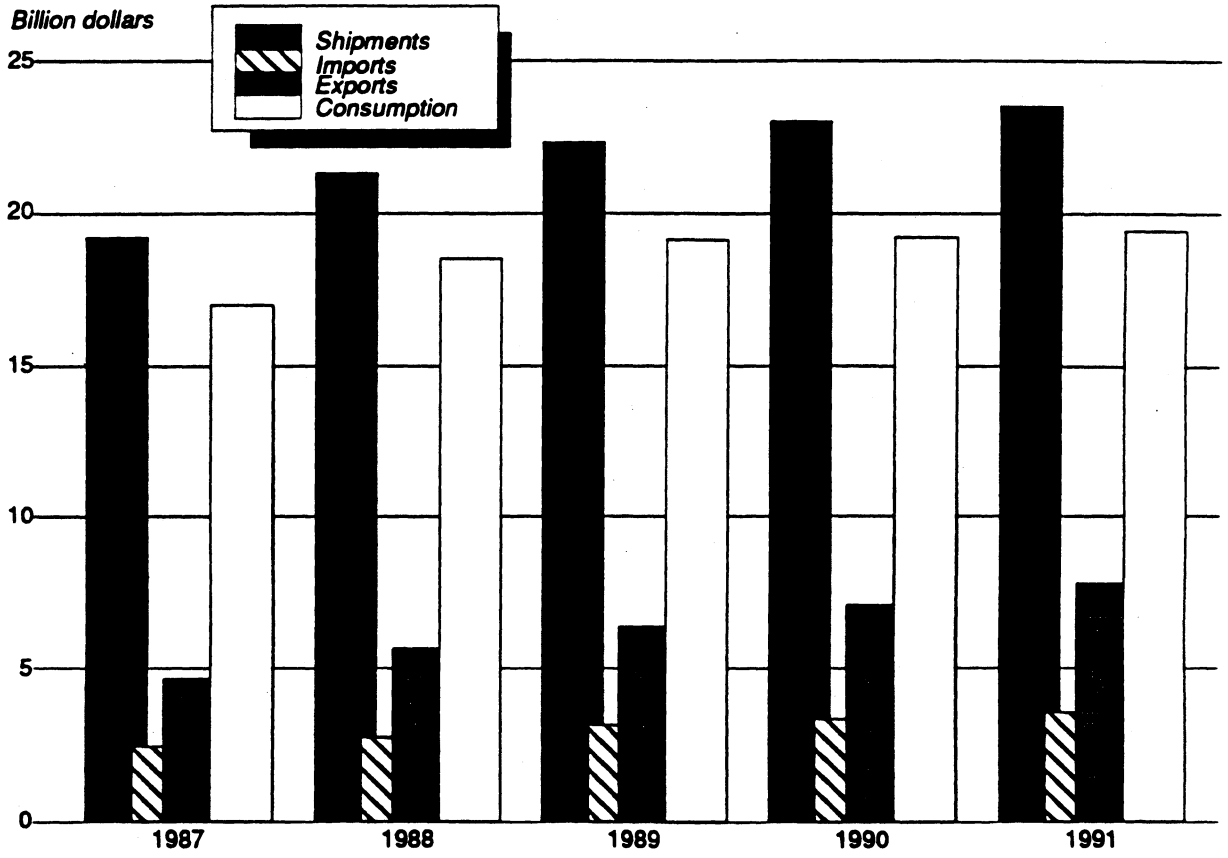
During 1987-91, U.S. producers' shipments of all instruments and systems grew at an average annual growth rate of 5 percent, from $19.2 billion to $23.5 billion (figure 1, and table 2), and in 1992 increased by about 1 percent, to $23.7 billion.[36] During 1987-91, U.S. producers' shipments of measuring and controlling instruments increased at an annual rate of 5 percent, from $5.7 billion to $6.9 billion (table B-2); shipments of instruments for measuring electrical quantities grew at an annual rate of 3 percent, from $6.2 billion to $6.9 billion (table B-3); shipments of analytical instruments rose at an annual rate of 11 percent, from $3.1 billion to $4.6 billion (table B-4); and shipments of measuring instruments not specified elsewhere increased at an annual rate of 5 percent, from $1.3 billion to $1.6 billion (table B-5). These four product groups accounted for 86 percent of total U.S. producers' shipments (figure 2). The rise in

[34] The Brazilian Informatics Law, as well as the Law of Similars, were intended to nurture and protect the domestic industry.

[35] Based on conversations with representatives of major U.S. producers of instruments and systems at the Instrument Society Association's International Conference and Exhibition in Anaheim, California, October 1991.

[36] The 1992 producers' shipments data are based on data extracted from 10 K reports and/or annual reports of 27 U.S. instrument manufacturers.

Figure 1
Measuring, testing, controlling, and analyzing instruments: U.S. producers' shipments, imports, exports, and apparent consumption, 1987–91



Apparent Consumption - Producer's Shipments + Imports - Exports.
Source: U.S. Department of Commerce; USITC.

Table 2
Measuring, testing, controlling and analyzing instruments: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1987-91

Year	Producers' shipments[1]	Exports[2]	Imports[3]	Apparent consumption	Ratio of imports to consumption
			Million dollars		*Percent*
1987	19,210	4,708	2,458	16,960	14.5
1988	21,345	5,683	2,799	18,461	15.2
1989	22,343	6,381	3,174	19,136	16.6
1990	22,960	7,098	3,369	19,231	17.5
1991	23,495	7,757	3,621	19,359	18.7

[1] Estimated by the staff of the U.S. International Trade Commission, based on official statistics of the U.S. Department of Commerce.
[2] Includes the value of U.S. exports of Schedule B Numbers 9023-9033, except Schedule B item 9027.40.00.
[3] Includes the value of U.S. imports of HTS headings 9023-9033, except subheading 9027.40.00.

Note.—Because of rounding, figures may not add to the totals shown.
Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

U.S. producers' shipments was due mostly to a sustained growth in U.S. exports of instruments and systems, which grew at an annual rate of 13 percent, from $4.7 billion to $7.8 billion. This growth in U.S. producers' shipments was primarily due to a growing demand for advanced-technology instruments and systems.

Imports

Products imported

U.S. imports of instruments and systems consist of low- to high-technology products. The product groups accounting for the highest level of U.S. imports in 1991 were measuring and controlling instruments, which accounted for more than 33 percent of total U.S. imports, followed by measuring instruments not specified elsewhere, with 20 percent of total U.S. imports; analytical instruments, with 19 percent of total U.S. imports; and instruments for measuring electrical quantities, with 14 percent of total U.S. imports.

Import levels and trends

U.S. imports of instruments and systems during 1987-91 grew steadily at an average annual growth rate of about 10 percent, from $2.5 billion to $3.6 billion (table 3), and in 1992 U.S. imports rose by 10 percent to $4.0 billion. During 1987-91, major product groups with high average annual growth rate of imports were measuring and controlling instruments, which increased at an annual rate of 10 percent, from $799 million to $1,209 million (tables B-2); analytical instruments, which increased at an annual rate of 19 percent, from $295 million to $675 million (tables B-4); and instruments for measuring electrical quantities, which grew at an annual rate of 10 percent, from $363 million to $523 million (tables B-3).

During 1987-91, total U.S. imports of instruments and systems entering free of duty increased by 90 percent, from $353 million to $670 million. During the same period, the value of duty-free imports under HTS subheading 9802.00.80 increased 47 percent, to $168 million; imports under the Generalized System of Preferences declined by 67 percent, to $71 million; imports under the Caribbean Basin Economic Recovery Act grew by 226 percent, to $3 million; and U.S. imports under the United States-Israel Free-Trade Area rose by 24 percent, to $26 million. During 1987-91, imports under the Agreement on Trade in Civil Aircraft grew by 15 percent, to $146 million; imports under the U.S.-Canada FTA rose by 104 percent, to $142 million; and imports under the Automotive Products Act increased by 62 percent, to $113 million.

Principal import suppliers

The top five supplying countries of instruments and systems were Japan with 26 percent of total imports in 1991, followed by Germany with 14 percent, Canada and the United Kingdom with 12 percent each, and Mexico with 8 percent. Collectively they accounted for 72 percent of total U.S. imports. The 12 EC countries supplied 35 percent of total U.S. imports of instruments and systems in 1991 (table 3, figure 3).

U.S. importers

The leading importers of the instruments and systems are the U.S. instrument manufacturers (both U.S. and foreign-owned), distributors of foreign-made instruments, and the motor vehicle and aircraft manufacturers. Related-party transactions are believed to have averaged about 40 percent of total imports, in terms of value.

FOREIGN MARKETS

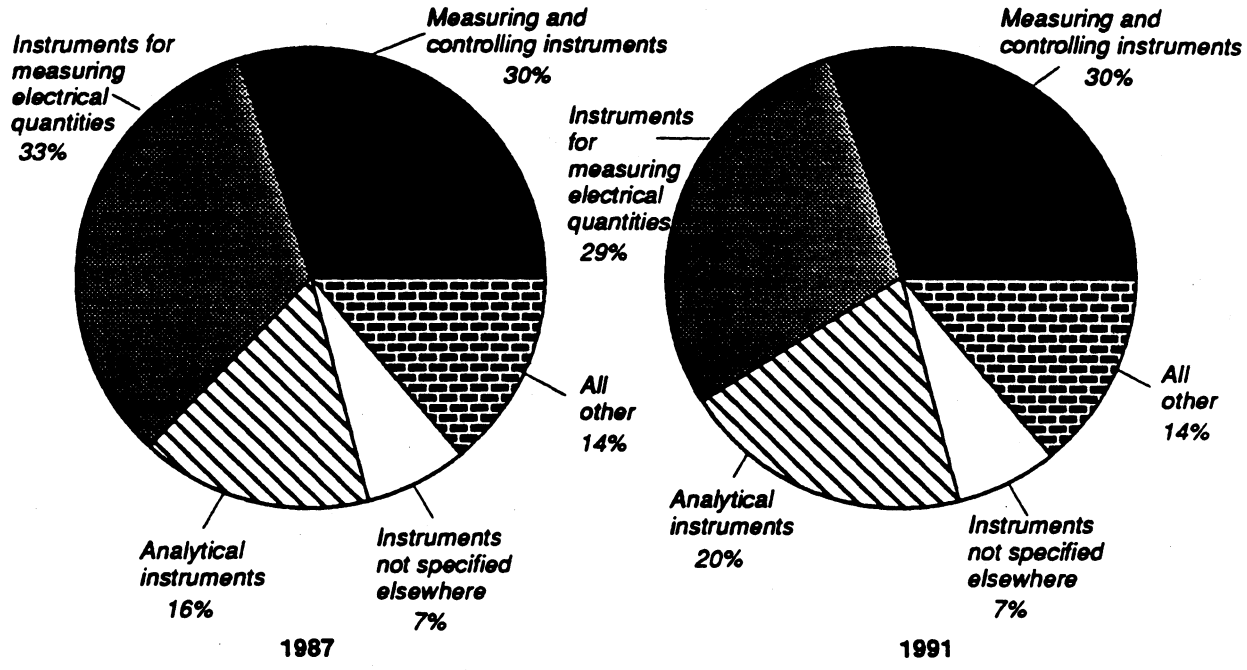
Foreign Market Profile

The United States has been and remains the leading world supplier of many of the advanced- to high-technology instruments and systems. The United States' preeminent position is best illustrated by the fact that about 50 percent of total EC imports of instruments and systems comes from the United States. However, U.S. manufacturers are encountering growing competition in foreign markets, especially from Japan, Germany, and the United Kingdom, as these countries produce a growing number of sophisticated instruments and systems. In addition, purchasers of technology-intensive instruments and systems generally prefer local suppliers that are able to provide assistance relating to preliminary engineering, detailed system design, fabrication and construction, training and startup, and maintenance. Because most of the leading U.S. instrument manufacturers have subsidiaries in most industrialized countries, they are able to provide such services. Many of the small and medium-sized U.S. companies generally do not have the capabilities to provide such service and therefore are less likely to successfully penetrate the overseas markets. However, in spite of increased competition, the United States is expected to remain the leading world supplier of instruments and systems in the foreseeable future.

Canada, Mexico, Japan, and Korea are currently the fastest growing markets for U.S.-made instruments and systems. The growth in U.S. trade with Canada reportedly is primarily due to the U.S.-Canada FTA, which has stimulated the rationalization of production and trade in the two countries.[37] The rising market in Japan for U.S.-made instruments and systems is primarily generated by Japan's need for highly

[37] Conversation with representative of major U.S. producers of instruments and systems at the Instrument Society Association's International Conference and Exhibition in Anaheim, CA., Oct. 1991.

Figure 2
Measuring, testing, controlling, and analyzing instruments: Share (percent) of U.S. producers' shipments, by product groups, 1987 and 1991



Source: U.S. Department of Commerce; USITC.

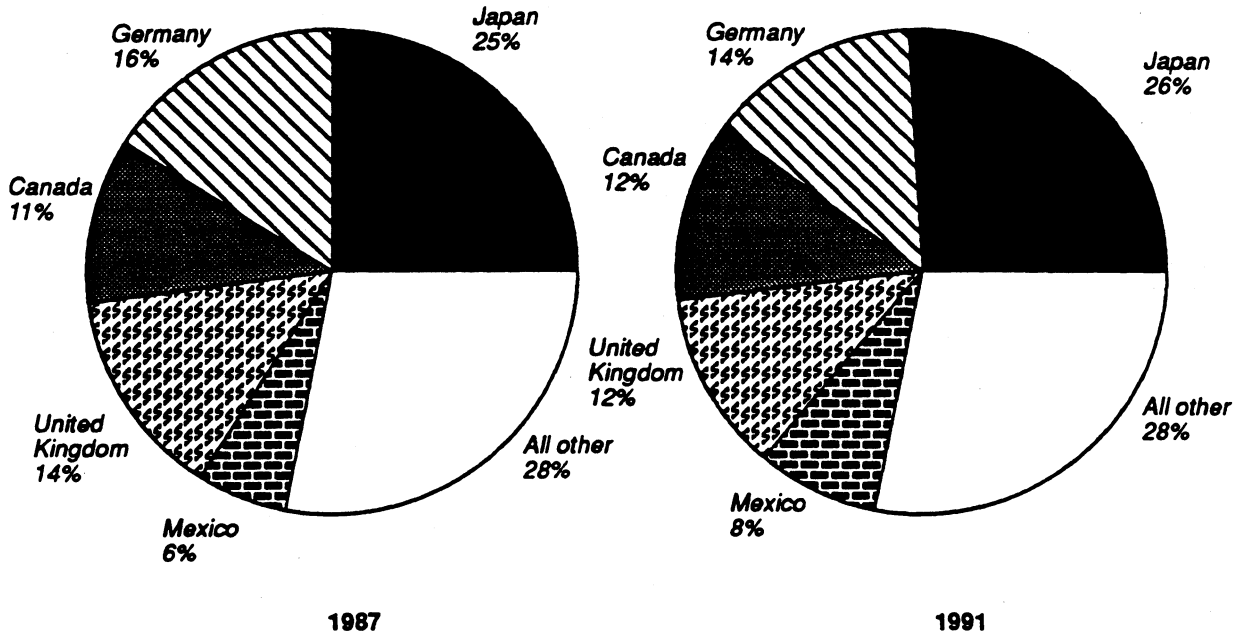
Table 3
Measuring, testing, controlling, and analyzing instruments: U.S. imports for consumption, by principal sources, 1987-91

(1,000 dollars)

Market	1987	1988	1989	1990	1991
Japan	604,710	717,316	850,115	851,298	937,081
Germany	398,825	445,096	476,017	507,121	496,635
Canada	265,381	258,320	305,735	378,526	427,632
United Kingdom	336,845	369,398	428,197	439,883	427,267
Mexico	153,913	193,334	251,299	252,588	302,789
France	77,697	94,056	118,711	129,200	149,061
Switzerland	93,365	101,039	107,341	122,522	121,200
Taiwan	133,355	143,740	132,311	106,628	114,020
Sweden	29,822	33,331	40,260	57,052	71,465
Italy	43,213	39,666	58,518	58,719	52,093
All other	320,622	403,215	405,946	465,181	521,713
Total	2,457,748	2,798,511	3,174,450	3,368,718	3,620,956

Source: Compiled from official statistics of the U.S. Department of Commerce.

Figure 3
Measuring, testing, controlling, and analyzing instruments: Share (percent) of U.S. imports by principal sources, 1987 and 1991



Source: U.S. Department of Commerce.

sophisticated equipment. Many of the instruments and systems exported to Japan are generally not produced in Japan or are regarded as superior to Japanese-made products. Continued growth of the industrial infrastructure in Mexico and in Korea reportedly generated the surge in U.S. exports to these countries.

The North American Free Trade Agreement (NAFTA)[38] incorporates on a trilateral basis most of the provisions of the existing U.S.-Canada FTA, and in many cases expands upon those provisions.[39] The primary NAFTA provisions affecting U.S.-Mexican trade include the removal of tariffs. U.S. imports of instruments and systems from Mexico, with the exception of bicycle speedometers, and parts thereof, will enter the United States duty-free beginning January 1, 1994. Duties on bicycles speedometers, and parts thereof will be removed in five equal annual stages starting January 1, 1994. However, in regards to Mexican imports from the United States, the customs duties of 82 of the 155 HTS subheading covering instruments and systems are scheduled to be totally removed on January 1, 1994, duties on 32 of the subheadings will be removed in five equal annual stages beginning January 1, 1994, and duties on 41 of the subheadings will be removed in 10 equal annual stages beginning in January 1, 1994. It is believed that the U.S. instrument industry will not be adversely impacted by NAFTA. The United States, which is the leading suppliers of instruments and systems to Mexico, is expected to retain this position in the foreseeable future.

[38] NAFTA was signed by the head of state of the United States, Canada, and Mexico, on December 17, 1992, and is scheduled to be in effect on January 1, 1994, subject to approval by the legislative branches of the three countries.

[39] USITC, *Potential Impact on the U.S. Economy and Selected Industries of the North American Free-Trade Agreement*, USITC publication 2596, Jan. 1992, p. vii.

U.S. Exports

Products exported

The United States exports low- to high-technology instruments and systems, but the predominant share of U.S. exports consists of technology-intensive equipment. The product groups accounting for the highest level of U.S. exports in 1991 were instruments for measuring electrical quantities, with 27 percent of total U.S. exports; followed by measuring and controlling

instruments, with 26 percent of total U.S. exports; analytical instruments, with 22 percent of total U.S. exports; and instruments not specified elsewhere, with 10 percent of total U.S. exports. Based on the high percentage of related party transaction, it is believed that a considerable portion of U.S. exports consists of intracorporate trade.

Export levels and trends

U.S. exports of instruments and systems during 1987-91 grew steadily at an average annual growth rate of 13 percent, from $4.7 billion to $7.8 billion (table 4), and in 1992 U.S. exports increased by 6 percent, to $8.2 billion. During 1987-91, U.S. exports of measuring and controlling instruments increased annually by 14 percent, from $1.2 billion to $2.0 billion (table B-2); analytical instruments rose annually by 13 percent, from $1.1 billion to $1.7 billion (table B-4); instruments for measuring electrical quantities grew by 6 percent, from $1.6 billion to $2.1 billion (appendix B, table B-3); and instruments not specified elsewhere increased by 31 percent, from $274 million to $801 million (appendix B, table B-5).

U.S. exports of instruments and systems to the 12 EC countries during 1987-91 grew by 44 percent, to $2.3 billion, and accounted for 34 percent of total U.S. exports in 1987, and 30 percent in 1991. The top six foreign markets were Canada with 16 percent of total imports in 1991, followed by Japan with 14 percent, Mexico with 9 percent, Germany with 8 percent, and the United Kingdom with 6 percent (table 4, and figure 4).

The U.S. instruments manufacturers are the predominant exporters of instruments and systems.

U.S. TRADE BALANCE

The U.S. merchandise trade surplus for instruments and systems during 1987-91 increased at an average annual rate of 16 percent, from $2.3 billion to $4.1 billion (figure 5, and table 5), and in 1992 the trade surplus grew by 2 percent, to $4.2 billion. During 1987-91, the U.S. trade surplus with Canada increased annually by 29 percent, from $281 million to $778 million; the U.S. trade surplus with Mexico rose annually by 31 percent, from $138 million to $407 million; and the U.S. trade surplus with Korea grew annually by 32 percent, from $109 million to $328 million. The U.S. trade surplus with the EC increased annually by 13 percent, from $657 million to $1.075 million. In 1991, the U.S. trade surplus with France, Japan, Germany, and the United Kingdom, all major instrument-producing countries, amounted to $244 million for France, $131 million for Japan and Germany, and $63 million for the United Kingdom. The favorable U.S. merchandize trade balance is attributable to several factors, including the weaker U.S. dollar, increased efforts by the U.S. instrument manufacturers to export, and the fact that the United States is the leading producer of many of the advanced-to high-technology instruments and systems benefitting most from the growing demand for such products.

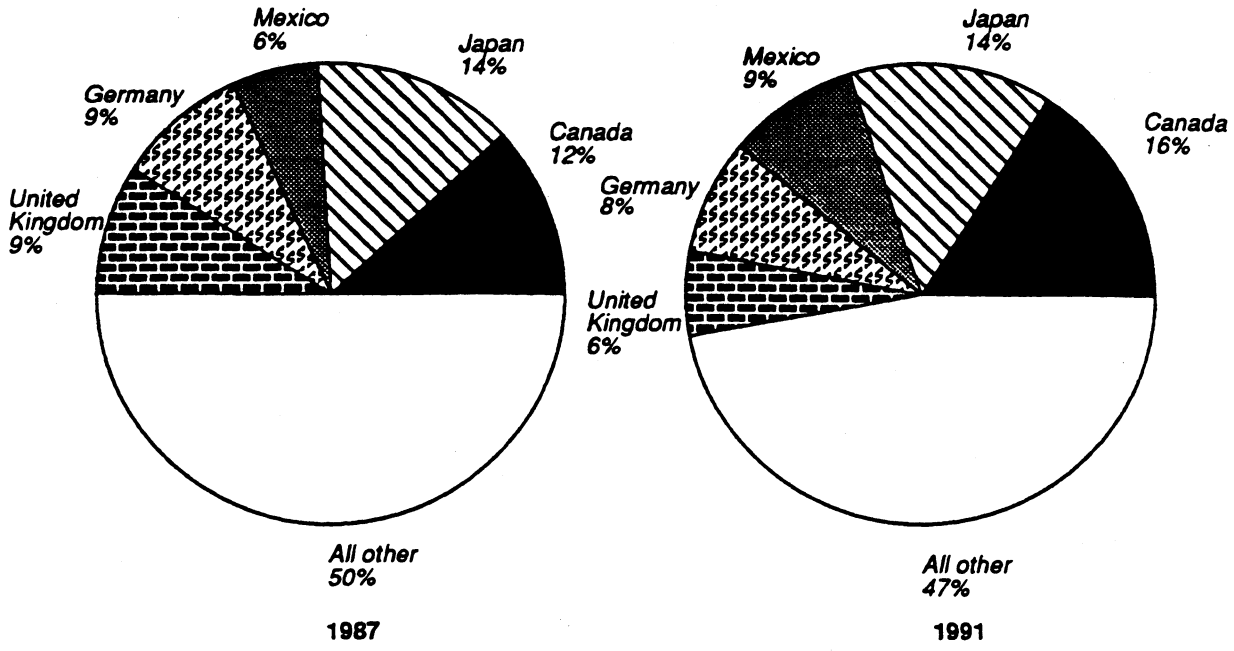
Table 4
Measuring, testing, controlling, and analyzing instruments: U.S. exports for domestic merchandise, by principal markets, 1987-91

(1,000 dollars)

Market	1987	1988	1989	1990	1991
Canada	546,454	646,120	664,163	1,202,997	1,206,247
Japan	650,327	941,244	1,014,078	972,681	1,067,723
Mexico	291,889	342,114	472,827	528,619	709,861
Germany	426,822	467,889	555,853	557,984	628,421
United Kingdom	416,702	505,078	524,184	519,773	490,493
France	234,355	295,051	305,387	329,553	393,241
Korea, South	149,678	192,992	272,692	339,170	362,111
Italy	174,220	200,857	255,808	261,583	266,018
Taiwan	148,308	181,311	203,028	200,413	223,643
Netherlands	164,551	179,153	185,066	194,752	212,985
All other	1,504,686	1,731,642	1,928,336	1,990,640	2,196,654
Total	4,707,992	5,683,451	6,381,422	7,098,165	7,757,397

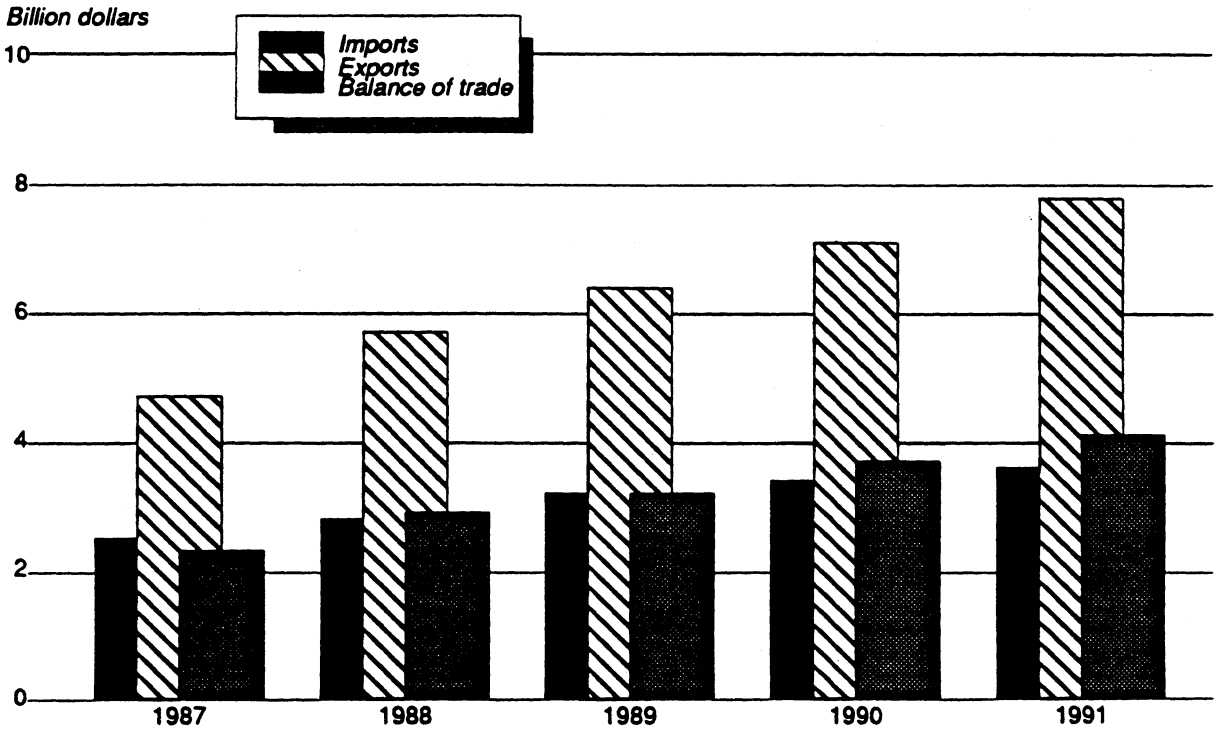
Source: Compiled from official statistics of the U.S. Department of Commerce.

Figure 4
Measuring, testing, controlling, and analyzing instruments: Share (percent) of U.S. exports by principal markets, 1987 and 1991



Source: U.S. Department of Commerce.

Figure 5
Measuring, testing, controlling, and analyzing instruments: Imports, exports, and balance of trade, 1987–91



Source: U.S. Department of Commerce; USITC.

Table-5
Measuring, testing, controlling, and analyzing instruments: U.S. exports of domestic merchandise, imports for consumption, and merchandise trade balance, by selected countries and country groups, 1987-91[1]

(Million dollars)

Item	1987	1988	1989	1990	1991
U.S. exports of domestic merchandise:					
Japan	650	941	1,014	973	1,068
Canada	546	646	664	1,203	1,206
Germany	427	468	556	558	628
Mexico	292	342	473	529	710
United Kingdom	417	505	524	520	490
France	234	295	305	330	393
Korea	150	193	273	339	362
Taiwan	148	181	203	200	224
Italy	174	201	256	262	266
Netherlands	165	179	185	195	213
All other	1,505	1,732	1,928	1,991	2,197
Total	4,708	5,683	6,381	7,098	7,757
EC-12	1,609	1,886	2,095	2,185	2,324
OPEC	148	134	156	151	279
ASEAN	180	251	305	333	355
CBERA	36	34	48	53	57
Eastern Europe	15	22	26	34	30
U.S. imports for consumption:					
Japan	605	717	850	851	937
Canada	265	258	306	379	428
Germany	399	445	476	507	497
Mexico	154	193	251	253	303
United Kingdom	337	369	428	440	427
France	78	94	119	129	149
Korea	41	50	44	37	34
Taiwan	133	144	132	107	114
Italy	43	40	59	59	52
Netherlands	36	46	42	48	51
All other	366	441	468	560	630
Total	2,458	2,799	3,174	3,369	3,621
EC-12	952	1,061	1,188	1,257	1,249
OPEC	0	0	0	0	0
ASEAN	22	37	34	37	90
CBERA	7	9	7	7	8
Eastern Europe	1	2	2	2	1
U.S. merchandise trade balance:					
Japan	45	224	164	122	131
Canada	281	388	358	824	778
Germany	28	23	80	51	131
Mexico	138	149	222	276	407
United Kingdom	80	136	96	80	63
France	156	201	186	201	244
Korea	109	143	229	302	328
Taiwan	15	37	71	93	110
Italy	131	161	197	203	214
Netherlands	129	133	143	147	162
All other	1,139	1,291	1,460	1,431	1,567
Total	2,250	2,884	3,207	3,729	4,136
EC-12	657	825	907	928	1,075
OPEC	148	134	156	151	279
ASEAN	158	214	271	296	265
CBERA	29	25	41	46	49
Eastern Europe	14	20	24	32	29

[1] Import values are based on customs value; export values are based on f.a.s. value, U.S. port of export. U.S. trade with East Germany is included in "Germany" but not "Eastern Europe".

Source: Compiled from official statistics of the U.S. Department of Commerce.

APPENDIX A
EXPLANATION OF TARIFF AND TRADE AGREEMENT TERMS

TARIFF AND TRADE AGREEMENT TERMS

The ***Harmonized Tariff Schedule of the United States*** (HTS) replaced the *Tariff Schedules of the United States* (TSUS) effective January 1, 1989. Chapters 1 through 97 are based upon the internationally adopted Harmonized Commodity Description and Coding System through the 6-digit level of product description, with additional U.S. product subdivisions at the 8-digit level. Chapters 98 and 99 contain special U.S. classification provisions and temporary rate provisions, respectively.

Rates of duty in the ***general*** subcolumn of HTS column 1 are most-favored-nation (MFN) rates; for the most part, they represent the final concession rate from the Tokyo Round of Multilateral Trade Negotiations. Column 1-general duty rates are applicable to imported goods from all countries except those enumerated in general note 3(b) to the HTS, whose products are dutied at the rates set forth in ***column 2***. Goods from Armenia, Bulgaria, the People's Republic of China, Czechoslovakia, Estonia, Hungary, Latvia, Lithuania, Moldova, Mongolia, Poland, Russia, the Ukraine and Yugoslavia are currently eligible for MFN treatment. Among articles dutiable at column 1-general rates, particular products of enumerated countries may be eligible for reduced rates of duty or for duty-free entry under one or more preferential tariff programs. Such tariff treatment is set forth in the ***special*** subcolumn of HTS column 1. Where eligibility for special tariff treatment is not claimed or established, goods are dutiable at column 1-general rates.

The ***Generalized System of Preferences*** (GSP) affords nonreciprocal tariff preferences to developing countries to aid their economic development and to diversify and expand their production and exports. The U.S. GSP, enacted in title V of the Trade Act of 1974 and renewed in the Trade and Tariff Act of 1984, applies to merchandise imported on or after January 1, 1976 and before July 4, 1993. Indicated by the symbol "A" or "A*" in the special subcolumn of column 1, the GSP provides duty-free entry to eligible articles the product of and imported directly from designated beneficiary developing countries, as set forth in general note 3(c)(ii) to the HTS.

The ***Caribbean Basin Economic Recovery Act*** (CBERA) affords nonreciprocal tariff preferences to developing countries in the Caribbean Basin area to aid their economic development and to diversify and expand their production and exports. The CBERA, enacted in title II of Public Law 98-67, implemented by Presidential Proclamation 5133 of November 30, 1983, and amended by the Customs and Trade Act of 1990, applies to merchandise entered, or withdrawn from warehouse for consumption, on or after January 1, 1984; this tariff preference program has no expiration date. Indicated by the symbol "E" or "E*" in the special subcolumn of column 1, the CBERA provides duty-free entry to eligible articles, and reduced-duty treatment to certain other articles, which are the product of and imported directly from designated countries, as set forth in general note 3(c)(v) to the HTS.

Preferential rates of duty in the special subcolumn of column 1 followed by the symbol "IL" are applicable to products of Israel under the ***United States-Israel Free Trade Area Implementation Act*** of 1985 (IFTA), as provided in general note 3(c)(vi) of the HTS. Where no rate of duty is provided for products of Israel in the special subcolumn for a particular provision, the rate of duty in the general subcolumn of column 1 applies.

Preferential rates of duty in the special subcolumn of column 1 followed by the symbol "CA" are applicable to eligible goods originating in the territory of Canada under the ***United States-Canada Free-Trade Agreement*** (CFTA), as provided in general note 3(c)(vii) to the HTS.

Preferential nonreciprocal duty-free or reduced-duty treatment in the special subcolumn of column 1 followed by the symbol "J" or "J*" in parentheses is afforded to eligible articles the product of designated beneficiary countries under the ***Andean Trade Preference Act*** (ATPA), enacted in title II of Public Law 102-182 and implemented by Presidential Proclamation 6455 of July 2, 1992 (effective July 22, 1992), as set forth in general note 3(c)(ix) to the HTS.

Other special tariff treatment applies to particular ***products of insular possessions*** (general note 3(a)(iv)), goods covered by the ***Automotive Prod-***

ucts Trade Act (APTA) (general note 3(c)(iii)) and the ***Agreement on Trade in Civil Aircraft*** (ATCA) (general note 3(c)(iv)), and ***articles imported from freely associated states*** (general note 3(c)(viii)).

The ***General Agreement on Tariffs and Trade*** (GATT) (61 Stat. (pt. 5) A58; 8 UST (pt. 2) 1786) is the multilateral agreement setting forth basic principles governing international trade among its more than 90 signatories. The GATT's main obligations relate to most-favored-nation treatment, the maintenance of scheduled concession rates of duty, and national (nondiscriminatory) treatment for imported products; the GATT also provides the legal framework for customs valuation standards, "escape clause" (emergency) actions, antidumping and countervailing duties, and other measures. Results of GATT-sponsored multilateral tariff negotiations are set forth by way of separate schedules of concessions for each participating contracting party, with the U.S. schedule designated as Schedule XX.

Officially known as "The Arrangement Regarding International Trade in Textiles," the ***Multifiber Arrangement*** (MFA) provides a framework for the negotiation of bilateral agreements between importing and producing countries, or for unilateral action by importing countries in the absence of an agreement. These bilateral agreements establish quantitative limits on imports of textiles and apparel, of cotton and other vegetable fibers, wool, man-made fibers and silk blends, in order to prevent market disruption in the importing countries—restrictions that would otherwise be a departure from GATT provisions. The United States has bilateral agreements with more than 30 supplying countries, including the four largest suppliers: China, Hong Kong, the Republic of Korea, and Taiwan.

APPENDIX B
STATISTICAL TABLES

Table B-1
Measuring, testing, controlling, and analyzing instruments: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1992; U.S. exports, 1991; and U.S. imports, 1991

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1992 General	Col. 1 rate of duty As of Jan. 1, 1992 Special[1]	U.S. exports, 1991	U.S. imports, 1991
				Million dollars	
9023.00.00	Instruments, apparatus and models, designed for demonstrational purposes (for example, in education or exhibitions), unsuitable for other uses, and parts and accessories thereof	Free		115	52
	Machines and appliances for testing the hardness, strength, compressibility, elasticity or other mechanical properties of materials (for example, metals, woods, textiles, papers, plastics), and parts and accessories thereof:				
9024.10.00	Machines and appliances for testing metals	4.8%	Free (A,E,IL) 2.8% (CA)	65	11
9024.80.00	Others machines and appliances	4.8%	Free (A,E,IL) 2.8% (CA)	209	29
9024.90.00	Parts and accessories	4.8%	Free (A,E,IL) 2.8% (CA)	162	18
	Hydrometers and similar floating instruments, thermometers, pyrometers, barometers, hygrometers and psychrometers, recording or not, and any combination of these instruments; parts and accessories thereof:				
	Thermometers, not combined with other instruments:				
	Liquid-filled, for direct reading:				
9025.11.20	Clinical	17%	Free (A*,E,IL) 10.2% (CA)	2	4
9025.11.40	Other	8.4%	Free (A,C,E,IL) 5% (CA)	14	5
9025.19.00	Other	5%	Free (A,B,C,E,IL) 3% (CA)[2]	19	45
	Barometers, not combined with other instruments:				
9025.20.40	Electrical	4.9%	Free (A,C,E,IL) 2.9% (CA)	[3]1	([4])
9025.20.80	Other	2.8%	Free (A,C,E,IL) 1.6% (CA)	([3])	1
	Other instruments:				
9025.80.10	Electrical	4.9%	Free (A,C,E,IL) 2.9% (CA)	[5]17	8
	Other:				
9025.80.20	Hydrometers and similar floating instruments, whether or not incorporating a thermometer, nonrecording	8.4%	Free (A,C,E,IL) 5% (CA)	([5])	1
9025.80.30	Hygrometers, psychrometers and pyrometers, nonrecording	3.9%	Free (A,C,E,IL) 2.3% (CA)	([5])	2

See footnotes at end of table.

Table B-1—Continued
Measuring, testing, controlling, and analyzing instruments: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1992; U.S. exports, 1991; and U.S. imports, 1991

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1992 General	Col. 1 rate of duty As of Jan. 1, 1992 Special[1]	U.S. exports, 1991	U.S. imports, 1991
				Million dollars	
9025.80.40	Thermographs, barographs, hygrographs and other recording instruments	3%	Free (A,C,E,IL) 1.8% (CA)	(5)	6
9025.80.50	Other	4.7%	Free (A,C,E,IL) 2.8% (CA)	(5)	5
9025.90.00	Parts and accessories	The rate applicable to the article of which it is a part or accessory	Free (A,C,E,IL) The rate applicable to the article of which it is a part or accessory (CA)	29	3
	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters), excluding instruments and apparatus of heading 9014, 9015, 9028 or 9032; parts and accessories thereof:				
	For measuring or checking the flow or level of liquids:				
9026.10.20	Electrical	4.9%	Free (A,B,C,E,IL) 0.9% (CA)	[6]191	34
	Other:				
9026.10.40	Flow meters	49¢ each + 7.6%	Free (A,C,E,IL) 9.8¢ each + 1.5% (CA)	(6)	6
9026.10.60	Other	4.7%	Free (A,B,C,E,IL) 0.9% (CA)	(6)	29
	For measuring or checking pressure:				
9026.20.40	Electrical	4.9%	Free (A,B,C,E,IL) 0.9% (CA)	[7]147	32
9026.20.80	Other	4.7%	Free (A,B,C,E,IL) 0.9% (CA)	(7)	67
	Other instruments and apparatus:				
9026.80.20	Electrical	4.9%	Free (A,B,C,E,IL) 0.9% (CA)	[8]97	42

See footnotes at end table.

Table B-1—Continued
Measuring, testing, controlling, and analyzing instruments: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1992; U.S. exports, 1991; and U.S. imports, 1991

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1992 General	Col. 1 rate of duty As of Jan. 1, 1992 Special[1]	U.S. exports, 1991	U.S. imports, 1991
				Million dollars	
	Other:				
9026.80.40	Heat meters incorporating liquid supply meters and anemometers	49¢ each + 7.6%	Free (A,C,E,IL) 9.8¢ each + 1.5% (CA)	([8])	1
9026.80.60	Other	4.7%	Free (A,B,C,E,IL) 0.9% (CA)	([8])	56
	Parts and accessories:				
9026.90.20	Of electrical instruments and apparatus	4.9%	Free (A,B,C,CA,E,IL)	[9]307	74
	Other:				
9026.90.40	Of flow meters, heat meters incorporating liquid supply meters and anemometers	9%	Free (A,C,CA,E,IL)	([9])	6
9026.90.60	Other	4.7%	Free (A,B,C,CA,E,IL)	([9])	38
	Instruments and apparatus for physical or chemical analysis (for example, polarimeters, refractometers, spectrometers, gas or smoke analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like; instruments and apparatus for measuring or checking quantites of heat, sound or light; microtomes; parts and accessories thereof:				
	Gas or smoke analysis apparatus:				
9027.10.20	Electrical	4.9%	Free (A,CA,E,IL)	[10]110	97
	Other:				
9027.10.40	Optical instruments and apparatus	10%	Free (A,E,IL) 6% (CA)	([10])	([4])
9027.10.60	Other	6.2%	Free (A,E,IL) 3.7% (CA)	([10])	15
	Chromatographs and electrophoresis instruments:				
	Electrical:				
9027.20.42	Electrophoresis instruments, not incorporating an optical or other measuring device	3.9%	Free (A,CA,E,IL)	28	4
9027.20.44	Other	4.9%	Free (A,CA,E,IL)	139	28
9027.20.80	Other	6.2%	Free (A,E,IL) 3.7% (CA)	104	2

See footnotes at end of table.

Table B-1—Continued
Measuring, testing, controlling, and analyzing instruments: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1992; U.S. exports, 1991; and U.S. imports, 1991

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1992 General	Col. 1 rate of duty As of Jan. 1, 1992 Special[1]	U.S. exports, 1991	U.S. imports, 1991
				Million dollars	
	Spectrometers, spectrophotometers and spectrographs using optical radiations (ultraviolet, visible, infrared):				
9027.30.40	Electrical	4.9%	Free (A,CA,E,IL)	187	71
9027.30.80	Other	10%	Free (A,CA,E,IL)	63	1
	Other instruments and apparatus using optical radiations (ultraviolet, visible, infrared):				
9027.50.40	Electrical	4.9%	Free (A,CA,E,IL)	[11]163	83
9027.50.80	Other	10%	Free (A,E,IL) 6% (CA)	([11])	3
	Other instruments and apparatus:				
9027.80.40	Electrical	4.9%	Free (A,E,IL) 2.9% (CA)	[12]682	178
9027.80.80	Other	6.2%	Free (A,E,IL) 3.7% (CA)	([12])	13
	Microtomes; parts and accessories:				
9027.90.20	Microtomes	6.2%	Free (A,CA,E,IL)	2	8
	Parts and accessories:				
	Of electrical instruments and apparatus:				
9027.90.42	Of electrophoresis instruments not incorporating an optical or other measuring device	3.9%	Free (A,CA,E,IL)	[13]224	5
9027.90.44	Other	4.9%	Free (A,CA,E,IL)	([13])	160
	Other:				
9027.90.60	Of optical instruments and apparatus	10%	Free (A,E,IL) 6% (CA)[14]	([13])	1
9027.90.80	Other	6.2%	Free (A,E,IL) 3.7% (CA)[14]	([13])	8
	Gas, liquid or electricity supply or production meters, including calibrating meters thereof; parts and accessories thereof:				
9028.10.00	Gas meters	45¢ each + 7%	Free (A,E,IL) 27¢ each + 4.2% (CA)	18	6
9028.20.00	Liquid meters	45¢ each + 7%	Free (A,E,IL) 27¢ each + 4.2% (CA)	37	2
9028.30.00	Electricity meters	45¢ each + 4.4%	Free (A,E,IL) 27¢ each + 2.6% (CA)	32	5
9028.90.00	Parts and accessories	9%	Free (A,E,IL) 5.4% (CA)	65	16

See footnotes at end of table.

Table B-1—Continued
Measuring, testing, controlling, and analyzing instruments: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1992; U.S. exports, 1991; and U.S. imports, 1991

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1992 General	Col. 1 rate of duty As of Jan. 1, 1992 Special[1]	U.S. exports, 1991	U.S. imports, 1991
				Million dollars	
	Revolution counters, production counters, taximeters, odometers, pedometers and the like; speedometers and tachometers, other than those of heading 9015; stroboscopes; parts and accessories thereof:				
	Revolution counters, production counters, taximeters, odometers, pedometers and the like:				
9029.10.40	Taximeters	15%	Free (A,B,E,IL) 9% (CA)	[15]14	([4])
9029.10.80	Other	Free		([15])	40
	Speedometers and tachometers; stroboscopes:				
9029.20.20	Bicycle speedometers	17%	Free (E,IL) 10.2% (CA)	[16]26	8
9029.20.40	Other speedometers and tachometers	Free		([16])	80
9029.20.60	Stroboscopes	45¢ each + 7%	Free (A,E,IL) 27¢ each + 4.2% (CA)[2]	([4])	1
	Parts and accessories:				
9029.90.20	Of taximeters	15%	Free (A,B,E,IL) 9% (CA)[2]	[17]15	([4])
9029.90.40	Of bicycle speedometers	17%	Free (E,IL) 10.2% (CA)[2]	([17])	([4])
9029.90.60	Of stroboscopes	9%	Free (A,E,IL) 5.4% (CA)	([17])	([4])
9029.90.80	Other	Free		([17])	56
	Oscilloscopes, spectrum analyzers and other instruments and apparatus for measuring or checking electrical quantities, excluding meters of heading 9028; instruments and apparatus for measuring or detecting alpha, beta, gamma, X-ray, cosmic or other ionizing radiations; parts and accessories thereof:				
9030.10.00	Instruments and apparatus for measuring or detecting ionizing radiations	4.7%	Free (A,C,E,IL) 2.8% (CA)	185	30
9030.20.00	Cathode-ray oscilloscopes and cathode-ray oscillographs	4.9%	Free (A,C,E,IL) 2.9% (CA)	181	38
	Other instruments and apparatus, for measuring or checking voltage, current, resistance or power, without a recording device:				
9030.31.00	Multimeters	4.9%	Free (A,B,C,CA,E,IL)	79	25
9030.39.00	Other	4.9%	Free (A,B,C,E,IL) 0.9% (CA)	518	187

See footnotes at end of table.

Table B-1—Continued
Measuring, testing, controlling, and analyzing instruments: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1992; U.S. exports, 1991; and U.S. imports, 1991

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1992 General	Col. 1 rate of duty As of Jan. 1, 1992 Special[1]	U.S. exports, 1991	U.S. imports, 1991
				Million dollars	
9030.40.00	Other instruments and apparatus, specially designed for telecommunications (for example, cross-talk meters, gain measuring instruments, distortion factor meters, psophometers) ..	4.9%	Free (A,B,C,E,IL) 0.9%(CA)	207	37
	Other instruments and apparatus:				
9030.81.00	With a recording device	4.9%	Free (A,B,C,E,IL) 2.9% (CA)	209	21
9030.89.00	Other	4.9%	Free (A,B,C,E,IL) 2.9% (CA)	539	103
	Parts and accessories:				
9030.90.40	For articles of subheading 9030.10	4.7%	Free (A,C,E,IL) 2.8% (CA)	39	11
9030.90.80	Other	4.9%	Free (A,B,C,E,IL) 2.9% (CA)[18]	324	111
	Measuring or checking instruments, appliances and machines, not specified or included elsewhere in this chapter; profile projectors; parts and accessories thereof:				
9031.10.00	Machines for balancing mechanical parts	4.9%	Free (A,E,IL) 2.9% (CA)	31	8
9031.20.00	Test benches	4.9%	Free (A,CA,E,IL)	33	14
9031.30.00	Profile projectors	7%	Free (A,E,IL) 4.2% (CA)	5	6
9031.40.00	Other optical instruments and appliances	10%	Free (A,CA,E,IL)	154	49
9031.80.00	Other instruments, appliances and machines	4.9%	Free (A,B,C,E,IL) 2.9% (CA)[2]	460	439
	Parts and accessories:				
9031.90.20	Of profile projectors	7%	Free (A,E,IL) 4.2% (CA)	[19]118	2
9031.90.40	Of other optical instruments and appliances, other than test benches	10%	Free (A,C,E,IL)	([19])	8
9031.90.60	Other	4.9%	Free (A,B,C,E,IL) 2.9% (CA)[20]	([19])	204
	Automatic regulating or controlling instruments and apparatus; parts and accessories thereof:				
9032.10.00	Thermostats	4.8%	Free (A,B,C,E,IL) 0.9% (CA)	61	116
9032.20.00	Manostats	4.8%	Free (A,B,C,E,IL) 0.9% (CA)	7	10

See footnotes at end of table.

Table B-1—Continued
Measuring, testing, controlling, and analyzing instruments: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1992; U.S. exports, 1991; and U.S. imports, 1991

HTS subheading	Description	Col. 1 rate of duty As of Jan. 1, 1992 General	Special[1]	U.S. exports, 1991	U.S. imports, 1991
				Million dollars	
	Other instruments and apparatus:				
9032.81.00	Hydraulic and pneumatic	4.7%	Free (A,B,C,E,IL) 2.8% (CA)[2]	67	27
	Other:				
	Automatic voltage and voltage-current regulators:				
9032.89.20	Designed for use in a 6, 12 or 24 V system	3.1%	Free (A,B,C,E,IL) 1.8% (CA)[2]	[21]26	25
9032.89.40	Other	4.9%	Free (A,C,E,IL) 2.9% (CA)[2]	([21])	13
9032.89.60	Other	4.9%	Free (A,B,C,E,IL) 2.9% (CA)[2 22]	629	499
	Parts and accessories:				
	Of automatic voltage and voltage-current regulators:				
9032.90.20	Designed for use in a 6, 12 or 24 V system	3.1%	Free (A,B,C,E,IL) 1.8% (CA)[2]	[23]499	12
9032.90.40	Other	4.9%	Free (A,C,E,IL) 2.9% (CA)[2]	([23])	5
9032.90.60	Other	4.9%	Free (A,B,C,E,IL) 2.9% (CA)[2 22]	([23])	118
9033.00.00	Parts and accessories (not specified or included elsewhere in this chapter) for machines, appliances, instruments or apparatus of chapter 90	4.9%	Free (A,B,E,IL) 2.9% (CA)	105	38

See footnotes at end of table.

Table B-1—Continued
Measuring, testing, controlling, and analyzing instruments: Harmonized Tariff Schedule subheading; description; U.S. col. 1 rate of duty as of Jan. 1, 1992; U.S. exports, 1991; and U.S. imports, 1991

[1] Programs under which special tariff treatment may be provided and the corresponding symbols for such programs as they are indicated in the "Special" subcolumn are as follows: Generalized System of Preferences (A); Automotive Products Trade Act (B); Agreement of Trade in Civil Aircraft (C); United States-Canada Free -Tree Agreement (CA); Caribbean Basin Economic Recovery Act (E); and United States-Israel Free Trade Area (IL).
[2] Equipment, originating in the territory of Canada, intended for use in the repair or maintenance of certain motor vehicles subject to accelerated staged rate reductions (see subheading 9905.00.00).
[3] Schedule B heading 9025.20.00.00 include articles covered in HTS subheadings 9025.20.40 and 9025.20.80.
[4] Less than $500,000.
[5] Schedule B heading 9025.80.00.00 include articles covered in HTS subheadings 9025.80.10-9025.80.50.
[6] Schedule B heading 9026.10.50.00 and 9026.10.70.00 include articles covered in HTS subheadings 9026.10.20-9026.10.60.
[7] Schedule B heading 9026.20.00.00 include articles covered in HTS subheadings 9026.20.40 and 9026.20.80.
[8] Schedule B heading 9026.80.00.00 include articles covered in HTS subheadings 9026.80.20-9026.80.60.
[9] Schedule B heading 9020.90.00.00 include articles covered in HTS subheadings 9026.90.20-9026.90.60.
[10] Schedule B heading 9027.10.00.00 include articles covered in HTS subheadings 9027.10.20-9027.10.60.
[11] Schedule B headings 9027.50.20.00-9027.50.50.00 include articles covered in HTS subheadings 9027.50.40 and 9027.50.80.
[12] Schedule B headings 9027.80.10.00-9027.80.80.00 include articles covered in HTS subheadings 9027.80.40 and 9027.80.80.
[13] Schedule B headings 9027.90.40.30-9027.90.40.70 include articles covered in HTS subheadings 9027.90.42-9027.90.80.
[14] Duty suspended on certain articles originating in the territory of Canada (see subheading 9905.90.11).
[15] Schedule B heading 9029.10.00.00 include articles covered in HTS subheadings 9029.10.40 and 9029.10.80.
[16] Schedule B headings 9029.20.40.40 and 9029.20.50.00 include articles covered in HTS subheadings 9029.20.20 and 9029.20.40.
[17] Schedule B heading 9029.90.00.00 include articles covered in HTS subheadings 9029.90.20-9029.90.80.
[18] Duty suspended or reduced on certain articles originating in the territory of Canada (see subheading 9905.90.05 and 9905.90.10).
[19] Schedule B heading 9031.90.00.00 include articles covered in HTS subheadings 9031.90.20-9031.90.60.
[20] Duty suspended on certain articles originating in the territory of Canada (see subheading 9905.90.15).
[21] Schedule B heading 9032.89.30.00 include articles covered in HTS subheadings 9032.89.20 and 9032.89.40.
[22] Duty reduced on certain articles originating in the territory of Canada (see subheadings 9905.90.20 and 9905.90.25).
[23] Schedule B heading 9032.90.00.00 include articles covered in HTS subheadings 9032.90.20-9032.90.60.

Source: U.S. exports and imports compiled from data of the U.S. Department of Commerce.

Table B-2
Instruments and apparatus for measuring, checking, or controlling the flow, level, pressure, or other variables of liquids or gases: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1987-91

Year	Producers' shipment[1]	Exports[2]	Imports[3]	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1987	5,688	1,191	799	5,296	15.1
1988	6,250	1,442	896	5,704	15.7
1989	6,640	1,340	1,050	6,350	16.5
1990	6,850	1,779	1,086	6,157	17.6
1991	6,940	2,029	1,209	6,120	19.8

[1] Estimated by the staff of the U.S. International Trade Commission, based on official statistics of the U.S. Department of Commerce.
[2] Includes the value of U.S. exports of Schedule B Number 9026 and 9032.
[3] Includes the value of U.S. imports of HTS heading 9026 and 9032.

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-3
Oscilloscope, spectrum analyzers, and other instruments and apparatus for measuring or checking electrical quantities: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1987-91

Year	Producers' shipment[1]	Exports[2]	Imports[3]	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1987	6,247	1,603	363	5,007	7.2
1988	6,911	1,929	423	5,405	7.8
1989	6.755	1,954	470	5,271	8.9
1990	6,750	1,884	492	5,358	9.2
1991	6,890	2,057	523	5,356	9.8

[1] Estimated by the staff of the U.S. International Trade Commission, based on official statistics of the U.S. Department of Commerce.
[2] Includes the value of U.S. exports of Schedule B subheadings 9030.20-9030.89, and 9030.90.80.
[3] Includes the value of U.S. imports of HTS subheadings 9030.20.00-9030.89.00, and 9030.90.80.

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-4
Instruments and apparatus for physical or chemical analysis: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1987-91

Year	Producers' shipment[1]	Exports[2]	Imports[3]	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1987	3,080	1,062	295	2,315	12.8
1988	3,700	1,289	351	2,762	12.7
1989	4,370	1,373	537	3,534	15.2
1990	4,530	1,525	641	3,646	17.6
1991	4,630	1,702	675	3,603	18.7

[1] Estimated by the staff of the U.S. International Trade Commission, based on official statistics of the U.S. Department of Commerce.
[2] Includes the value of U.S. exports of Schedule B No. 9027, except subheading 9027.40.00.
[3] Includes the value of U.S. imports of HTS heading 9027, except subheading 9027.40.00.

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-5
Measuring, or checking instruments, appliances and machines not specified elsewhere: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1987-91

Year	Producers' shipments[1]	Exports[2]	Imports[3]	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1987	1,275	274	644	1,645	39.1
1988	1,340	334	752	1,758	42.8
1989	1,425	663	727	1,489	48.8
1990	1,500	800	688	1,388	49.6
1991	1,550	801	730	1,479	49.4

[1] Estimated by the staff of the U.S. International Trade Commission, based on official statistics of the U.S. Department of Commerce.

[2] Includes the value of U.S. exports of Schedule B No. 9031.

[3] Includes the value of U.S. imports of HTS heading 9031.

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-6
Gas, liquid or electricity supply or production meters: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1987-91

Year	Producers' shipments[1]	Exports[2]	Imports[3]	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1987	950	82	22	890	2.5
1988	990	89	21	922	2.3
1989	1,050	99	26	977	2.7
1990	1,115	115	25	1,025	2.4
1991	1,180	152	29	1,057	2.7

[1] Estimated by the staff of the U.S. International Trade Commission, based on official statistics of the U.S. Department of Commerce.

[2] Includes the value of U.S. exports of Schedule B No. 9028.

[3] Includes the value of U.S. imports of HTS heading 9028.

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-7
Revolution counters, production counters, taximeter, odometers, pedometers, and the like; speedometers, and tachometers: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1987-91

Year	Producers' shipments[1]	Exports[2]	Imports[3]	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1987	800	44	136	892	15.2
1988	870	51	136	955	14.2
1989	845	49	141	937	15.0
1990	875	52	178	1,001	17.8
1991	900	56	186	1,030	18.1

[1] Estimated by the staff of the U.S. International Trade Commission, based on official statistics of the U.S. Department of Commerce.

[2] Includes the value of U.S. exports of Schedule B heading 9029.

[3] Includes the value of U.S. imports of HTS heading 9029.

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-8
Instruments and apparatus for measuring or detecting alpha, beta, gamma, X-ray, cosmic or other ionizing radiations: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1987-91

Year	Producers' shipments[1]	Exports[2]	Imports[3]	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1987	585	159	21	447	4.7
1988	655	175	22	502	4.4
1989	606	185	29	450	6.4
1990	650	194	38	494	7.7
1991	670	223	40	487	8.2

[1] Estimated by the staff of the U.S. International Trade Commission, based on official statistics of the U.S. Department of Commerce.
[2] Includes the value of U.S. exports of Schedule B subheading 9030.10.00 and 9030.90.40.
[3] Includes the value of U.S. imports of HTS heading 9030.10.00, and 9030.90.40.

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-9
Machines and appliances for testing the hardness, strength, compressibility, elasticity or other mechanical properties of metal, wood, textile, paper and plastics: Producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1987-91

Year	Producers' shipments[1]	Exports[2]	Imports[3]	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1987	385	243	24	166	14.5
1988	419	312	31	138	22.5
1989	437	422	58	73	79.5
1990	472	454	60	78	76.9
1991	510	436	58	132	43.9

[1] Estimated by the staff of the U.S. International Trade Commission, based on official statistics of the U.S. Department of Commerce.
[2] Includes the value of U.S. exports of Schedule B No. 9024.
[3] Includes the value of U.S. imports of HTS heading 9024.

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-10
Hydrometers and similar floating instruments, thermometers, pyrometers, barometers, hygrometers, psychrometer, recording or not, and any combination of these instruments: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1987-91

Year	Producers' shipments[1]	Exports[2]	Imports[3]	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1987	200	38	69	231	30.0
1988	210	49	65	226	28.8
1989	215	57	71	229	30.9
1990	218	78	74	214	34.6
1991	225	82	80	223	35.9

[1] Estimated by the staff of the U.S. International Trade Commission, based on official statistics of the U.S. Department of Commerce.
[2] Includes the value of U.S. exports of Schedule B heading 9025.
[3] Includes the value of U.S. imports of HTS heading 9025.

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-11
Instruments, apparatus and models, designed for demonstrational purposes, unsuitable for other uses: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1987-91

Year	Producers' shipments	Exports[1]	Imports[2]	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1987	N/A	9	1	N/A	N/A
1988	N/A	13	2	N/A	N/A
1989	N/A	74	28	N/A	N/A
1990	N/A	94	52	N/A	N/A
1991	N/A	115	52	N/A	N/A

[1] Includes the value of U.S. exports of Schedule B heading 9023.
[2] Includes the value of U.S. imports of HTS heading 9023.

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.

Table B-12
Parts and accessories not specified or included elsewhere in chapter 90: U.S. producers' shipments, exports of domestic merchandise, imports for consumption, and apparent U.S. consumption, 1987-91

Year	Producers' shipments	Exports[1]	Imports[2]	Apparent consumption	Ratio of imports to consumption
	Million dollars				*Percent*
1987	N/A	(3)	84	N/A	N/A
1988	N/A	1	99	N/A	N/A
1989	N/A	166	38	N/A	N/A
1990	N/A	122	35	N/A	N/A
1991	N/A	105	37	N/A	N/A

[1] Includes the value of U.S. exports of Schedule B heading 9033.
[2] Includes the value of U.S. imports of HTS heading 9033.
[3] Less than $500,000.

Note.—Because of rounding, figures may not add to the totals shown.

Source: Compiled from official statistics of the U.S. Department of Commerce, except as noted.