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Part III: Clinical Departments and Divisions Continued --- Chapter 33: Division of Cardiothoracic Surgery (pages 580-609)

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CHAPTER THIRTY-THREE

Division of Cardiothoracic Surgery

BERNARD J. MILLER, M.D., Sc.D.

"The only weapon with which the unconscious patient can immediately retaliate upon the incompetent surgeon is hemorrhage."
—WILLIAM STEWART HALSTED (1852–1922)

Jeffersonians have made a worldwide impact on the development of cardiothoracic surgery. Perhaps the earliest prediction concerning the future of cardiac surgery was made by John B. Roberts (Jefferson, 1874) who, at a meeting of the American Surgical Association in 1885, suggested that wounds of the heart be repaired by direct suture.1

Pioneers

In 1901, again at a meeting of the American Surgical Association, W.W. Keen (Jefferson, 1862) described a new and dramatic operation, the resection of a large portion of the chest wall for sarcoma.2 A tumor mass measuring \(15 \times 26 \times 7.6\) cm. and involving four ribs was removed by wide resection of the associated chest wall. An insufflating apparatus for artificial respiration, a primitive device when compared with present day respirators, did not function satisfactorily, and the lung collapsed. Because of the expertise of the surgeon and the speed of the operation, the patient tolerated the collapsed lung and eventually recovered. The apparatus consisted of a laryngeal tube as used in the treatment of laryngeal edema complicating diptheria and a simple bellows as a source of air pressure.
In 1902 John H. Gibbon, Sr. (Jefferson, 1891), later a full Professor of Surgery at Jefferson (1907–1931), reported the fourth case of a penetrating wound of the heart operated upon in this country.1

In 1910 W.W. Keen visited Alexis Carrel at the Rockefeller Institute in New York City and observed him divide the aorta of an experimental animal followed by primary repair. A unique suture technique was employed while respirations were maintained with a Meltzer–Auer apparatus during open thoracotomy. Keen predicted at the time that this method would be applicable to the treatment of aortic disease of man in the future.

Further advances in thoracic surgery were dependent upon the development of a suitable apparatus that could maintain expansion of the lungs and respiration during open thoracotomy under anesthesia. Widely dispersed pioneers such as O'Dwyer, Meltzer, Matas, and Sauerbruch extended the field.4–7 During the first three decades of the twentieth century thoracic surgery advanced with relation to the treatment of inflammatory diseases of the chest such as empyema, lung abscess, and bronchiectasis.

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**Surgery for Tuberculosis**

Surgery soon became the principal method of treating complicated tuberculosis that did not respond to simple collapse therapy and medical management. Because of the steadily increasing number of cases of tuberculosis, a separate section in the Department of Medicine was established for treatment. In 1913 the Department for Diseases of the Chest was relocated in a private dwelling at 238 Pine Street that had been the Henry Phipps Institute for the treatment of tuberculosis. In 1928 the role of surgery in the treatment of tuberculosis was established, and the Board of Trustees authorized the construction of an annex at adjacent 236 Pine Street. A newly built operating room was used mostly for the establishment and maintenance of pneumothorax until 1938 when closed pneumolysis, phrenicectomy, and thoracoplasty became standard operations in the treatment of complicated cases in which cavitation persisted.

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**Jefferson’s First Thoracic Surgeons**

John B. Flick (Figure 33-1) was the first of the group of thoracic surgeons at Jefferson and is credited with the concerted effort to develop a separate Division within the Department. He had received his M.D. degree from Jefferson in 1913 and spent the following year at White Haven Sanatorium in the Poconos, followed by two additional years as an intern at the Pennsylvania Hospital. During 1915 he saw service in the American Ambulance Hospital in Paris and received the rank of First Lieutenant in 1917, with promotion to Captain in 1918. He served as...
surgical assistant in a French base hospital and also with a British General Hospital in 1918, followed by duty as medical officer to the British tank reinforcement depot. In 1919 he was admitted to the Jefferson faculty. As surgeon to Jefferson, Pennsylvania, and Bryn Mawr Hospitals and White Haven Sanitorium, Flick was noted for his thoroughness, diagnostic ability, careful operative technique, and numerous contributions to the literature.

Dr. Flick performed the first thoracoplasty at Jefferson in 1924. In 1926 he published a paper dealing with the management of 127 cases of lung abscess. Within the following ten years he wrote extensively about techniques and results of thoracoplasty in the treatment of tuberculosis and lobectomy for bronchiectasis. He performed the first successful pneumonectomy in Philadelphia in 1933, soon after Dr. Evarts A. Graham earlier that year reported the first in the world at Washington University in St. Louis. Dr. Flick’s was the sixth such operation reported in the literature.

Throughout his career he was active in the local and national surgical societies. At Jefferson he was Assistant Professor of Surgery from 1933 to 1935, Associate Professor from 1935 to 1937, and Clinical Professor from 1937 to 1946. He subsequently pursued his distinguished career with teaching affiliations at the University of Pennsylvania. For many years he devoted himself to the care of his invalid wife, and he died in 1979 at the age of 86.

Howard H. Bradshaw (Figure 33-2) succeeded Dr. Flick as the thoracic surgeon at Jefferson. He graduated from Jefferson in 1927 and remained at the Jefferson Hospital until 1929 as an intern. He continued his training during the next five years at Harvard and the Massachusetts General Hospital, where he had the opportunity to serve under Drs. Edward Churchill and Charles Beecher. During that period he published numerous papers with Beecher and Lindskog pertaining to basic research in anesthesia and pulmonary physiology. On his return to Jefferson he activated the thoracic surgical service at the Pine Street Hospital, maintained an active role in clinical thoracic surgery at Jefferson Hospital, lectured to students, and published numerous clinical papers.

Unfortunately for Jefferson, Dr. Bradshaw was frustrated by the limited facilities for basic research at that time. In 1940 his international reputation led to an invitation to the Bowman Gray School of Medicine as Professor of Surgery, where he continued to contribute to the development of thoracic surgery. He died, tragically, of a brain tumor in 1969.

Following the untimely death of Dr. Edward J. Klopp in 1936, Dr. George P. Muller (Figure 33-3) came to Jefferson as Chief of the “B” surgical service and enhanced the existing strength in thoracic surgery. He received his early education in the public schools of Philadelphia and was
graduated from Central High in 1895 with an A.B. degree (which was possible to do at that time). He immediately entered the Medical School of the University of Pennsylvania, received his degree in 1899, and served as an intern at the Lankenau Hospital until 1902. Thereafter he became a member of the Department of Surgery at the University of Pennsylvania, where he rapidly advanced to the position of Professor of Clinical Surgery and Professor of Surgery in the Graduate School of Medicine of the University. During the early years at Lankenau he served under John B. Deaver and was next in rank to Charles Frazier at the University. His association with these gifted surgeons aided his rapid national recognition.

Dr. Muller was a member of the Founders Group of the American Board of Surgery, President of the American College of Surgeons, the Philadelphia County Medical Society, the Philadelphia Academy of Surgery, the College of Physicians of Philadelphia, and the American Association for Thoracic Surgery, and a member of the American Surgical Association and the Society of Clinical Surgery. He served with distinction in the Armed Forces during World War I. Subsequently he joined the staffs of White Haven Sanitorium, Rush Hospital for Consumption and Allied Diseases, and Lankenau and Misericordia Hospitals. He received honorary degrees from Villanova College in 1926 and Muhlenberg College of Allentown in 1937 and served on the editorial board of *Annals of Surgery*.

Dr. Muller was among the great pioneers in the development of thoracic surgery in America. As early as 1912 he contributed an important article on endotracheal anesthesia and showed at that time a remarkable understanding of the physiology of respiration. He also modified existing endotracheal apparatus. Muller was among the first to describe the removal of foreign bodies from the lung, and he reported such a case (removal of a bullet) in 1918. He was actively involved in the establishment of policies for the treatment of thoracic wounds and the management of empyema in the wounded during World War I. In 1924 he made contributions to the surgical management of carcinoma of the esophagus. He was among the few in Philadelphia actively involved in the surgical management of the complications of uncontrolled active tuberculosis. With Dr. Muller as Chief, the thoracic surgical section of Jefferson Hospital, in collaboration with Dr. Bradshaw, progressed rapidly. Large numbers of cases were referred for surgical treatment. These for the most part were of intrathoracic inflammatory disease, particularly lung abscess and bronchiectasis, but with an increasing number of cases of pulmonary neoplasms, which were treated by resection. Dr. Muller was among the first in Philadelphia to perform a pneumonectomy for the treatment of lung cancer. He was noted for the vastness of his knowledge, for his quick evaluation of surgical problems, his profound judgment, and a masterful technique. He utilized meticulous sharp dissection and stressed the importance of

**Fig. 33-3.** George P. Muller, M.D., Sc.D., Professor of Surgery (1936) and first Grace Revere Osler Professor (1939–1946). He pioneered in the development of thoracic surgery in America.
avoiding contamination of the wound from the skin by the use of wound towels. He forbade the use of large clamps and advocated fine suture material and interrupted sutures. Proper fluid balance by the intravenous route and use of the newly discovered sulfa drugs were taught in his weekly surgical amphitheater presentations. Dr. Muller became the Grace Revere Osler Professor of Surgery in 1939 and Emeritus Professor in 1946. It is believed that this very brilliant man, who died in 1947, developed Alzheimer's disease.

James Miller Surver (Figure 33-4) was born in Altoona, Pennsylvania, in 1905. He attended Franklin and Marshall College and graduated from Jefferson Medical College in 1929. He served his internship at Jefferson from 1929 to 1931, and as Chief Resident Physician from 1931 to 1933. He then went abroad for seven months to visit many of the outstanding clinics in Europe. From November of 1933, he was a private assistant and

the protégé of Dr. Edward J. Klopp, Professor of Surgery at that time, until the latter's untimely death in 1936. Starting as a Clinical Assistant in the Surgical Department, Division “B”, he rose through the academic ranks to become Assistant Professor of Surgery in 1952. He assisted Dr. George P. Muller, Professor of Surgery and Chief of the “B” Surgical Service, with all the pulmonary surgery and with much of the major abdominal surgery at that time.

In the hospital Dr. Surver was always available for assistance to the surgical resident when called, regardless of inconvenience. He lectured on basic principles of surgery in the sophomore year, and on oncology and in the Tumor Clinic during the junior year. He conducted the weekly tumor conferences, which were always well attended by both staff and students. His records were prepared with great detail and delivered with meticulous clarity. The Senior Class of 1954 dedicated its yearbook to him. In addition to general surgery, Dr. Surver was a pioneer in pulmonary surgery and played an important role in the early phases of chest surgery at Jefferson.

Dr. Surver was a Diplomate of the American Board of Surgery, which at that time was a special distinction, and he belonged to the major surgical societies. He published very little but gave many talks on oncology and conducted the Tumor Clinic at Jefferson Hospital for many years. Ill health forced him to resign in 1962, and he died of coronary insufficiency in 1968. To his colleagues he was affectionately known as “Swifty,” an opposite attribute, and to his students who held him in highest esteem, he was known as “Shifting Dullness” because of the monotone in which he lectured.

Dr. George J. Willauer (Figure 33-5) was an important participant in the advance of thoracic surgery during this period at Jefferson. He graduated from Franklin and Marshall College in 1917 and enlisted in the U.S. Army, spending two years in the cavalry as a drill sergeant. He entered Jefferson in 1919 and graduated in 1923. Following a year of internship at Jefferson, he studied surgery in Vienna. In addition, he visited a

Fig. 33-4. James M. Surver, M.D., thoracic surgeon, teacher, and oncologist (1933–1962).
number of other famous surgical centers, particularly Sauerbruch's clinic in Munich. Upon his return to Philadelphia Willauer was admitted to the Jefferson faculty, where he continued his interest in anatomy as Assistant Demonstrator of Operative Surgery in the Daniel Baugh Institute. He then joined with Dr. Bradshaw as a member of the thoracic surgical group, working both in Jefferson Hospital and the Pine Street Division. Some of the principles upon which thoracic surgery is based today were developed by Willauer. He became especially expert in the surgical treatment of tuberculosis and its complications. He was a pioneer in the use of continuous spinal anesthesia for thoracoplasty and devoted much time to teaching students and young staff members. He designed surgical instruments, some of which are in use today. The Willauer modification of the Deaver retractor is invaluable, and the Willauer dissecting clamp has been used worldwide by countless numbers of surgeons. His vividly colorful explanations and descriptions made lasting impressions. With a unique assertiveness, Willauer remained a drill sergeant and taskmaster. He was noted for his great regard for patients and for the extremely high standards he set for himself and others. Willauer saw things in black and white and thus took a strong stand on issues. As an Alumni Association President (1962), fund raiser, and Alumni Trustee on the Board (1968–1971), he could be counted in that select few who from time to time are designated “Mr. Jefferson.” His portrait was presented to the College by the Surgical Residents in 1965. This forceful leader died in 1977.

John H. Gibbon, Jr., M.D., Sc.D., LL.D., F.R.C.S.

Dr. John H. Gibbon, Jr. (Figure 33-6) followed Dr. Muller in 1946 with appointment as Professor of Surgery and Director of Experimental Surgery. His arrival at Jefferson initiated a period of rapid development, particularly in the technical and physiological aspects of thoracic surgery. The surgical service became strongly oriented toward research. This period influenced world-wide the treatment of diseases of the chest; under his outstanding leadership the Department of Surgery attracted aspiring young surgeons from great distances for their surgical training. These Residents were stimulated by his knowledge and inquisitiveness. Many of them achieved high academic positions through their contributions to thoracic surgical research. Dr. Gibbon’s basic interest was in the development of an extracorporeal circuit containing an artificial heart and lung. The first heart-lung machine suitable for human use was developed under his direction at Jefferson. In addition to this primary interest, he was concerned with the problems of blood volume changes during thoracic operations and respiratory acidosis during anesthesia.
Dr. Gibbon graduated from Princeton in 1923 with an A.B. degree and from Jefferson in 1927. He served his internship at the Pennsylvania Hospital from 1927 to 1929 and then became a Research Fellow in the Department of Surgery of Harvard Medical College until 1931. Upon returning to Philadelphia he became a Fellow in Medicine at the University of Pennsylvania and also Assistant Surgeon at the Pennsylvania Hospital. In 1933, after two years of clinical practice, he returned to Harvard. It was during this period that he became interested in a heart-lung device. In 1937 he was able with a primitive machine to demonstrate for the first time the feasibility of total maintenance of the cardiorespiratory function during arrest of the circulation in an experimental animal. He returned to Philadelphia in 1936 as Harrison Fellow of Surgical Research at the University of Pennsylvania. It was at this time that the second extracorporeal device was constructed. Additional successful animal experiments provided support for the original notion that the heart-lung machine could be used as a means of maintaining the cardiorespiratory function during arrest of the circulation. Gibbon responded to the call of duty during World War II in 1942, entering the Army as a Major. Promoted to Lieutenant Colonel in 1945, he served as Chief of the Surgical Service at the Mayo General Hospital until his honorable discharge.

The Heart-Lung Machine

Upon arriving at Jefferson in 1946, Dr. Gibbon succeeded in obtaining the services of Mr. Thomas Watson of the International Business Machines Corporation in support of the continued investigation of extracorporeal circuits. A postwar model, similar to the 1933 model in principle, was constructed and placed in the laboratory. The smooth film oxygenator was enlarged to increase its capacity sufficiently to maintain the respiratory function of dogs. In addition, the collecting assembly was improved, and the machine was enclosed in two cabinets. One contained the power supplies and controls and the other contained the oxygenator and pumps. The entire device was temperature controlled. It was at this time that Dr. Gibbon included a period of basic research training in the laboratory as an important addition to the residency training program.

Drs. T. Lane Stokes (Jefferson, 1947) and John B. Flick, Jr., were early Residents to work with the experimental heart-lung machine. Both partial and total perfusion of dogs were studied. The mortality rate was excessively high and a number of serious defects in the first device provided by International Business Machines became apparent (see Figure 33-12). Oxygenation was inadequate. Controls malfunctioned, and hemolysis was excessively high. Stokes and Flick were able to incorporate the principle of turbulence and improve the oxygenation efficiency of the artificial lung. Even with the improved oxygenation it was clearly obvious that the machine was not suitable for maintaining the cardiorespiration of even small dogs. Another period of redesign and experiment was required.
Bernard J. Miller, who had just completed his surgical residency, became Dr. Gibbon's Research Associate in charge of the laboratory. He made critical contributions that led to the eventual perfection and application of the device for human use. The heart-lung machine was stripped to bare essentials (Figure 33-7). A skeleton apparatus was used exclusively for testing of modifications and new components. Another machine, the second IBM model, arrived at Jefferson in 1951, and this initiated the final phase of development (Figure 33-8). On May 6 of 1953, after a period of intense evaluation, the machine was finally used by Dr. Gibbon in the heroic performance of an open cardiotomy for the repair of a congenital interatrial septal defect in a young woman while the cardiorespiratory function was maintained by an extracorporeal circuit (Figure 33-9). An interatrial septal defect was successfully repaired and she was restored to normal health. The operation heralded a new era in thoracic surgery, and cardiac surgery was no longer beset by the barrier which had prevented its advancement.

Dr. Gibbon received many honors. Visiting professorships and lectureships were routine. In 1956 he was the George A. Ball Visiting Professor of Surgery, Indiana University; in 1959 the Taub Visiting Professor of Surgery, Baylor University;
in 1960 the Visiting Professor of Surgery, Harvard Medical School; and in 1967 the Barney Brooks Visiting Professor of Surgery, Vanderbilt University. In 1956 he gave the Churchill Lecture, Excelsior Surgical Society; in 1958 the Harvey Lecture at the New York Academy of Medicine; in 1958 the Conner Memorial Lecture of the American Heart Association; in 1962 the Alvarenga Prize and Lectureship of the College of Physicians of Philadelphia; and in 1962 the Arthur Dean Bevan Lectureship at the Chicago Surgical Society. He was away so much of the time that even at Jefferson he was sometimes called “The Visiting Professor.”

Dr. Gibbon occupied numerous clinical positions. From 1937 to 1950 he was Surgeon to the Pennsylvania Hospital, and from 1945 to 1946 he was Assistant Professor of Surgery at the University of Pennsylvania. In 1946 he was Attending Surgeon at Jefferson Hospital, and from 1950 to 1967 he was Consultant in General Surgery at the Veterans Administration Hospital in Philadelphia. His appointment as Samuel D. Gross Professor and Chairman of the Department at Jefferson in 1956 unified the Chair that had been split into two divisions since the retirement of the elder Gross in 1882 (Figure 33-10). From 1967 to 1973 he was the Samuel D. Gross Emeritus Professor of Surgery.

The societies to which Dr. Gibbon belonged were: American Association of Arts and Sciences; American Association for Thoracic Surgery, of which he was President from 1960 to 1961; American Cancer Society; American College of Surgeons; Board of Governors of the American College of Surgeons from 1950 to 1964; American Heart Association; American Medical Association; American Medical Writers Association; American Surgical Association, of which he was President in 1944; Association of American Medical Colleges; College of Physicians of Philadelphia, of which he was President from 1964 to 1967; Halsted Society; Heart Association of Pennsylvania; International Surgical Group; J. Aitken Meigs Medical Society; Laennec Society of Philadelphia; Pennsylvania Association for Thoracic Surgery; Pennsylvania Public Health Association; Pennsylvania State Medical Society; Pennsylvania Trudeau Society; Philadelphia Academy of Surgery, of which he was President from 1956 to 1958; Philadelphia County Medical Society; Pulmonary Neoplasm Research Group of Philadelphia; Society of Clinical Surgery, of which he was President from 1964 to 1965; World Medical Association; and National Academy of Sciences. He was a member of the Board of Directors of City Trusts of Philadelphia. In addition, Gibbon received national honorary memberships, such as the Chicago Surgical Society in 1962 and the Buffalo Surgical Society in 1966,

![Fig. 33-8. Dogs line up with Dr. John Flick, Jr., Research Assistant, and a laboratory technician. The animals had fully recovered from operations during which their hearts were isolated for 30, 33, and 32 minutes, respectively.](image1)

![Fig. 33-9. First open heart operation (May 6, 1953) by Dr. Gibbon using the heart-lung machine successfully.](image2)
and was initiated into Fellowship of the Royal College of Surgeons of England in 1959 and the Society of Thoracic Surgeons of Great Britain and Ireland in 1961.

Dr. Gibbon served on the editorial board of the *Annals of Surgery* from 1947 to 1973 and on the board of *Circulation Research*. For his accomplishments he received numerous awards, beginning in 1931: the John Scott Award; the Charles Mickle Fellowship (University of Toronto); the Clarence E. Shaffrey Award (St. Joseph's College); the Rudolph Matas Award in Vascular Surgery (Tulane University); the Distinguished Service Award (International Society of Surgery); the Strittmatter Award (Philadelphia County Medical Society); the Distinguished Service Award of the Pennsylvania Medical Society (Figure 33-11); the Philadelphia Award; the Research Achievement Award (American Heart Association); the Roswell Park Medal; the Albert Lasker Clinical Research Award; and the Dixon Prize in Medicine (University of Pennsylvania). Some of the medals associated with these awards are on display in the archives cabinet of the Samuel D. Gross Conference Room. Dr. Gibbon died on his tennis court in 1973.

- Residents and Fellows: Improvements in the Heart-Lung Machine

The Residents who received their surgical training in the Gibbon era were John J. DeTuerk, Joseph W. Stayman, Jr., Frederick W. Dash, T. Lane

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**Figure 33-10.** Dr. Gibbon on ward rounds. Dr. Herbert Cohn is at his right.
The intense academic environment in the laboratory during the early 1950s provided the stimulus for the staff and residents to engage in both clinical and basic investigation in thoracic surgery. A number of this group were subsequently rewarded by high academic positions on other medical faculties.

Dr. Bernard J. Miller was closely associated with Dr. Gibbon and responsible for the design of electronic and other components within the extracorporeal circuit and conducted the research program that made the heart-lung machine practical for human use. In addition, he demonstrated the important role of expiratory assistance during anesthesia and the method for the avoidance of air embolization during open cardiotomy and total bypass. His vent for the left ventricle remains in standard usage.

Dr. Miller graduated from Villanova College in 1939 with a B.S. degree and from Jefferson in 1943. While an undergraduate at Villanova he engaged in research in embryology and tissue culture at the Research Institute of Lankenau Hospital, which eventually became the Cancer Research Institute at Fox Chase. It was at this period that he was influenced by his first mentor of medicine, Dr. Stanley P. Reimann, Director of the Institute. Dr. Reimann remained his close friend, mentor, and advisor for the following 30 years until his death. During this early period, research in embryology involved the recovery of the first human tubal ova and the first demonstration of induced parthenogenetic activity in the human ovum in vitro. The initial efforts at tissue culture of fertilized rabbit ova using the Carrel–Lindbergh artificial heart took place in the laboratory of the Lankenau Hospital Research Institute. Following this, the effects of some amino acids that had been shown to have selective effects on the various phases of normal cellular growth were studied on fertilized rabbit ova in tissue culture. He worked part-time at the Pennsylvania Medical Society’s Distinguished Service Award from President Daniel H. Bee, M.D.
Institute during his collegiate years and the early part of medical school.

Dr. Miller served his internship at Jefferson Hospital and the early period of his surgical residency from 1944 to 1945 on the “B” surgical service under Dr. George P. Muller. In the Armed Forces he was assigned to the surgical service at Fort Bragg from 1945 to 1947 and then returned to Jefferson to complete the remainder of his surgical residency under Dr. Gibbon, the successor to Dr. Muller. The first assignment during his surgical residency was to study blood volume changes and extracellular fluid losses during major thoracic operations, and the results were presented to the American Thoracic Association in 1948. With completion of his residency in 1950 and appointment as Research Associate to Dr. Gibbon, Miller spearheaded a team effort to improve the heart-lung machine to the point that it could be moved from the experimental laboratory into the operating room for safe use on patients. It has been said of Dr. Gibbon’s work that the embryo was planted at Harvard, gestation went on at the University of Pennsylvania, and the birth occurred at Jefferson. A more detailed history of the problems and solutions in the final development of the machine is justified because of the benefit to humanity and the acclaim to Jefferson.

Limitations and defects in the first apparatus built by the International Business Machines Corporation (Figure 33-13) determined that the device could not be used for patients. New data and additional circuits developed in the surgical laboratory were used by the International Business
Machines engineers in a second machine (Figures 33-14a and b). The oxygenator was redesigned by incorporating the principle of turbulence that Stokes and Flick had demonstrated would enhance oxygenation. In addition, the new oxygenator was no longer cylindrical but consisted of a series of vertical screens suspended from a distributing chamber. The artificial lung, containing six screens, each measuring 30.5 x 45.1 cm., was found to be adequate to maintain the respiratory requirement of large dogs. The electronic control that maintained a constant level of blood at the bottom of the oxygenator was critical for two reasons: first, since the total volume of blood required to fill the apparatus was quite large, it was necessary to reduce to a bare minimum the size of the pool of blood at the bottom of the oxygenator; second, it was imperative to rigidly control this blood level so that air would not be inadvertently pumped by the arterial pump into the subject being perfused. The original photoelectric controls had malfunctioned and were unreliable. A variable capacitor circuit was designed. This control proved to be reliable and was incorporated in the new machine. The new electronic control was also used to sense changes in pressure in the tubes conducting blood from the vena cava to the venous pumps. Occlusion of the vena cava due to high pump rates and resultant high negative pressure was automatically prevented by sensing the changes in the diameter of the tubes conducting venous blood into the machine before complete cessation of blood flow occurred as a result of the caval wall being sucked into the cannula. The capacitor functioned properly in this application. A number of additional controls were incorporated, and a special filter was designed so that fibrin debris could effectively be evacuated during the perfusion.

Fig. 33-13. The first heart-lung machine provided by International Business Machines Corporation.
The pH was automatically controlled by utilizing continuous measurement and recording, which in turn automatically controlled the amount of carbon dioxide added to the gas within the oxygenator. The saturation of blood with oxygen was continuously measured and recorded photoelectrically. The temperature of the blood within the extracorporeal circuit was maintained within narrow limits by means of a recording potentiometer. The new machine constructed by International Business Machines in 1951 contained all the new circuits and refinements and was completely enclosed in a hermetically sealed case, containing a small positive pressure of nitrogen. This prevented the possible entry of explosive anesthetic gases from the operating room atmosphere, a potential danger because there was constant sparking in the armature of the arterial pump motor (Figures 33-14a and b). Beginning in 1951 the new machine (Figure 33-15) was used in a large number of animal experiments in which the systemic venous return to the heart was diverted into the extracorporeal circuit by temporarily occluding the vena cava while arterialized blood from the machine was returned to the animal by means of a cannula placed within the femoral artery. The mortality rate before 1951 was approximately 80%. With the new machine, a markedly reduced mortality rate of approximately 20% was achieved by 1952. The highest mortality occurred in the early bypass experiments. At this point attention was focused on gasometric studies that revealed the development of hypoxia and acidosis during anesthesia with the regular laboratory respirator. The principle of assisting expiration as a means of preventing respiratory acidosis was conceived and incorporated in an apparatus in which suction produced by a Venturi jet was used to rapidly evacuate the tidal gas during expiration. The use of negative pressure completely corrected the problem of acidosis. With this new device it was possible to supersaturate arterial blood with oxygen using only room air. In addition, the partial pressure of carbon dioxide in the circulating blood was reduced to the point where the animal would remain apneic for a number of minutes following discontinuance of artificial respiration. This principle was subsequently incorporated into a ventilator known as the “Jefferson Ventilator.”

The ultimate goal of this research was to obtain a bloodless cardiac chamber as a means of performing precise surgical operations within the heart while the cardiorespiratory function was maintained by the device. Accordingly, cardiac defects were next made within the interatrial and interventricular septa of dogs and repaired while the cardiorespiratory function was maintained by the heart-lung machine. During the first bypass

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**FIG. 33-14a.** Front view of the second International Business Machines heart-lung machine used by Dr. Gibbon for repair of an interatrial septal defect in 1953.

**FIG. 33-14b.** Dr. John H. Gibbon, Jr. with his successful heart-lung machine of 1953.
and open cardiotomy in an experimental animal, the magnitude of cardiac venous blood returning to the right atrium was not fully anticipated. The large volume of blood could not be coped with, and the experiment failed because of uncontrolled blood loss. An additional unforeseen complication also became apparent when experimental interatrial septal defects were produced during bypass. Air entering the left atrium as soon as the interatrial septal defect was produced was trapped beneath the mitral leaflets, and since the heart was still beating, the left ventricle pumped the air into the systemic circulation with resulting embolization to the coronary circulation and other systemic arteries. This was indeed a profound complication, but the solution proved to be simple. A tiger tube was introduced into the left ventricle through a small ventriculotomy at the apex and secured with a purse-string suture. A low-resistance pathway was then provided for the escape of air from the contracting left ventricle with the use of mild suction. A special collecting apparatus was conceived. This collecting chamber received both returning venous blood from the open right atrium and the blood and air aspirated by the left ventricular catheter. Because air was always mixed with the blood, the bubbles were dissipated by the gradual descent of the blood film onto the inner surface of a tall cylinder. In addition, the negative pressure assisted in the dissipation of bubbles. As this blood accumulated in a pool at the bottom of the collecting chamber, the position of the blood level was then sensed by the same variable capacitor circuit used to control the arterial pump. This circuit then energized an additional pump that returned both the cardiac venous blood and the left ventricular blood to the extracorporeal circuit with minimal loss.

Interatrial septal defects produced in dogs under direct vision during total bypass were repaired by a pericardial patch. In some situations the patch was introduced into the right atrium by stab wound in its mesial wall and remained connected to its base with the aim of providing circulatory support to the graft. In another group of animals, interventricular septal defects were produced during open ventriculotomy and repaired by suture or patch. Because the venous pumps in this new machine were at heart level, a moderate degree of suction was needed to ensure a maximum flow rate from the vena cava. This resulted in frequent occlusions of the cannula at near maximal flow rate. To correct this problem, a further modification was made using low negative pressure. Caval blood was directed into a separate collecting chamber similar to the one used for the collection of cardiac venous blood. Its level was again sensed by a similar circuit, and from there the circuit was as before (Figure 33-16).

In order to initiate total bypass it was merely necessary to remove the clamps from the venous and arterial lines and secure the ligatures about the vena cavae, thus diverting cardiac venous return to the extracorporeal circuit. The extracorporeal

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**Fig. 33-15.** Diagram of extracorporeal blood circuit of the basic 1951 heart-lung machine constructed by International Business Machines Corporation.

**Fig. 33-16.** Circuit of the modified 1951 heart-lung machine containing an additional circuit for receiving cardiac venous blood and air from the left ventricle during bypass.
circuit then functioned automatically by continually sensing the flow rate of the diverted venous blood. An occasional adjustment of the negative pressure in the collecting chambers was all that was usually required to maintain ideal perfusion conditions.

A large and successful experimental experience had been achieved by this time. Oxygenation with the new oxygenator was sufficient for a human patient of average size, and all controls functioned optimally (Figures 33-17a and b). There was every indication that the next phase, use of the apparatus in operations on humans, would also be successful. Two children failed to survive for reasons other than failure of the perfusion. Finally, in May of 1953, the first open cardiotomy in a human patient for the repair of an interatrial septal defect was performed by Dr. John H. Gibbon, Jr., assisted by Drs. Frank F. Allbritten, Jr. and Bernard J. Miller. The heart-lung machine was transported from the laboratory on the eighth floor of the College to the hospital operating room (the fourth floor of 1907 “Old Main”) along with the newly conceived laboratory device used for collecting both the cardiac venous blood and the blood from the left ventricular vent. After this first successful perfusion of a human, other applications of extracorporeal circuits soon became apparent.

In accord with a long-held interest in anatomy, Dr. Miller joined the staff of the Daniel Baugh Institute, under the Chairmanship of Dr. George Bennett, also Dean of the College. He initiated and maintained an active research program in the Anatomy Department and also developed a private general surgical practice. Miller continued his interest in the further development of extracorporeal circuits and engaged in tumor research; he was a pioneer in the use of a heart-lung machine for segmental perfusion as a method of chemotherapy for inoperable malignant tumors. He designed a completely automatic extracorporeal circuit embodying a single pump and the first hyperbaric oxygenator for this purpose. With this device he was among the first to treat malignant tumors of the extremities, particularly melanomas and sarcomas, by segmental perfusion with the Russian drug sarcolysin\(^2\) and alkylating agents. Miller's work in instrumentation and electronics resulted in five patents.

Dr. Miller was Research Associate to Dr. Gibbon from 1950 to the end of 1954, Chief of Cardiopulmonary Surgery at the St. Mary Franciscan Hospital in Philadelphia from 1951 through 1974, Surgical Consultant to the Philadelphia Naval Hospital from 1971 to 1975, and Chief of the “B” Surgical Service of the Germantown Hospital and Medical Center from 1962 to 1983. He attained the position of Professor of Anatomy at the Daniel Baugh Institute and

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**FIG. 33-17a.** Enlarged version of the screen oxygenator suitable for human perfusion.
Associate Professor of Surgery. In addition to activity in many local and national societies, Miller was the recipient of the Sheeham Gold Medal in Surgery at his Jefferson graduation, the Samuel D. Gross Distinguished Service Award, and an Honorary Degree of Doctor of Science by his undergraduate alma mater, Villanova University, in 1982.

Frank F. Allbritten, Jr. was an example of Dr. Gibbon's influence on the academic careers of young men. He had graduated from the University of Pennsylvania Medical School in 1939 and served as Intern in the Hospital of the University of Pennsylvania in 1940. After a surgical residency under Dr. Flick at the Pennsylvania Hospital from 1940 to 1943, Allbritten entered the Armed Services during World War II. Upon discharge he assumed the position of Associate to Dr. Gibbon and was also appointed Chief of the Thoracic Surgical Service at the Barton Memorial Division of Jefferson Hospital. His major effort was in clinical thoracic surgery, but he also maintained a peripheral interest in research. With Dr. George Haupt, a Resident at that time, he participated in the investigation of expiratory assistance as a means of improving ventilation and avoiding respiratory acidosis during anesthesia. He made clinical contributions to the treatment of carcinoma of the esophagus, the cardiac end of the stomach, and the lung. In association with Drs. Miller and Gibbon he was involved in studies concerning blood volume loss and extracellular fluid loss during open thoractomy. Allbritten assisted Dr. Gibbon in the historic first open heart operation.

Dr. Allbritten relinquished his position of Associate Professor of Surgery and Research Assistant at Jefferson to become Professor of Surgery and Chairman of the Department of Surgery at the University of Kansas. There he continued his interest in pulmonary physiology and made additional contributions in general surgery and open heart surgery using both hypothermia and cardiopulmonary bypass. He also served on the editorial board of the *Annals of Surgery*.

John J. DeTuerc (Jefferson, 1938) completed his internship at Jefferson (1940), and began his surgical training as the second Resident on the service of Dr. Thomas A. Shallow (the first Resident was Dr. Ned T. Raker, Jefferson, 1935, who started in July 1939). After serving only one year, he was called from the reserves to active duty (1941) at Camp Lee, Virginia, attached to the Jefferson Unit of the 38th General Hospital. In the summer of 1942 the Jefferson Unit was transferred from Texas to the Middle East near Cairo, Egypt, called "Kilo 13" because it was 13 km. outside of Cairo. He served in the North African theater until 1946. On returning to Jefferson he served for a few months as the last Resident of Dr. George P. Muller. The first Resident on the Muller service had been Dr. James O'Neill (Jefferson, 1936), who started in tandem with Raker in 1939. Dr. John H. Gibbon, Jr., arrived later in 1946, and DeTuerc completed his training (1948) as Gibbon's first Resident. He then entered private practice at both Jefferson and Methodist Hospitals and joined Dr. George Willauer as an Associate. Both men conducted a very active thoracic and general surgical practice. DeTuerc contributed a number of papers to clinical thoracic surgery with

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**Fig. 33-17b.** Components of the adult screen oxygenator.
Willauer. He became Chief of Surgery at Methodist Hospital in 1962, occupying this position until 1977. He was President of the Medical Staff and a Trustee at Methodist. The “Annual John J. DeTuerk Lectureship in Surgery” was established at Methodist in 1979.

The major thrust in the establishment of clinical cardiac surgery at Jefferson was the result of the pioneering efforts of Dr. John Young Templeton, III (Figure 33-18), who also was the first resident to work with Dr. Gibbon in the laboratory at Jefferson. He graduated from Jefferson in 1941 and served his internship at Jefferson Hospital. Following service in the Armed Forces, he took his residency under Dr. Gibbon at Jefferson in 1946 and was appointed to the faculty in 1950. While a Fellow of the American Cancer Society and also the Damon Runyon Society, Templeton’s major effort was first in surgical research, followed by an outstanding clinical career. As a prolific writer he published more than 80 articles on a wide spectrum of topics related to the heart, lungs, blood vessels, gastrointestinal tract, hypothermia (Figure 33-19), metabolism, and human resuscitation. Among the Residents who assisted him in his investigations were Benjamin Bacharach, George J. Haupt, John Prehatny, John J. McKeown, Jr., Thomas F. Nealon, Jr., Rudolph C. Camishion, Louis Pierucci, and Stanton N. Smullens. His major interest became cardiac surgery, and he worked closely with Dr. Gibbon in the first open heart operations.

With Drs. Bacharach and Smullens, Dr. Templeton continued an active clinical program at the Henry R. Landis Tuberculosis Hospital in Philadelphia, which was a state-operated center for the surgical treatment of this disease. Board certified in thoracic as well as general surgery, he rose in the teaching ranks at Jefferson from Instructor in 1950 to Clinical Professor in 1957. In 1964 he transferred to the University of Pennsylvania as Professor of Surgery and Chief of

Fig. 33-18. John Y. Templeton, III, M.D., Sc.D., LL.D., a pioneer in open heart surgery.

Fig. 33-19. John Y. Templeton, III, M.D., Sc.D., LL.D., examines catheters being used to pump blood to the heat exchanger in a hypothermia experiment.
Surgery at the Pennsylvania Hospital, Templeton’s clinical success outside of Jefferson along with his research achievements led to his appointment as the Samuel D. Gross Professor and Chairman of the Department in 1967, as the successor to Dr. Gibbon, who had taken an early retirement. His name was engraved on the fourth plate of the gold-headed cane given to Dr. John Chalmers DaCosta by the Jefferson Class of 1926. In the full bloom of a successful Chairmanship he resigned for personal reasons in January, 1969, and remained as Professor of Surgery.

Dr. Templeton belonged to more than 50 local, national, and international societies and served on the board of governors or as committee chairman in 14 of these. He became President of the Laennec Society, Pennsylvania Association for Thoracic Surgery, Philadelphia Academy of Surgery, Philadelphia County Medical Society, Pennsylvania State Medical Society, and Meigs Medical Association. At Jefferson he served as President of the Medical Staff and the Alumni Association. In 1977 he received the unique award of the “Golden Scalpel” from the Division of Cardiothoracic Surgery, and in 1980 the first Templeton Lecture, established by Dr. and Mrs. Benjamin Bacharach, was given by internationally known Dr. Denton A. Cooley, Surgeon-in-Chief and founder of the Texas Heart Institute. In the same year Templeton’s portrait was presented to the College. He received the Jefferson Alumni Achievement Award in 1981. With unanimous respect of his colleagues, he has been idolized by residents, admired by students, and revered by his nursing and technical aides, and has been regarded as “a legend in his own time.”

William Wallace Lumpkin Glenn (Jefferson, 1938) completed his internship at the Pennsylvania Hospital in 1940. He was a surgical resident at the Massachusetts General Hospital from 1940 to 1943 and again from 1945 to 1946. A major part of the first period of his residency was spent in the Department of Physiology under the direction of Dr. Cecil Kent Drinker. He was an Associate in Surgery at Jefferson from 1946 to 1948, working exclusively in the research laboratory. He next became associated with Yale University, where he eventually achieved the rank of Professor of Surgery. During the following 30 years at Yale he made many significant contributions in experimental thoracic surgery. His areas of interest encompassed the lymphatic system, the treatment of congenital and acquired heart disease, the use of cardiac prostheses, and the application of phrenic stimulation for the maintenance of respiration. He was the principal author of two texts in thoracic surgery and the chapter on “Cardiac Pacemakers and Heart Block” in Gibbon’s Surgery of the Chest and received the Jefferson Alumni Achievement Award in 1973.

Joseph W. Stayman, Jr., (Jefferson, 1942) served his internship (1942–1943) and general surgical residency (1943–1945) at Germantown Hospital. He took his Fellowship in thoracic surgery at Jefferson from 1947 to 1948. After appointment as Dr. Gibbon’s Associate for the following year he joined the surgical service of the Germantown Hospital in 1949. He played an important role in the teaching of Jefferson surgical residents who were assigned to the Germantown Hospital at that time. After terminating his association with Germantown in 1960 he became Chief of Surgery at the Chestnut Hill Hospital (which became affiliated with Jefferson in 1974) until the time of his retirement in 1980. His teaching was deeply appreciated by the surgical residents on rotation from Jefferson, where he achieved the position of Clinical Professor of Surgery and subsequent Emeritus status.

John J. McKeown, Jr., (Jefferson, 1947) served his internship and a part of his surgical residency at Jefferson Hospital until 1950. Following a period of service with the U.S. Armed Forces (1950–1952) he returned to Jefferson to complete his training (1954). He became Research Associate for experimental and clinical application of extracorporeal circulation in the surgical treatment of congenital and acquired heart disease (1954–1959). A number of his papers dealt with diseases of the chest, the treatment of postinfarction ventricular aneurysm, and studies of the vertical screen oxygenator. He became Consulting Thoracic Surgeon to the Henry R. Landis State Tuberculosis Sanatorium and Attending Surgeon and eventually Chairman of the Department of Surgery of Misericordia Hospital and the Mercy Catholic Medical Center (Figure 33-20). A member of numerous prestigious societies, he attained the rank of Clinical Professor of Surgery at Jefferson (1979).
Robert K. Finley, Jr., (Jefferson, 1948) served his internship at the Lankenau Hospital and obtained his surgical training at Jefferson (1954). He entered the armed services and became Chief of the Department of Surgery in the United States Navy at the submarine base in New London, Connecticut. He then entered private practice in Dayton, Ohio, where he remained. His interests centered mostly about the treatment of severe burns, in which he was among the first to describe their early excision. He was also interested in percutaneous transhepatic cholangiography and published a number of articles on this subject. In addition to appointment as Co-Director of Education and of the Burn Unit at the Miami Valley Hospital, he was appointed Clinical Professor of Surgery at Wright State University School of Medicine.

George J. Haupt (Jefferson, 1948) returned to Jefferson in 1952 as a Resident in surgery, following service in the Armed Forces. He studied respiratory acidosis during anesthesia with Frank Allbritten and developed a mechanical respirator employing the principle of expiratory assistance (Figure 33-21). The patent obtained by him was awarded to Jefferson Medical College. He subsequently became associated with Lankenau Hospital as Chief of Cardiothoracic Surgery and
achieved the position of Clinical Professor of Surgery at Jefferson in 1977. At Lankenau Hospital he developed a clinical program in cardiothoracic surgery and became an active investigator in the Lankenau Medical Research Center. Dr. Haupt's contributions to the literature were numerous and of broad scope, including studies of respiratory physiology, especially as they pertained to aerospace science during the 1960s and early 1970s. His widespread activity in cardiothoracic and allied societies paralleled his clinical and research interests.

Harold C. Cohn (Jefferson, 1948) served his internship at St. Joseph's Hospital in Reading and received his surgical training at Jefferson. He participated actively in the laboratory during the period of design and testing of the first successful heart-lung machine. Following the completion of his residency, Cohn returned to Reading and served as a Director of the Vascular Laboratory at the Community General Hospital, of the Vascular Laboratory at the Reading Hospital, and also the Vascular Laboratory at St. Joseph's Hospital. This active practice included bypass grafting for lower-extremity ischemia, treatment of cardiac shock with intraaortic balloon pumping, and wide experience in carotid endarterectomy.

Robert G. Johnson (Jefferson, 1949) served his internship and residency at Jefferson. He then continued as a Fellow in Cardiac Surgery and Fellow in Cancer Surgery until 1955. Before coming to Jefferson, Dr. Johnson had a distinguished World War II record in the Armed Forces Second Armored Division under General Patton. He received the Bronze Star, Individual Commendation Award, Purple Heart, Combat Infantry Badge, Presidential Citation, American Defense Medal, ETO medal (five campaigns), Bronze Arrowhead (two campaigns) for invasion landing, Victory Medal, and the Croix de Guerre.

At Jefferson, Dr. Johnson became a Clinical Assistant Professor of Surgery and contributed articles in the field of general surgery. He was among the first to utilize hypothermia in open cardiomyotomy for the treatment of congenital anomalies of children. He was Chief of the Surgical Outpatient Department at Jefferson and Consultant in Thoracic Surgery at the Methodist Hospital, Veterans Hospital, and Eagleville Tuberculosis Sanatorium. He relocated in Las Vegas, Nevada, in 1971 and pursued private practice.

Thomas F. Nealon, Jr., (Jefferson, 1944) served in the U.S. Naval Hospital and entered Jefferson's surgical residency training program in 1950. He participated in one of the major ongoing problems at that time, namely studies of pulmonary ventilation during anesthesia with the use of expiratory assistance and its effects on cardiac output, the carbon dioxide content, and the saturation of arterial and venous blood with oxygen (Figure 33-22). Following the completion of his residency, Nealon continued an active research program together with clinical surgery and student teaching. He ascended rapidly in academic rank and by 1963 achieved the position of Professor of Surgery. He was appointed Director of Surgery at St. Vincent's Hospital in

![FIG. 33-21. George J. Haupt, M.D., with the “Jefferson Ventilator” employing the principle of expiratory assistance.](image)
New York City and Professor of Surgery at the New York University School of Medicine in 1968. In addition to numerous articles, Dr. Nealon contributed the chapter on "Trauma to the Chest" in Dr. Gibbon's Surgery of the Chest and was coauthor with Dr. Gibbon of the chapter on "Neoplasms of the Lungs and Trachea." He was the sole author of Fundamental Skills in Surgery, which appeared in 1963 and reached a third edition in 1979, and of Management of the Patient with Cancer in 1965, with a third edition in 1986. Along with membership in a host of societies he served as President of the New York Surgical Society and Alumni Trustee on the Board of Jefferson.

One of the outstanding residents serving his period in research training in the laboratory during the early part of this period was Dr. Charles Fineberg (Figure 33-23). He had graduated from Hahnemann Medical College in 1950 and completed his surgical residency at Jefferson in 1955. In addition to work with the extracorporeal circuit, he assisted with studies of the newly designed ventilator, experimental perfusion techniques, and studies of partial perfusion in subjects with experimentally induced pulmonary edema. Following the completion of his residency, he became a member of the Jefferson Hospital staff and the faculty of the College. He also continued active research embracing such projects as experimental myocardial revascularization and various clinical entities in general surgery.

Dr. Fineberg rose through the academic ranks to Professor of Surgery. Among activities in many local and national societies he was Chairman of the Surgical Advisory Committee of the American College of Surgeons, Chairman of the Executive Cancer Committee of Jefferson Hospital, and Director of Thoracic and Vascular Surgery at the Daroff Division of Albert Einstein Medical Center of Philadelphia. His portrait was presented to the College in 1983.

Dr. Anthony R. C. Dobell came to Jefferson in 1952 as Resident in thoracic surgery, after

**Fig. 13-22.** Thomas F. Nealon, Jr., M.D., watches a laboratory technician inject a blood sample into a gas chromatograph that measures concentration of gases.

**Fig. 13-23.** Charles Fineberg, M.D., Professor of Surgery, researcher, and effective teacher.
graduating from McGill University in 1951, and he, too, was among the outstanding group assigned to the heart-lung laboratory. Following the completion of his residency in 1956, he returned to McGill. There he ascended to the position of Professor of Surgery in 1971 and to Director of the Division of Cardiovascular Surgery in 1973. In addition to an active clinical practice in cardiothoracic surgery, he made important contributions to the literature, further advancing the horizons of cardiac surgery, particularly in the treatment of congenital heart disease and in experimental cardiac surgery. He contributed to surgical techniques, studies of heart preservation, and extracorporeal circuits.

Dr. Dobell was appointed to the Montreal Children's Hospital in 1957 and achieved the position of Director of the Cardiovascular Surgical Service in 1968. In 1974, he became Surgeon-in-Chief of the Royal Victoria Hospital. In addition, he served as Senior Surgeon at the Montreal General Hospital and occupied honorary positions at the Santa Cabrini Hospital, the Queen Elizabeth Hospital in Montreal, and the Montreal Chest Hospital Center. He became active in the important cardiothoracic societies of both Canada and the United States.

Jose H. Amadeo (Jefferson, 1952) completed his surgical training at Jefferson, during which time he participated in many of the ongoing problems in the laboratory. In cooperation with members of the surgical staff he published studies of pulmonary ventilation produced by aiding the deflation phase of respiration during anesthesia, the use of a retrosternal route in the placement of the ascending colon for esophageal substitution, the management of spontaneous pneumothorax, and the results of mitral valvulotomy for mitral stenosis.

Amadeo returned to the University of Puerto Rico, where he was involved in studies of infusion chemotherapy for advanced malignancy of the head and neck and the use of adjuvant chemotherapy for the management of carcinoma of the stomach. This led to his appointment as Professor of Surgery and Co-Chairman in the School of Medicine.

Dr. Nicholas Gimbel joined the Department as a Visiting Fellow in May 1953. He had been involved in the development of experimental cardiac surgery and extracorporeal perfusion at the Hospital of the University of Pennsylvania. He subsequently became associated with Wayne University as Professor of Surgery.

Dr. Hans Engel (Figure 33-24) was a Rockefeller Research Associate who came to the surgical laboratory at Jefferson during the period of 1953–1954 when the heart-lung machine was first successfully used on a human being. Dr. Engel had been involved in cardiovascular surgery with Professor Erik Hisbid, the founder of cardiac surgery in Denmark. Following his stay at Jefferson and upon returning to Denmark, Engel participated in the development of the first heart-lung machine in Denmark, where it was used in open heart surgery. He was a member of that operating team and was co-author of the first published report of the Danish machine in the same year. He became a prominent vascular surgeon in Denmark, founded the Danish Society of Vascular Surgery, and achieved the position of Professor of Surgery at the University of Copenhagen. During Dr. Engel's stay at Jefferson, Dr. Gibbon had provided him with a set of drawings of the heart-lung machine that had been used successfully in the first human case. These plans were subsequently used when a replica of that machine was made in 1982 for permanent display in the College of Physicians of Philadelphia (Figure 33-24).

Rudolph C. Cantishion (Jefferson, 1954) served his internship at the Cooper Hospital in Camden, New Jersey, and completed his surgical residency at Jefferson in 1959. He was a National Cancer Institute Fellow until 1962. As a surgical Resident he, too, was assigned to the surgical research laboratory (Figure 33-25), and he investigated myocardial revascularization and methods of inducing hypothermia. After completion of his residency Cantishion made important contributions either as a principal investigator or in association with others in studies of carcinoma of the esophagus, use of talc poudrage as a method of controlling malignant pleural effusion, postoperative atelectasis, hydrodynamics of extracorporeal circulation, the technique of cardiopulmonary bypass, and the use of valve prostheses. He rose in the academic ranks at Jefferson to full Professor in 1978 Dr. Cavishion was appointed Professor
and Head of the Department of Surgery of the University of Medicine and Dentistry of New Jersey, Rutgers Medical School in Camden. In addition to awards and honors, he was active in the local and national societies of his field, including founder membership of the Delaware Valley Vascular Society and the Vascular Society of New Jersey.

Herbert E. Cohn (Jefferson, 1955) served his internship at the Atlantic City Hospital and entered the residency program at Jefferson in 1957 (Figure 33-10). He was appointed to the faculty of Jefferson and to the staff of Albert Einstein, Northern Division. His research experience was related to the various aspects of surgical endocrinology and renal transplantation at Jefferson. His surgical practice emphasized pulmonary disease and the endocrine system. Dr. Cohn achieved the positions of Professor of Surgery, Director of the Residency Training Program, and Vice-Chairman of the Department. He was elected President of the staff of Thomas Jefferson University in 1985.

Louis Pierucci (Jefferson, 1955) served his internship and early residency in the Department of Surgery until 1957. Following a period of duty with the armed forces he completed his residency in 1962. He participated in clinical surgery at Jefferson and continued an active experimental program. In association with Drs. Templeton, Ballinger, and Camishion, he studied experimental profound hypothermia, anaerobic metabolism and metabolic acidosis during cardiopulmonary bypass, the acidosis of hypothermia, and methods of removal of excess lactate in patients during hypothermia and biventricular bypass.

![Figure 33-24. Hans Engel, M.D., with President Lewis W. Bluemle, Jr., in 1982, reviewing plans for a replica of the first successful heart-lung machine, to be on permanent display at the College of Physicians of Philadelphia.](image-url)
In 1968, Pierucci became the Chief Attending Surgeon of the Cooper Hospital University Medical Center in Camden, New Jersey, and in addition continued an active surgical practice. His interests centered in vascular surgery, of which he made numerous observations concerning the surgical treatment of carotid and vertebral artery insufficiency. He remained an Associate Professor of Surgery at Jefferson while practicing at the Cooper Hospital University Medical Center and other New Jersey Hospitals.

Edward D. McLaughlin (Jefferson, 1956) interned at Jefferson and became a surgery resident at the National Institutes of Health in Bethesda (1957–1959). When at Bethesda he identified a fraction in human blood that appeared to inhibit growth of malignant experimental tumors and received a number of awards for this particular work. He completed his residency training at Jefferson. After an additional six months in England in the Department of Thoracic Surgery at the Hawkmoor Chest Hospital, Bovey Tracey, Devon, he associated with Mercy Catholic Medical Center, Misericordia Division, in Philadelphia as Chairman of Surgery. At Jefferson he ascended the academic ranks to become Professor of Surgery. In 1974 he received the Christian R. and Mary F. Lindbach Award for Distinguished Teaching.

Benjamin Bacharach (Jefferson, 1956) received

Fig. 33-35. Drs. Leon Scicchitano, Rudolph Camishion, Edward J. Baranski, and Walter Ballinger, with a laboratory technician, studying the effect of the denervation of a lung.
his surgical training at Jefferson (1958–1963) and became a Fellow in cardiothoracic surgery at the Pennsylvania Hospital (1963–1964), following which he associated with Dr. John Y. Templeton in clinical practice.

During his surgical residency he was assigned to the surgical research laboratory to study various oxygenators and methods for inducing profound hypothermia. He was then appointed to the faculty at Jefferson and Attending Physician to the Jefferson Hospital. In the early years of clinical practice, Dr. Bacharach, in association with Drs. Templeton and John McKeown, was responsible for the thoracic surgical service at the Henry B. Landis Tuberculosis Hospital in Philadelphia and operated on most of the cases of complicated tuberculosis during the period of 1962 to 1965. He made extensive studies relating to the inhalation of carbon dioxide and brain cooling during hypothermia, the techniques of induction of profound hypothermia by biventricular bypass, and bilateral carotid sinus nerve stimulation in the treatment of hypertension, as well as some of the early studies of computerized tomography as a diagnostic aid in bronchogenic carcinoma. Dr. Bacharach was President of the Alumni Association in 1981. In 1983 he was advanced to the rank of Clinical Professor of Surgery and also became Associate Dean for Admissions of Jefferson Medical College (Figure 33-26). The following year he was appointed a Vice-Chairman of the Department of Surgery.

David C. Schechter (Jefferson, 56) interned at Jefferson and then continued in the surgical research laboratory. Following a tour of duty with the Armed Forces, he pursued his residency in general surgery at the University of Colorado Medical Center in Denver. He was a recipient of a Fellowship award for postgraduate study and training under Sir Russell Brock at the Institute for Diseases of the Chest at Brompton Hospital in London and Professor Charles Dubost in Paris at the Hospital Broussais. He then associated with the New York Medical College in the Department of Surgery and gradually ascended the academic ranks to become Clinical Professor of Surgery.

Walter Ballinger (Figure 33-25) graduated from the University of Pennsylvania School of Medicine in 1951 and pursued his surgical training at the first Columbia Surgical Division of the Bellevue Hospital in New York. He next joined the Jefferson faculty in 1956 as Assistant in Surgery and in 1964 became Associate Professor of Surgery. He left Jefferson, associated with the Johns Hopkins University School of Medicine as Associate Professor of Surgery, and then became the Bixby Professor of Surgery and Head of the Department at the Washington University School of Medicine until 1978.

Walter Ballinger's interests centered mostly in vascular and endocrine surgery. During his period at Jefferson he was involved in some of the research projects related to the cardiothoracic program (Figure 33-25). He contributed to a number of papers involving the preservation of blood platelets, hepatic physiology and metabolic...
changes during cardiorespiratory bypass, metabolic changes during hypothermia, physiologic changes within the intestine as a result of autotransplantation, methods of small vessel anastomosis, the intestinal effects of vagotomy, and extensive clinical studies of biliary operations and gastric drainage procedures. Dr. Ballinger was named the Markle Scholar in Medical Science from 1961 to 1966 and gave the National Lecture at Sigma Xi. He became concerned with nationwide surgical training programs and served on numerous special committees. In 1971 he was appointed Coeditor-in-chief of Surgery. In addition he was Associate Editor of the Journal of Surgical Research and also served on the Editorial Board of Video Surgery.

John R. Prehatny (Jefferson, 1957) completed his residency training at Jefferson in 1964. He was involved with many of the ongoing problems and participated in a number of studies relating to the oxygen uptake of tissues following profound hypothermia with resulting acidosis, shifts in the partial pressure of carbon dioxide in hypothermia during ventilation with 5% carbon dioxide, the contraindications for the use of biventricular bypass, and the metabolic effects of profound hypothermia and circulatory arrest.

Prehatny became Clinical Professor of Surgery at Jefferson and Chairman of the Department of Surgery of the Methodist Hospital in Philadelphia. Very active in all the affairs of Jefferson, he served as President of the Alumni Association in 1985.

Stanton N. Smullens (Jefferson, 1961), following an internship at the Presbyterian University of Pennsylvania Medical Center in Philadelphia, entered the armed forces for a period of duty. He was Chief of the Outpatient Services, U.S. Army Hospital, Fort Walters, Mineral Wells, Texas. After discharge from the Army, he took his surgical residency at Jefferson in 1964 and in 1965 became a Fellow in cardiothoracic surgery at the Pennsylvania Hospital.

Dr. Smullens associated with Dr. John Y. Templeton and Dr. Benjamin Bacharach in clinical practice. He was appointed Instructor in Surgery at Jefferson and ascended to the position of Associate Professor. He became active in many prestigious societies and was a founding member of the Delaware Valley Vascular Society. His research interests were predominantly of a clinical nature. With Dr. Templeton and others, he made studies of the patency of abdominal aortic grafts, describing hypovolemic shock due to massive edema following cardiopulmonary bypass and the surgical management of acute evolving myocardial infarction. His interests centered in the area of vascular surgery, to which he made basic contributions in ultrasonic imaging. He was coinvestigator in the National Institutes of Health contract involved with the assessment of ultrasonic B-scan imaging for detection and quantification of atherosclerotic lesions in the iliofemoral arteries and additional studies concerning prostaglandin (PGE Sub 1) infusion for the treatment of obstructive arterial disease.

Louis F. Plzak, Jr. graduated from the University of Chicago Medical School in 1958. Following his surgical training at the Peter Bent Brigham Hospital, he obtained a pediatric surgical fellowship at the Children's Hospital in Boston. He was appointed the Arthur Cabot Tracy Teaching Fellow at Harvard Medical College. Following two years of military service, he joined the United States Army Medical Research and Development Command within the office of the Surgeon General as Lieutenant Colonel. In this capacity he directed research in shock and trauma and the use of blood and plasma volume expanders. Plzak returned to Harvard in 1970 as Assistant Professor of Surgery in the Department of Cardiothoracic Surgery. In July 1971 he was appointed Professor of Surgery at Jefferson.

Dr. Plzak had an extensive basic research experience beginning during his medical school years in studies related to erythropoiesis and the influence of factor S on red cell production. He published a number of papers during this period and made basic contributions on erythropoietin production. His research interests were next directed toward experimental cardiac surgery, in which he studied the effect of alkalosis on right ventricular hypertrophy in experimentally induced pulmonary hypertension, coronary blood flow and diastolic pressure during prolonged cardiopulmonary bypass, and the amelioration of pulmonary hypertension by metabolic alkalosis. He participated in studies relating to the use of cardiac transplant as a left ventricular assist device.

Dr. Plzak's broad training was evidenced by his versatility in pediatric, general, and cardiothoracic
surgery. He belonged to an array of national societies, including charter membership in the American Pediatric Surgical Association. His hospital affiliations, in addition to Jefferson, were at Pennsylvania, the Graduate, and Bryn Mawr.

Division of Cardiothoracic Surgery Established (1973)

Stanley Karl Brockman (Figure 33-27) came to Jefferson in 1973 as Director of the newly created Division of Cardiothoracic Surgery. He had graduated from Boston University School of Medicine in 1955 and was a surgical Resident at the Johns Hopkins Hospital until 1956. He became the Harvey Cushing Fellow in Surgery at Hopkins, followed by an appointment as Senior Assistant Surgeon in the laboratory of cardiovascular physiology in the National Heart Institute at Bethesda until 1959. He completed his surgical training at the Vanderbilt University Hospital in 1963, followed by an immediate appointment as Assistant Professor of Surgery. During 1966–1967 he was on sabbatical leave for a special assignment in clinical cardiac surgery at the Mayo Clinic on the service of Dr. Dwight McGoon. He then became associated with the University of Chicago School of Medicine as Associate Professor of Surgery (1968) and served as Director of the Division of Cardiac and Thoracic Surgery of the Michael Reese Medical Center in Chicago (1968–1973). He rapidly ascended the academic ranks at the University and was appointed Professor of Surgery in 1970.

At Jefferson, Dr. Brockman developed an active clinical program and established the Cardiothoracic Surgical Research Laboratory under the Directorship of J. Yasha Kresh, Ph.D., Research Assistant Professor of Surgery. He made numerous contributions in the areas of experimental open heart surgery with hypothermia, studies of basic physiology of ventricular contraction, the relationship of congestive heart failure and cardiac output in heart block during pacing, valvular replacements, surgical management of cardiogenic shock in acute myocardial infarction, and many studies relating to the use of the pacemaker.

Dr. Brockman promptly commanded respect for his brilliance as a teacher and his demands for perfection in the operating room. He sponsored continuing education programs in the form of conferences and symposia with Visiting Professors from the leading cardiothoracic centers of the country. His membership in a host of societies and his training of cardiothoracic fellows further enhanced the reputation of this Division. He resigned from Jefferson in 1986 to direct the cardiothoracic program and service at Hahnemann University.

Richard N. Edie (Figure 33-28) succeeded Dr. Brockman in 1987 as Director of the Division of Cardiothoracic Surgery. He was born in 1937 in Yonkers, New York. After receiving his B.A. degree from Princeton University (1959), he spent
two years in the United States Navy (1959–1961) and earned his M.D. degree at Columbia University College of Physicians and Surgeons (1965), and then interned at Roosevelt Hospital in New York City (1966–1966). He took a residency in General Surgery at the same Hospital (1966–1970) and extended his training at Columbia Presbyterian Medical Center as a resident in Thoracic Surgery (1970–1972). Between 1972 and 1979 he served as Assistant and then Associate Professor of Clinical Surgery in the College of Physicians and Surgeons of Columbia University, while also on the staff of the Presbyterian and the Roosevelt Hospitals. From 1979 to 1987 he was Associate Professor of Surgery at the University of Pennsylvania and on the staff of its Hospital, the Children’s Hospital of Philadelphia, and the Presbyterian University of Pennsylvania Medical Center. In 1988 Edie also became an Attending Surgeon at the Pennsylvania Hospital. During this time he had authored or coauthored 34 scientific articles relating to cardiothoracic surgery in the important journals of his field. Certified in general as well as thoracic surgery, he also belonged to the prestigious local and national societies in his specialty.

Dr. Edie brought to Jefferson not only his wealth of experience but an energy to expand the well-established programs in teaching, research, and patient care. Specifically, he has endeavored to interdigitate his Division more closely with that of Cardiology in a cooperative effort for the treatment of acute myocardial infarction and the implantation of ventricular assists of both the autologous and artificial-device types. Another goal is the creation of a unified Thoracic Surgery Service in closer collaboration with pulmonary medicine, radiology, and radiation therapy for even more improved service to patients with lung cancer and other forms of pulmonary disease. His research efforts are directed to development of a corps of clinical scientists who will work with cardiologists in the study of electrophysiology and cardiac drugs.

For more than a century many of the great strides in the growth and development in surgery of the thorax have been made by Jeffersonians at Jefferson itself. From the early attempts at removal of foreign bodies from the heart and lungs to the treatment of inflammatory and neoplastic disease of the lung and to the first great epochal attempt at open heart surgery, Jefferson-trained men have played a leading role. This great contribution to the advancement of the knowledge in thoracic surgery is evidenced by the publication of more than 1,200 scientific papers describing these experiences, both experimental and clinical, appearing worldwide in leading scientific journals.

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