# THE EVOLUTION OF IRON LUNGS

J. H. EMERSON COMPANY

CAMBRIDGE, MASSACHUSETTS 02140

# THE EVOLUTION OF

# "IRON LUNGS"

## (RESPIRATORS OF THE BODY-ENCASING TYPE)

Gathered by J. H. EMERSON COMPANY

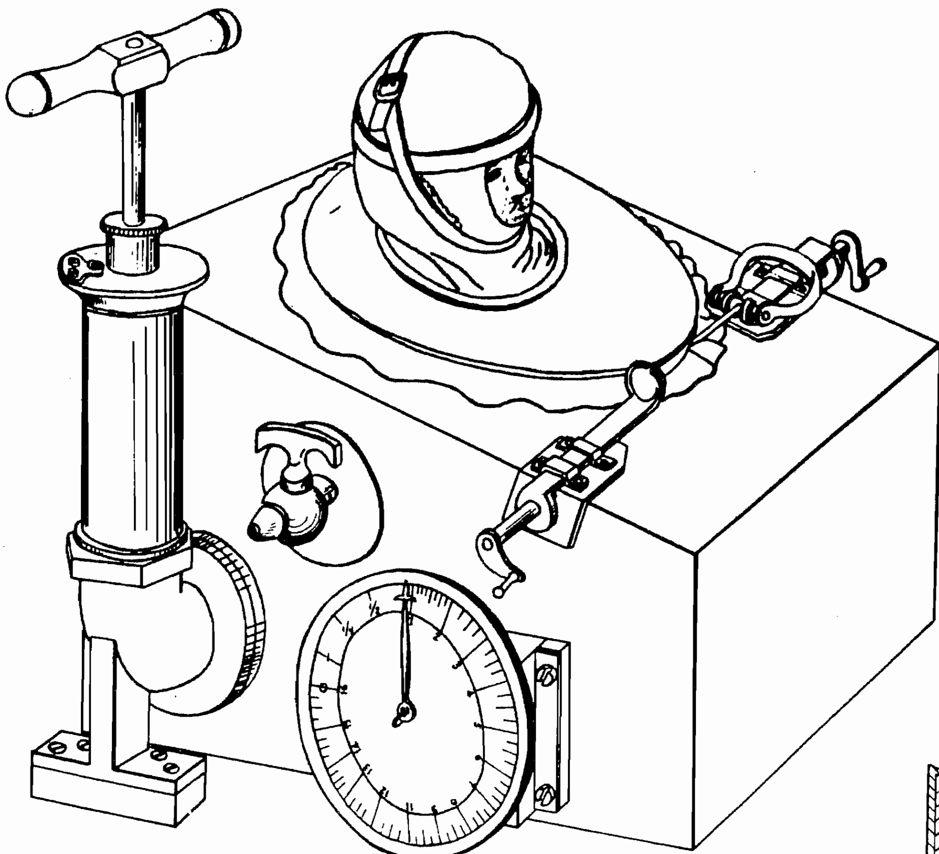
from PATENTS and MEDICAL PUBLICATIONS

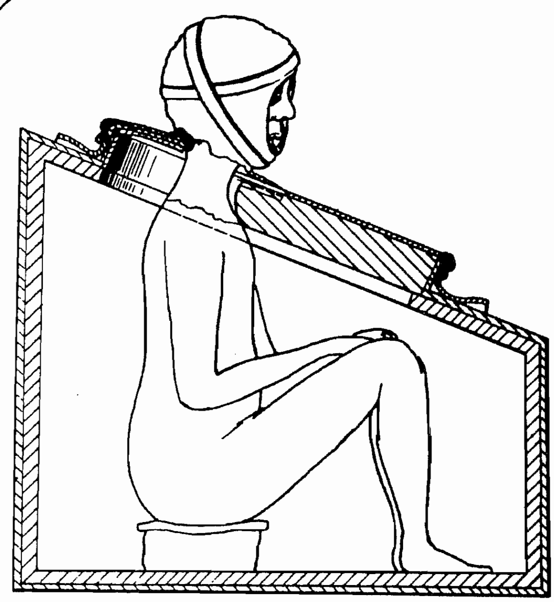
One finds that inventors in many countries have reached the same goals, working almost completely without knowledge of each others' achievements. All contributed valuable ideas in this life-saving evolution, although very few built respirators that were widely used. Complete success was difficult, requiring mechanical ability, knowledge of physiology, attention to nursing care, widespread demand (as in an epidemic) and adequate finances.

The evolution pictured here has not ended, but wonderful machines now exist, and thousands of lives have been saved.

Sixteen plates (reproduced here in smaller size) were prepared in 1958 and exhibited at the Brussels World's Fair. They were deposited afterwards in the Smithsonian Institution, Washington, D.C. The drawings, except No. 2, were made by Jean A. Loynes. The commentary is by John Haven Emerson.

Since 1958 we have learned about several other early respirators. These are listed in a Supplement following the original 16 Plates.

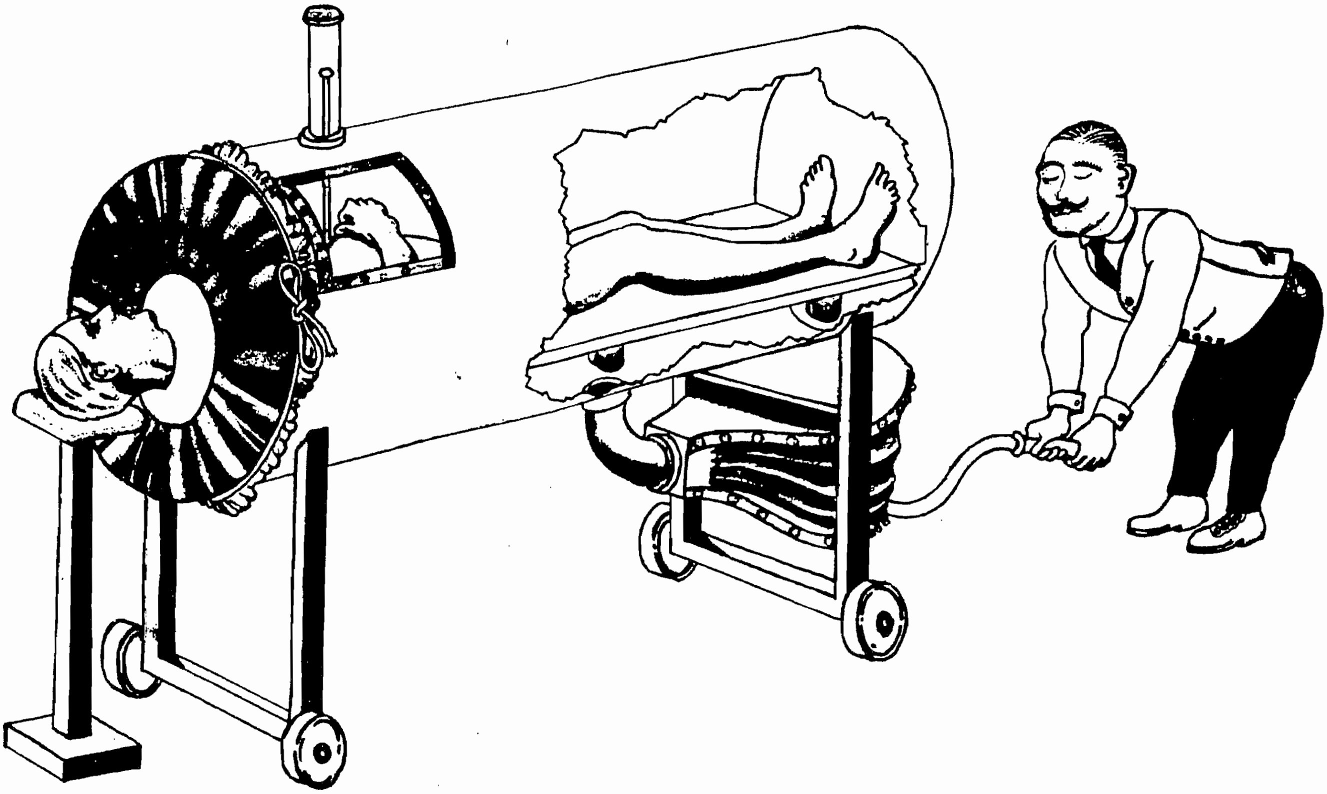


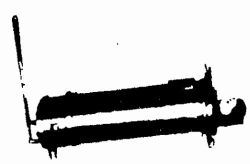


1864 NO. 1 – EMERSON EXHIBIT JONES

The earliest body-enclosing iron lung we know of was described by Alfred F. Jones of Lexington, Kentucky, in 1864. U.S. patent No. 44 198 says he "cured paralysis, neuralgia, rheumatism, seminal weakness, asthma, bronchitis, and dyspepsia. Also deafness." . . . when properly and judiciously applied many other diseases may be cured . . ."

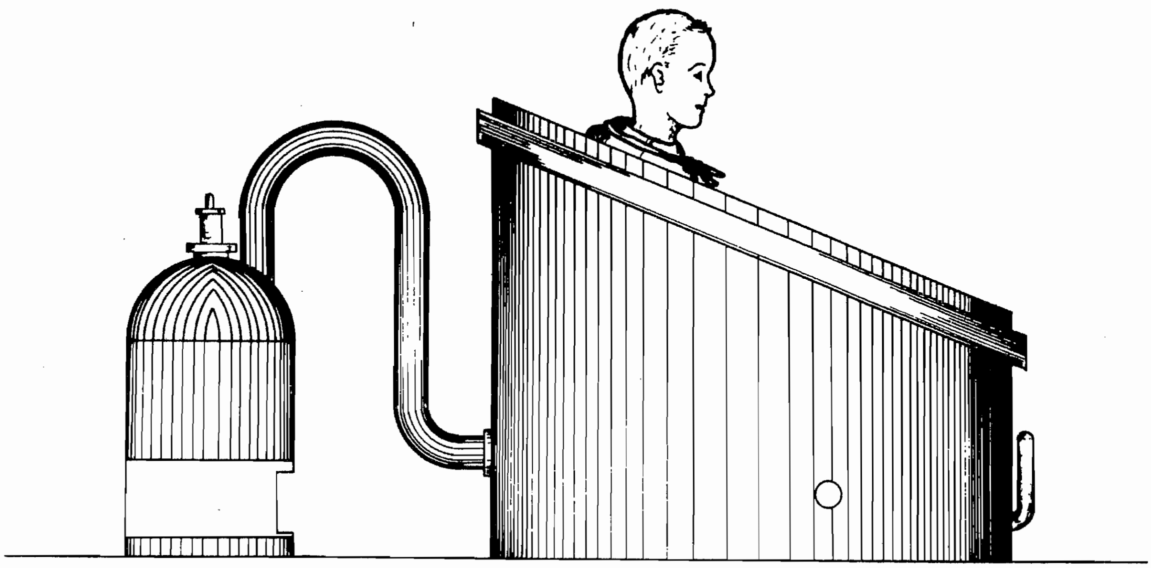
M.Parrish Jr. 1932 (1) 1958 (2)





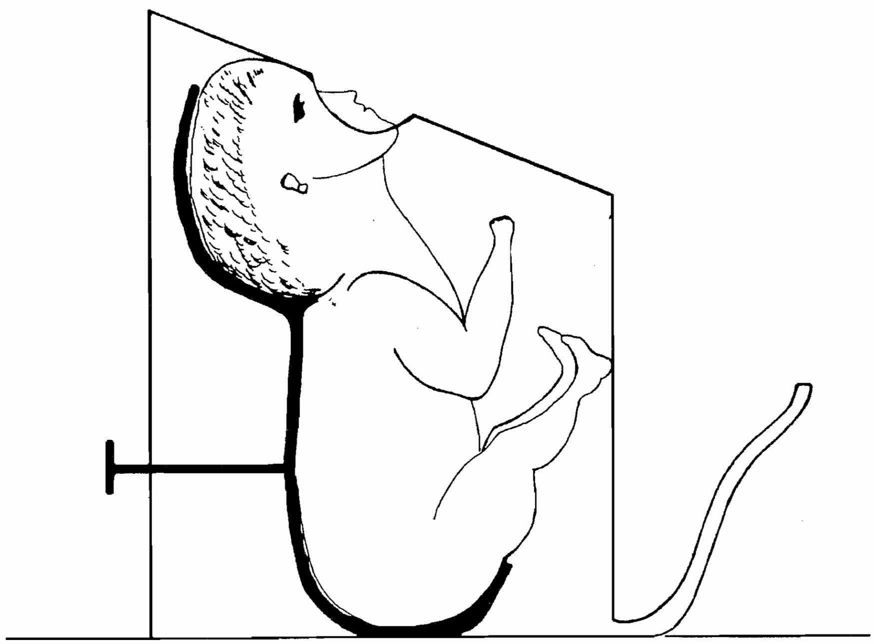
# 1876 NO. 2 – EMERSON EXHIBIT WOILLEZ

In 1876 Dr. Woillez of Paris built the first workable iron lung, which he called a "spirophore". It had the basic elements of modern respirators, including an adjustable rubber collar and a sliding bed. A unique feature was a rod which rested lightly on the patient's chest, to give visual proof of actual lung expansion. In a brilliant lecture presented before the Academy of Medicine on June 20, Woillez showed a thorough understanding of the physiology and mechanics of artificial respiration. He refused to patent his invention. A colleague suggested placing spirophores all along the Seine, for drowning rescues, but finances for this public service were lacking. (The illustration was reconstructed by Maxfield Parrish, Jr., for a legal battle, years before the inset photograph was discovered.)



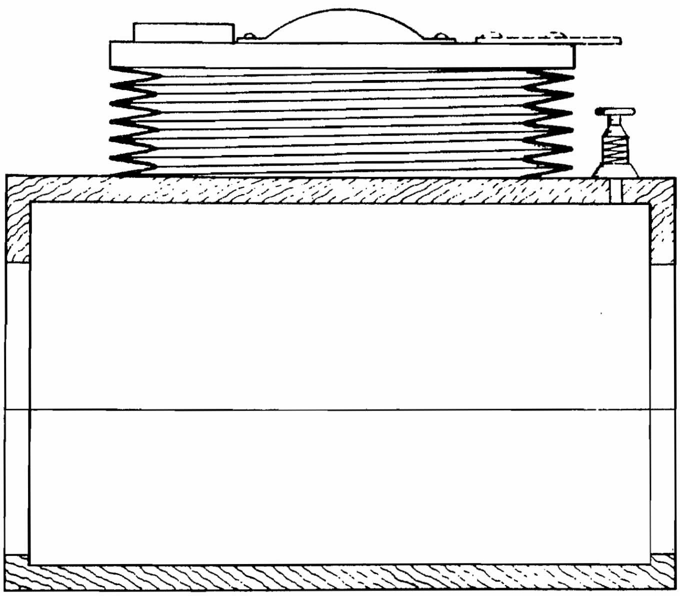
# 1887 NO. 3 – EMERSON EXHIBIT BREUILLARD

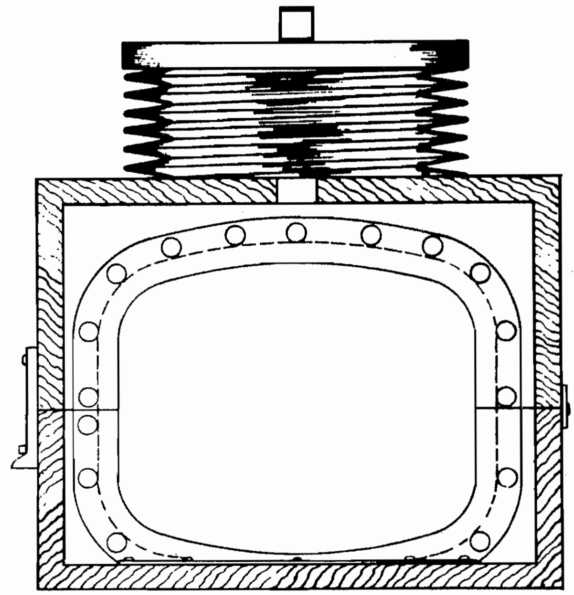
Dr. Charles Breuillard of Paris patented a "bath cabinet" type of respirator in 1887. For a source of vacuum he recommended "a steam ejector fed by a steam boiler...heated by a spirit lamp." The patient himself was supposed to operate a valve, alternately connecting the cabinet with the vacuum, for inhalation, and with the atmosphere, for exhalation. Breuillard also described a chest respirator ("cuirass") to be operated in the same way, and a face-mask.

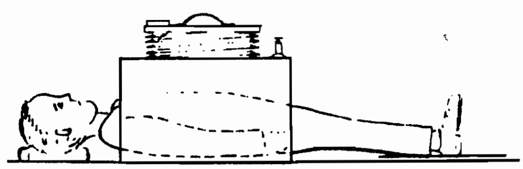


1889 NO. 4 – EMERSON EXHIBIT BRAUN

For "resuscitating asphyxiated children" Dr. Egon Braun of Vienna devised a small wooden box in which pressure and suction were created by the doctor's own breath (through the tube at the right). The infant was supported in a plaster mold, with nose and mouth pressed against an opening in the rubber closure. (This picture, from the Boston Medical and Surgical Journal of 1889, is only a rough diagram.) Dr. Braun reported 50 consecutive successful cases.



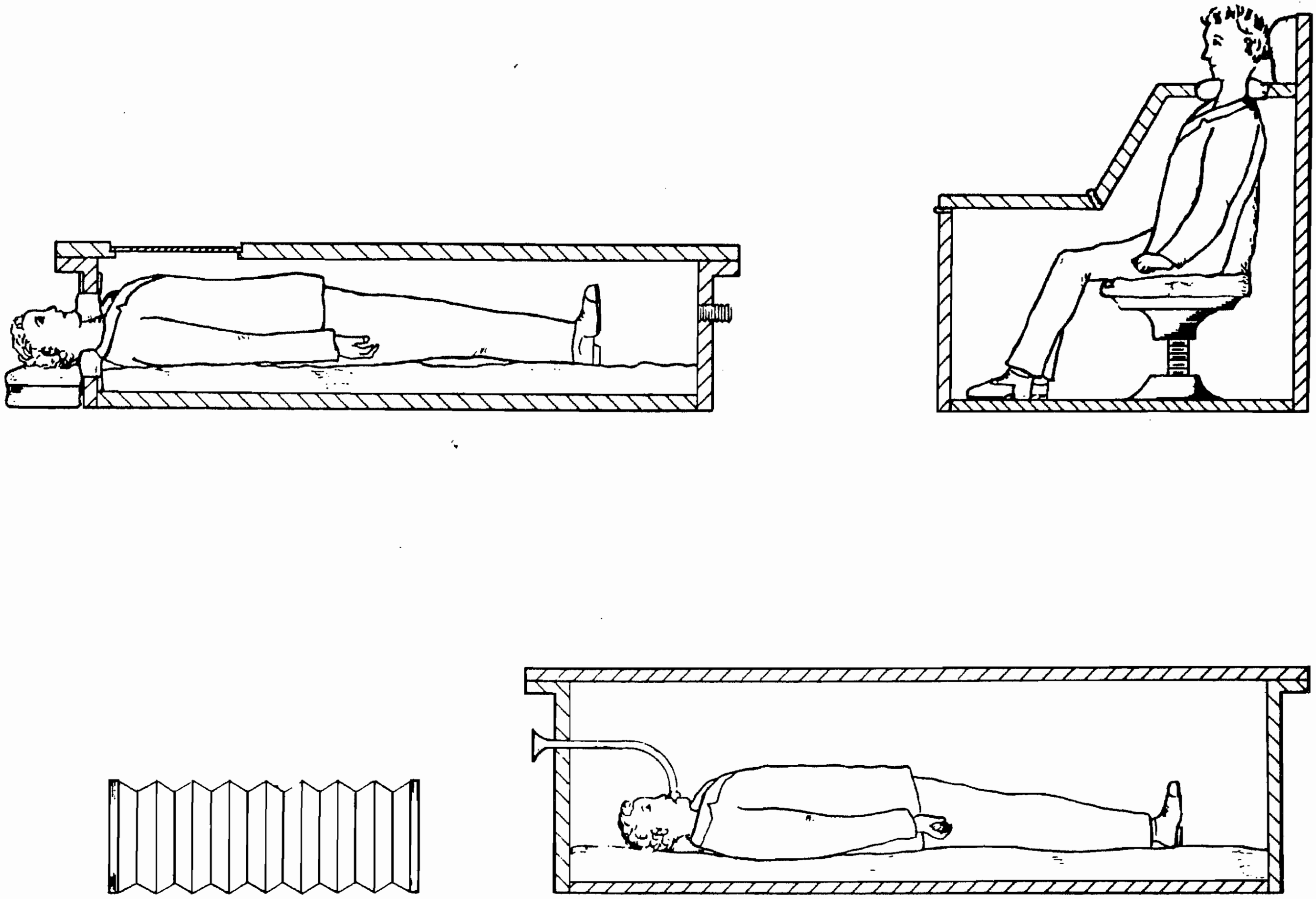




1901 NO. 5—EMERSON EXHIBIT

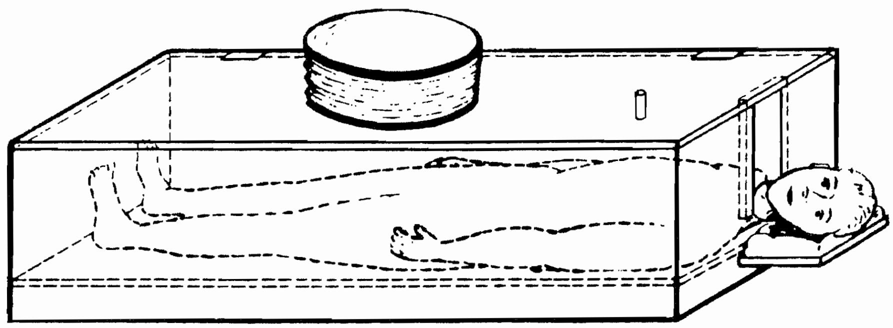
# EISENMENGER

In 1901 Rudolf Eisenmenger of Piski, Hungary, patented a portable respirator which consisted of a "simple, two-part box" enclosing only the patient's chest and abdomen. Later he became medical professor in Vienna, and there continued to improve his invention. He stressed the importance of access to the patient's throat and limbs, of portability, and of hand-operation. (Motors were also mentioned.) There are reports of "extraordinary success" with Eisenmenger's respirators.



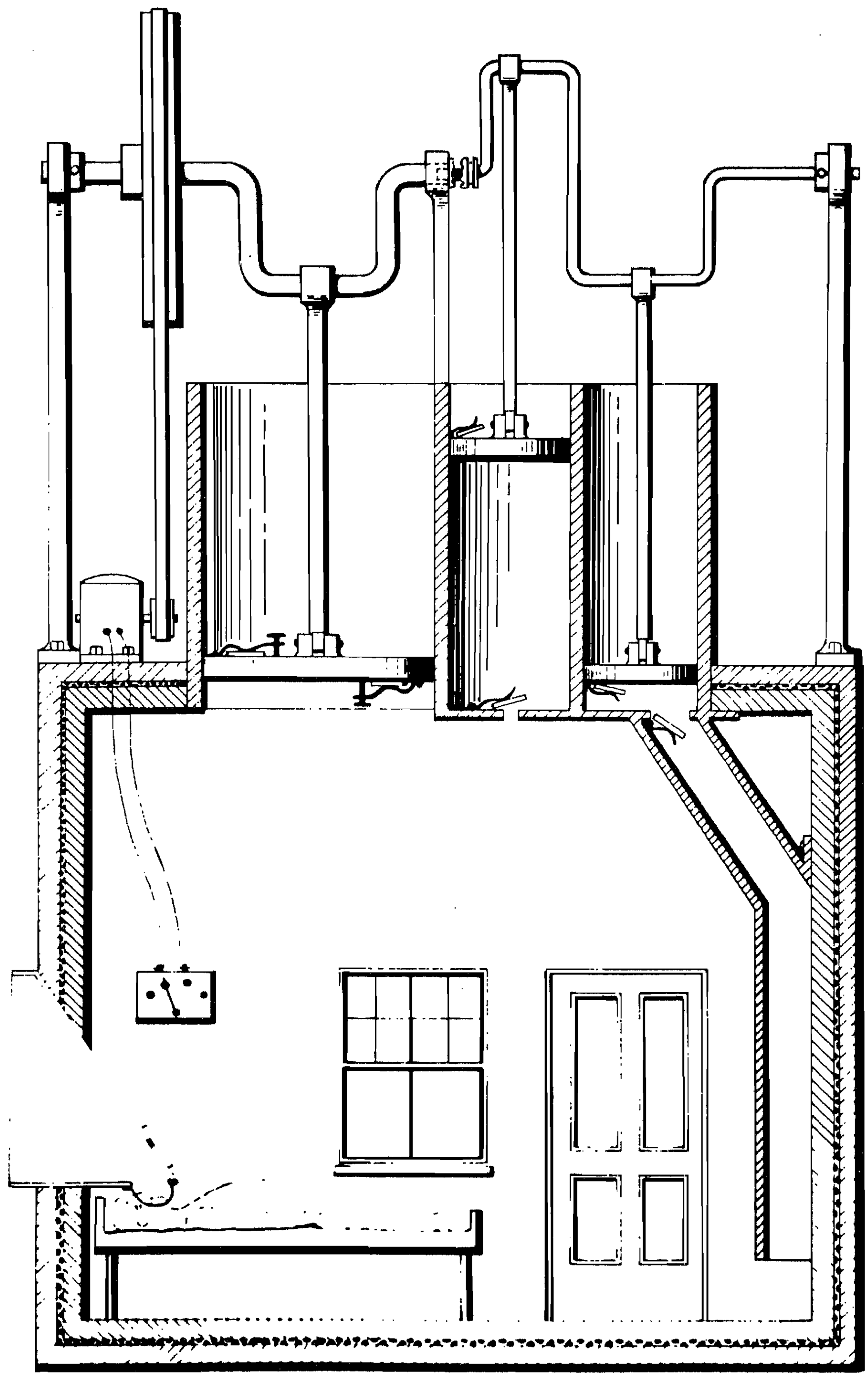
# 1905 — NO. 6 – EMERSON EXHIBIT — DAVENPORT

William Davenport of London understood the mechanics of artificial respiration clearly. His patent in 1905 mentions a box, a rubber collar, and a simple bellows or piston pump. He lacked the sliding bed (of Woillez and modern iron lungs) but made several good suggestions, including the supplementary use of oxygen. He proposed several types, including a "collapsable form . . . to facilitate transit."



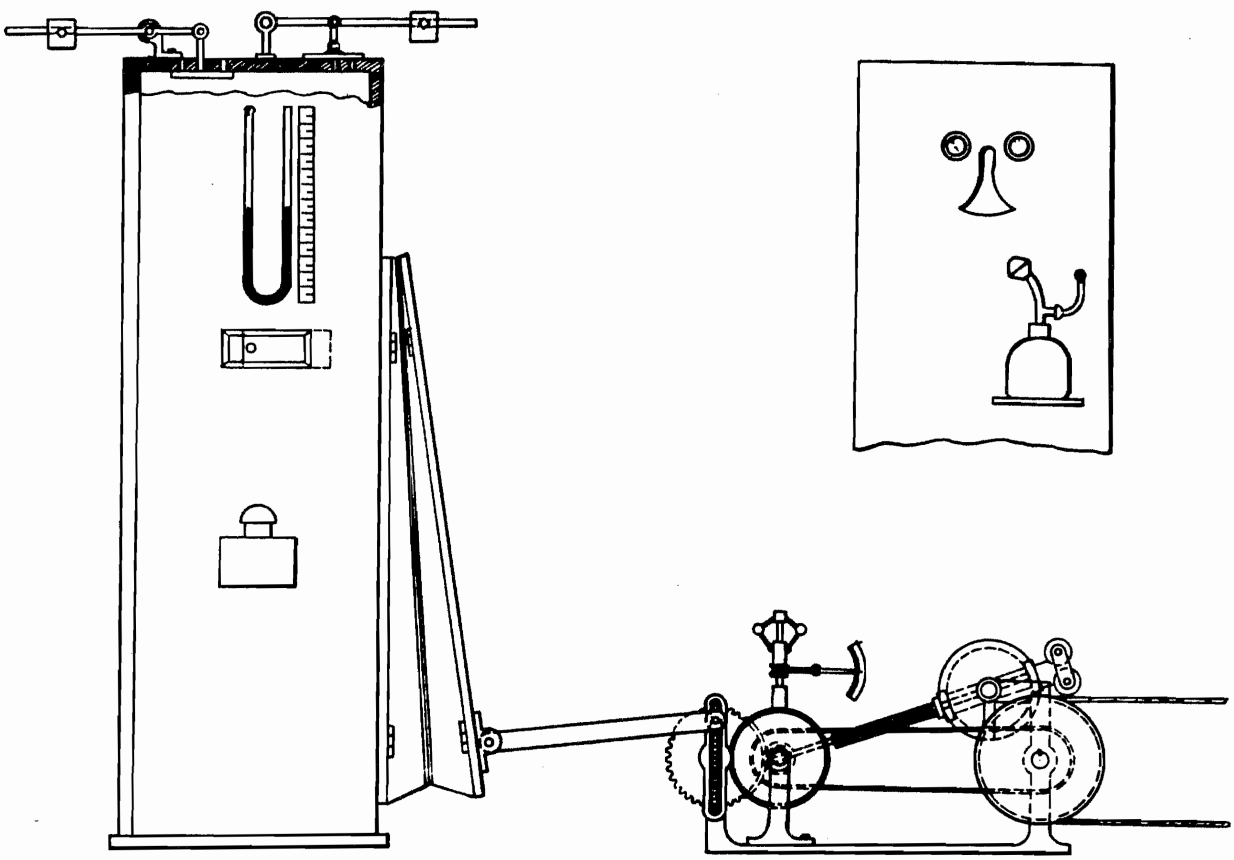
1905 NO. 7—EMERSON EXHIBIT HAMMOND

Dr. Charles Morgan Hammond of Memphis, U.S.A., built his first "artificial lung" in 1905 and a series of improved models throughout the next 20 years. He performed experiments and treated patients successfully, but his respirators were not produced commercially and remained unknown to the public for many years.



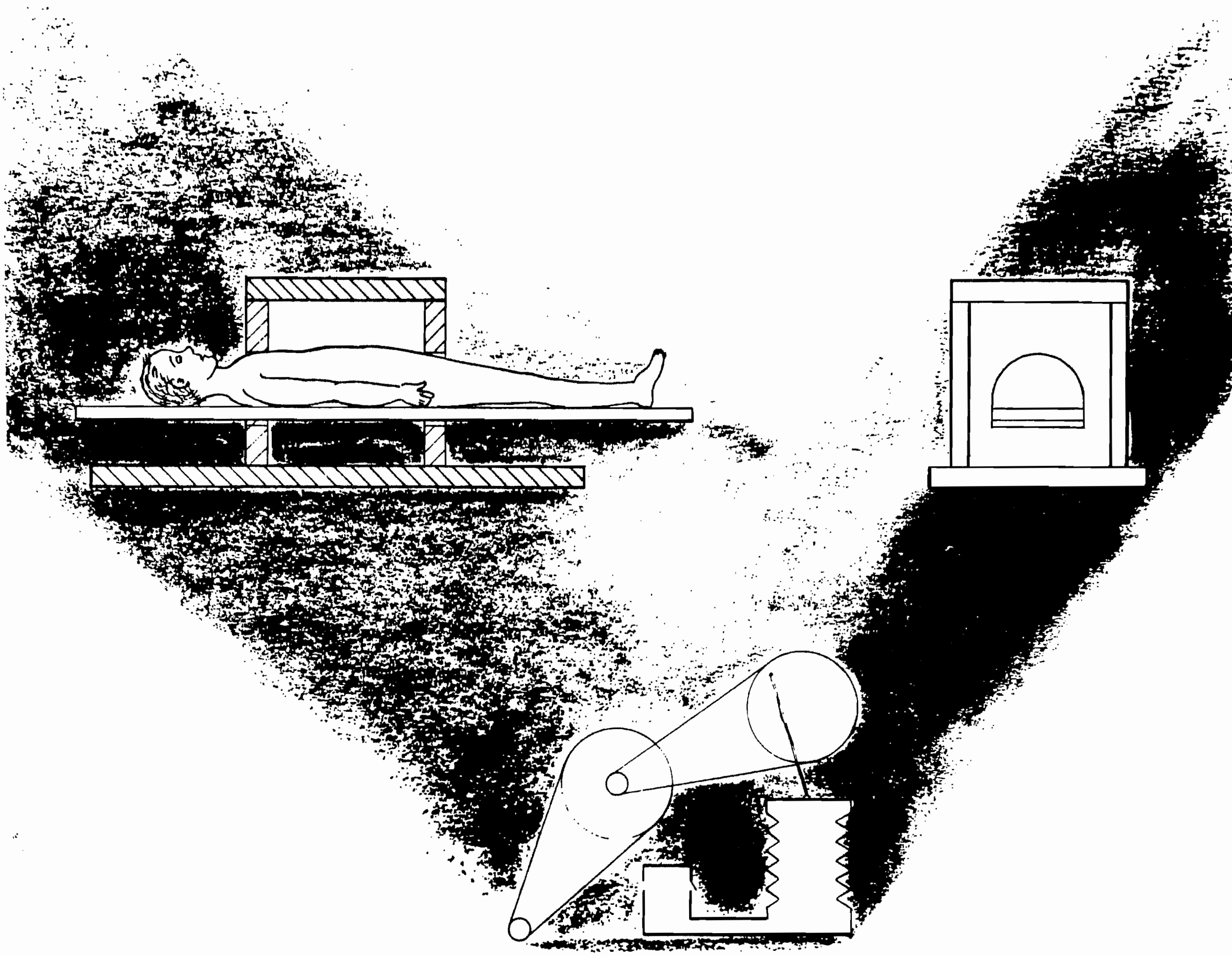
# 1908 NO. 8 – EMERSON EXHIBIT LORD

In 1908 Peter Lord of Worcester, U.S.A., patented a respirator room. He pictured huge pistons to create the pressure changes and to supply fresh air. An enormous motor would have been needed and very heavy construction. However, the idea of a room is good, because it makes nursing care easy.



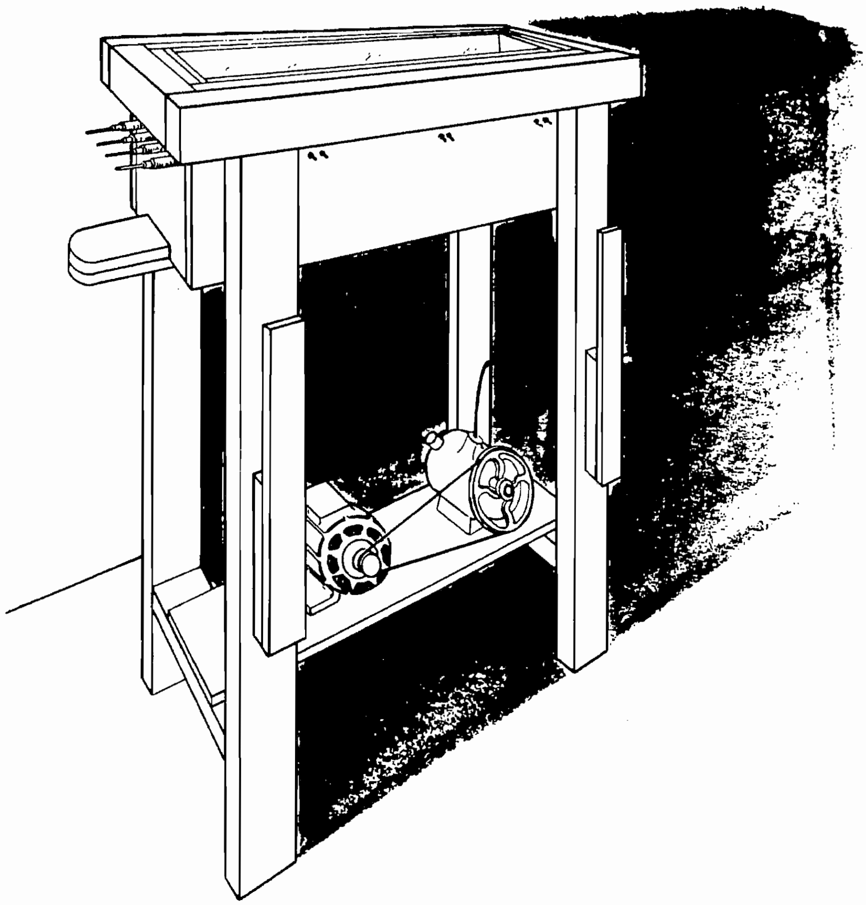
1916 NO. 9 – EMERSON EXHIBIT SEVERY

The patent granted to Melvin L. Severy of Boston, U.S.A., in 1916 shows little concern for the patient's comfort but includes ingenious mechanical elements. In the model illustrated, the patient was obliged to stand, pressing his nose and mouth against a triangular aperture below 2 eye-windows. Severy also described variable-speed pulleys and elaborate electromagnetic controls for regulating speeds and pressures. He suggested cams to produce various pressure curves. A cuirass respirator and mask resuscitator were mentioned also.



1918 NO. 10 – EMERSON EXHIBIT **STEUART**

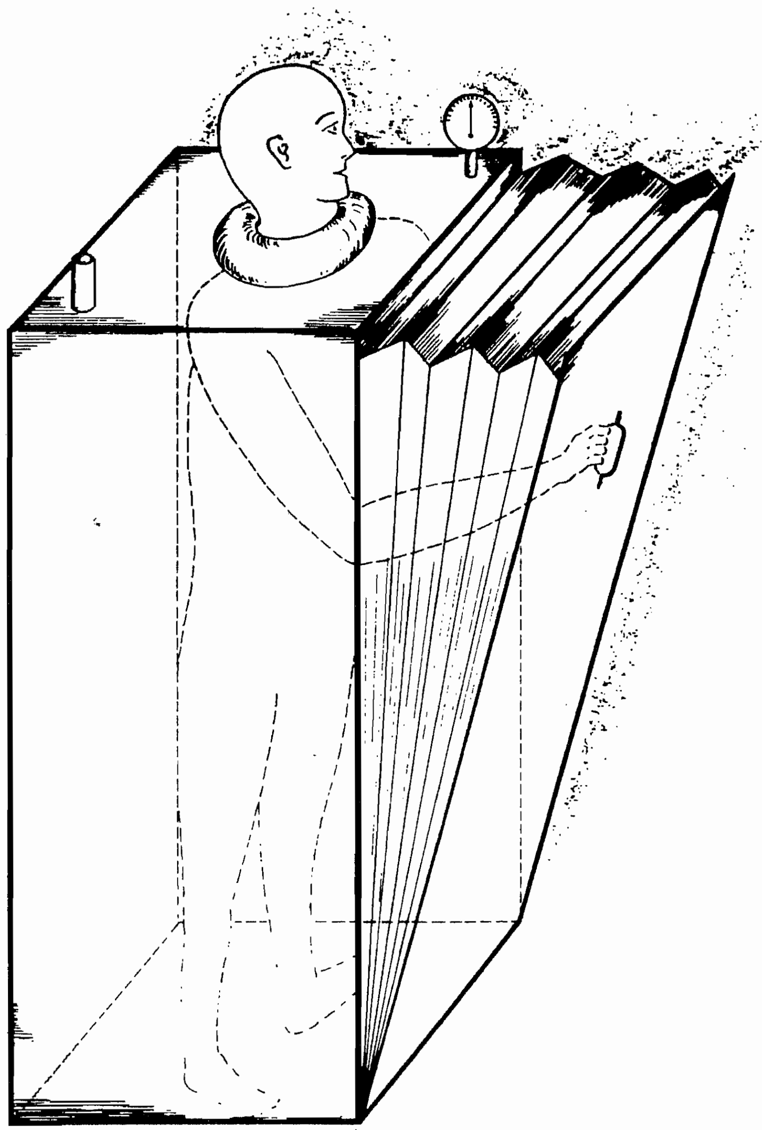
Dr. W. Steuart of South Africa built a simple respirator and demonstrated a working model to his colleagues (Medical Journal of South Africa, 1918). He proposed plaster of Paris to seal around the patient's shoulders and pelvis, but friends quickly suggested other more practical materials. Steuart was the first to think primarily of poliomyelitis. He even envisaged a ward piped with intermittent suction, to which individual body casings could be attached.



1919 NO. 11 – EMERSON EXHIBIT

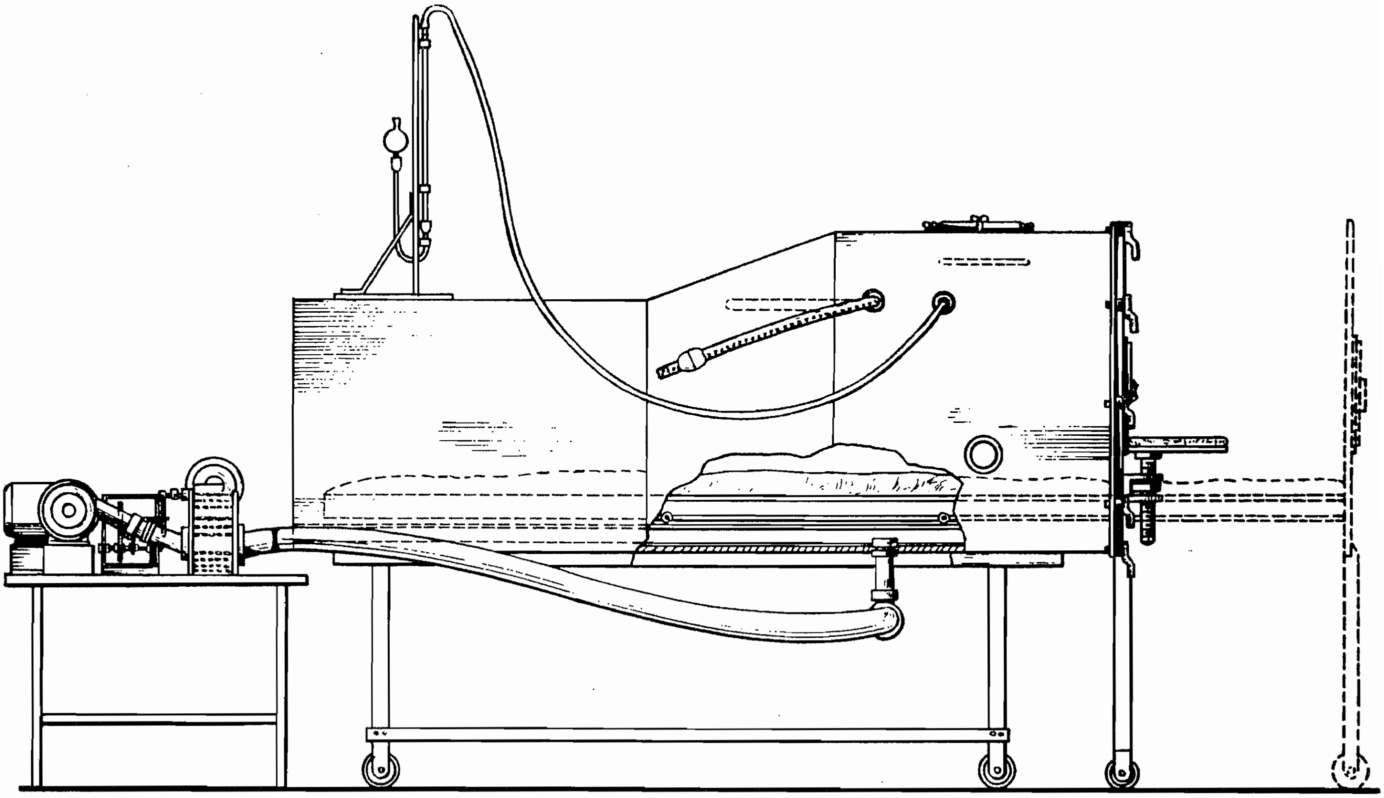
# CHILLINGWORTH

Felix P. Chillingworth and Ralph Hopkins of New Orleans, U.S.A., built a plethysmograph to study circulatory changes resulting from lung distention. They also used it as a dog respirator. "... pulmonary ventilation is accomplished by rhythmic changes in air pressure within the plethysmograph causing alternate distention and collapse of the lungs." (1919, Journal of Laboratory and Clinical Medicine.)



1926 NO. 12 – EMERSON EXHIBIT SCHWAKE

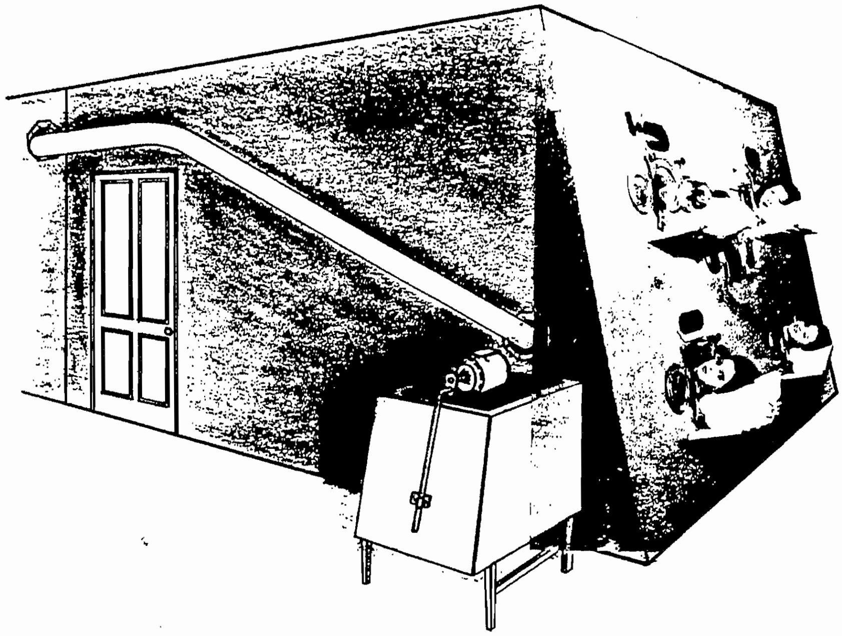
Wilhelm Schwake of Oranienburg-Eden, Germany, patented a "pneumatic chamber" in 1926. He was concerned with portability and with exactly matching the patient's breathing depth and rhythm. He also stated that "negative pressure... upon the skin... draws out... the gaseous by-products." We would not consider this respirator practical for severely ill patients, but the picture is a great favorite.



1928 NO.13-EMERSON EXHIBIT

# DRINKER & SHAW

The first "iron lung" to receive widespread use was developed in 1928 in Boston, and was patented by Philip Drinker and Dr. Louis Agassiz Shaw. It was cumbersome and inconvenient but saved a number of lives. It had a sliding bed with head-wall attached, and a rubber collar. Pressure changes were created by a rotary blower and an alternating valve. During a polio epidemic the Consolidated Gas Company of New York paid for building large numbers of these respirators, and reports of their use spread quickly around the world.

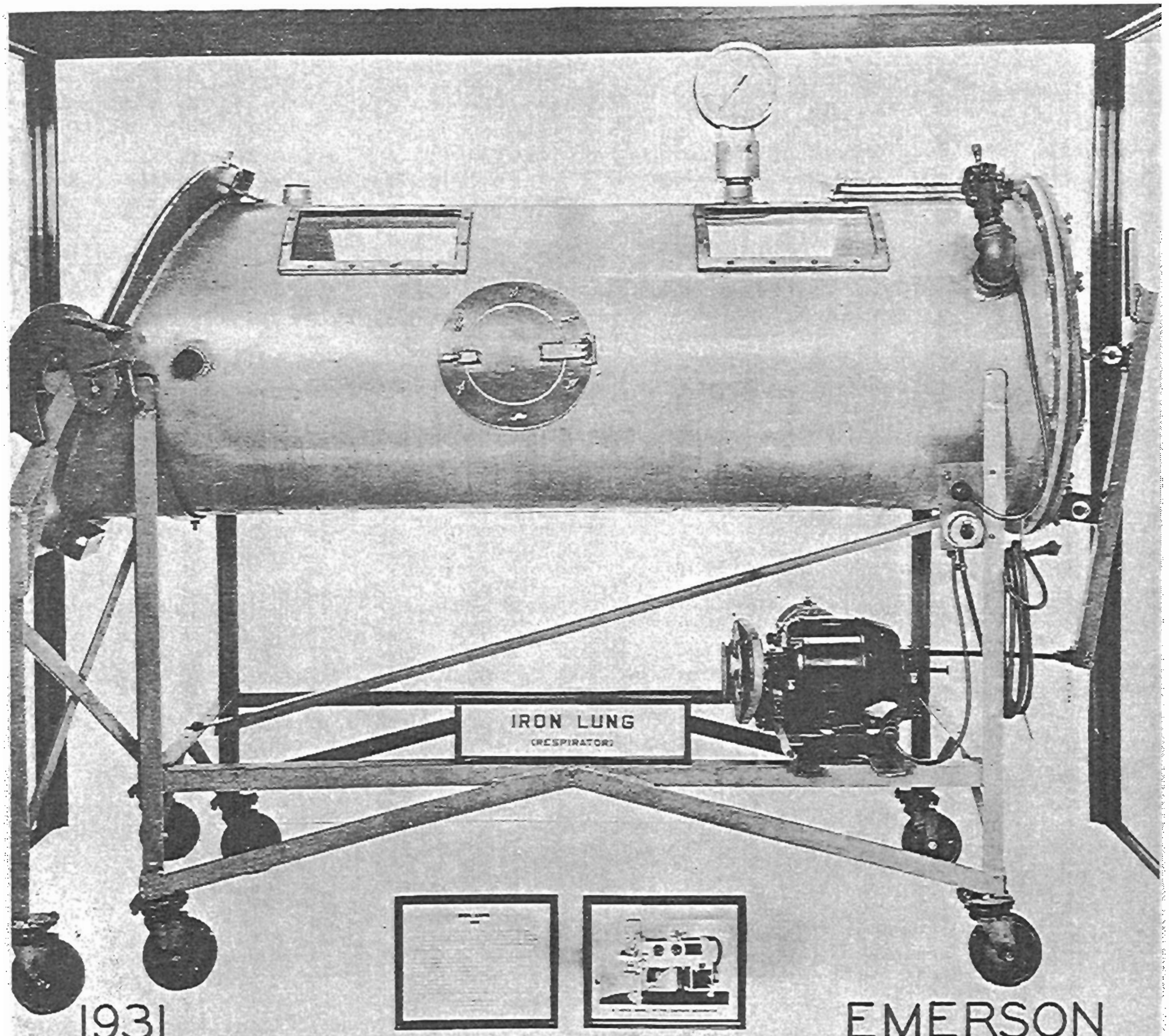


ACTUAL PHOTOGRAPH

NO. 14—EMERSON EXHIBIT

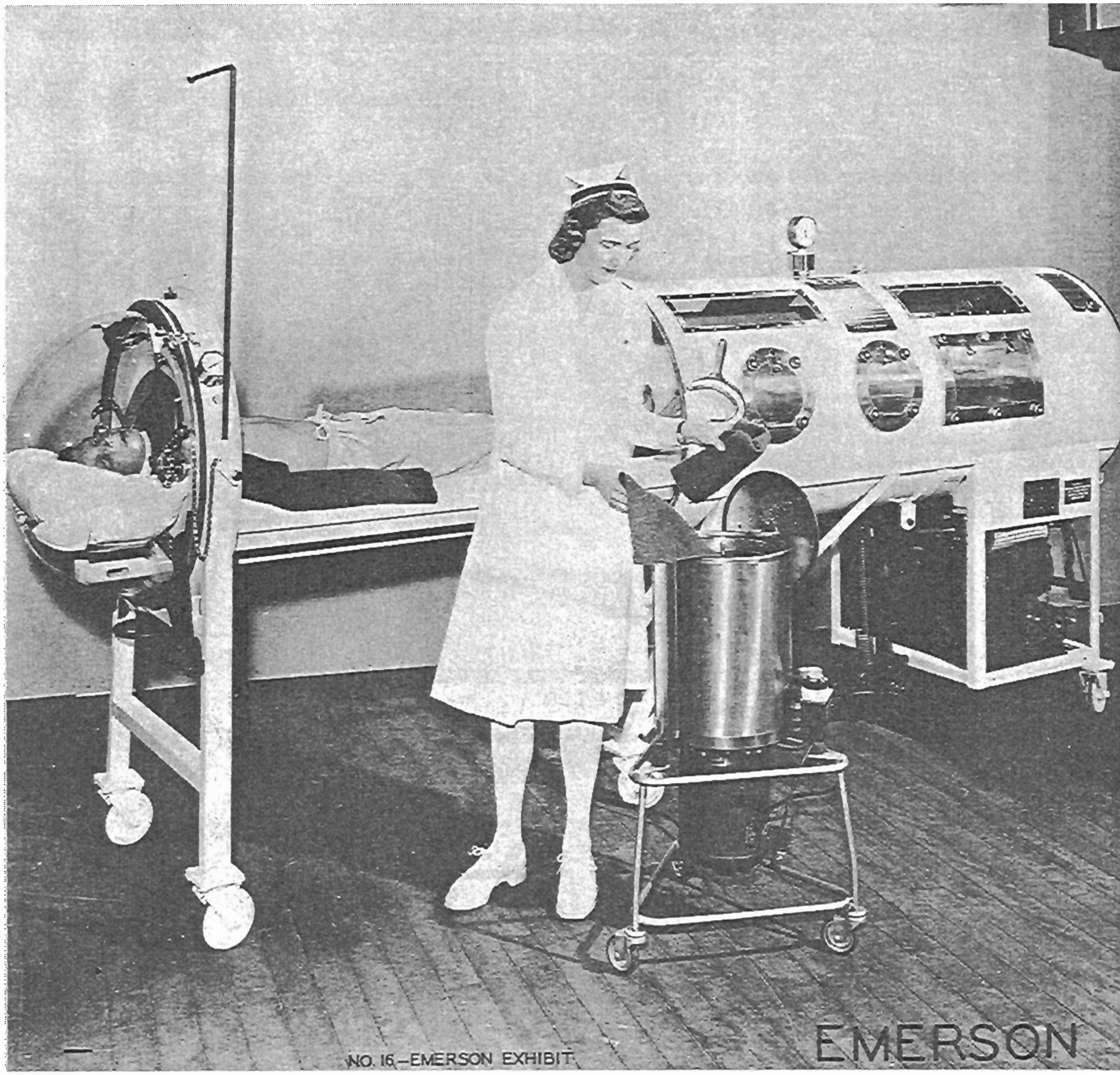
# WILSON & DRINKER

In the early respirators it was difficult to give complete nursing care and to change the patients' position frequently. This care was found to be of life-saving importance, so Dr. James L. Wilson asked for a room in which several patients could be made to breathe simultaneously. A nurse could enter by the door and perform all procedures efficiently. The room pictured was built at the Children's Hospital in Boston, U.S.A., and was used successfully during several epidemics.




NO. 15—EMERSON EXHIBIT

Because of a severe poliomyelitis epidemic in 1931 John Haven Emerson of Cambridge, U.S.A., built a simplified respirator. It cost less than half as much as others, but contained many improvements. It operated quietly, using a bellows to create the changes of pressure (as Woillez's did, but with a motor added). A wide range of speeds was instantly available. Opening and closing were rapid and convenient. It could be pumped by hand if electricity failed. The first Emerson "iron lung" is now preserved in a glass case in the United States National Museum (the Smithsonian Institution) as the prototype of respirators constructed since 1931 in America and Europe.




Modern respirators differ mainly in providing even more completely for the patient's comfort and safety. There are accessories such as footboards, a mirror, and an alarm which will signal if the electric power fails. Most important of all is the dome which breathes for the patient whenever the respirator is opened (developed by Emerson in 1932). The well-being of a polio patient depends on faultless attention to every detail of nursing. When the dome is used, all procedures can be performed safely and easily, even the administration of hot packs (illustrated above). To train nurses in these exacting techniques, a transparent iron lung is ideal.

## SUPPLEMENT

Since 1958 several other early respirators (of the body-encasing type) have come to our attention. Among them perhaps the most important were those of Dalziel, von Hauke and Bell.

In 1832 Dr. John Dalziel of Drumlanrig, Scotland, described a respirator in which the patient sat up with his head out. A bellows created pressure changes. We find no information concerning clinical use, but Dr. Robert Lewins of Leith was able to produce breathing motions when a "drowned seaman" was placed in Dalziel's respirator. See Historical Notes by C.H.M. Woollam in *Anaesthesia, 31:537* (1976).

Ignez von Hauke of Austria in 1874 made a cuirass for continuous negative pressure (an early use of CPAP). In 1876 he built a whole-body respirator. See Woollam's references, pages 538-9.

About 1882 Alexander Graham Bell designed a "vacuum jacket" pumped by a separate large bellows. Apparently this was not used clinically, but was tried on healthy volunteers, who attested to its effectiveness. The original pump and two-part shell are on display at the Alexander Graham Bell Museum in Baddeck, Nova Scotia. (The proper connecting hose is missing.) Dr. Bell's notes show a complete understanding of the needs of artificial respiration.

T. Thunberg in Sweden designed a unique respirator in 1920. It was not an iron lung of the usual kind because the patient was totally inside, ventilated by changes in air pressure; but it was a novel solution to an old problem.

An interesting sequence started with Chilingworth and Hopkins (exhibit no. 11) who in 1919 mentioned use of their plethysmograph as a respirator. At about this time or soon afterwards Dr. Carl Binger in New York, using a plethysmograph, made the same observation. In the late 1920's Dr. Louis Agassiz Shaw in Boston, also studying small animals in a plethysmograph, observed that rhythmic pressure changes within it caused respiration. He subsequently teamed up with Philip Drinker to devise the first widely-used iron lung (exhibit no. 13).

After 1932 there were refinements and many variations of basic respirators. Almost certainly other iron lungs were invented which our search has failed to discover. If you have information about any valuable invention of this kind not shown here, we hope you will send it to J. H. EMERSON COMPANY, Cambridge, Massachusetts, 02140.

### From a Statement in the Mid-1930's

It has long been known that varying the pressure at regular intervals on the chest of a patient, without varying the pressure at the nose and mouth, will produce artificial respiration. Numerous devices of this nature have been evolved in many parts of the world during the last half century. They differ in design from simple portable bellows strapped over the patient's chest, to chambers in which variations of pressure may be produced, designed to enclose the patient's whole body with the exception of the head.

In 1876 Woillez, a Frenchman, described an invention of this nature before a meeting of the French Academy of Medicine in Paris. He spoke of his apparatus as ". . . a zinc or sheet iron cylinder large enough to receive the body of an adult up to the neck. It is equipped with wheels which permit moving it rapidly to the place where it is necessary. The cylinder set almost horizontal, slightly inclined, is hermetically closed at the boot end and open at the head end. Through this opening at the head end you slide the body of the patient by means of a sort of stretcher equipped with rollers, on which he is previously placed; then you close the head opening around his neck by means of a diaphragm that you attach to the edges of the opening. The head thus remaining free rests on an appropriate support. A flexible, impermeable fabric, attached to the cover diaphragm is secured around the neck — to avoid as far as possible the passage of exterior air to the inside of the apparatus, at the moment when the vacuum is produced there.

The air thus confined in the apparatus around the body of the patient can be partially rapidly withdrawn by means of a powerful aspirator bellows of about 20 litres capacity . . . actuated by means of a lever. The interior of this pump communicates with the interior of the apparatus through a large tube tightly screwed on."

In 1889 Dr. O. W. Doe described to the Obstetrical Society of Boston an infant respirator devised by Dr. Egon Braun of Vienna which operated on the same physical principles employed earlier by Dr. Woillez with the exception that the attending doctor's own lungs, as he forced air in and out of the small cabinet, took the place of the bellows described by Woillez. There followed a period when workers in many parts of the world including South Africa, Austria, England, and particularly the United States developed variations of Dr. Woillez's machine.

Partly due to the fact that electricity was not generally available during this early developmental stage, none of these machines found any considerable acceptance. It was not until about 1928 that a machine developed at the Medical School of Harvard University in cooperation with the New York Consolidated Gas Company was well received by the Medical profession.

In the summer of 1931, during a widespread epidemic of poliomyelitis (infantile paralysis) the need for respirators was so general that the supply was not sufficient to fill the demand. The Emerson Respirator was developed with the purpose of designing a machine so simple in construction that the price would be within the reach of a large number of hospitals. At the same time the paramount importance of having the machine practical and convenient was kept in mind. This development incorporated a number of improvements never before available. These included a respiration rate variable over a wide range; quiet operation; quick insertion and removal of the patient being treated; and a means for rapid shift to emergency hand operation in the event of current failure.

This machine with its many improvements was sold for less than half the price of any respirator then on the market. In a short time the Emerson design replaced entirely the type of machine developed by the Medical School of Harvard University.

The new features (which Emerson had refrained from patenting in this life-saving invention) were adopted by all manufacturers and were soon used universally.

# J. H. EMERSON COMPANY

## *50th Anniversary*

## 1928-1978

## Pioneering in Respiration Equipment

***Barcroft-Warburg Apparatus***

***Oxygen Tents***

***Iron Lungs***

***Rocking Beds***

***Resuscitators***

***IPPB***

***Ucyclits***

***Exhalators***

***Equalizing Barospirator***

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