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Abstract: Radiology has been a science, an art, an industry and a business since Roentgen's discovery of XRays
in 1895. Studying the centennial history of the radiology department at the Necker Hospital in Paris, France, the author has recently discovered a close and important, but forgotten, personal relationship between the
founder of the first radiological laboratory, the radiographer Gaston Contremoulins (1867-1950) and the
illustrious physiologist, Etienne-Jules Marey (1830-1904), with whom he had worked previously on chronophotography at the start of cinematography in the 1890s. The dozen characters described in the paper
provide an interesting reminder of how photography induced a translational medicine process which was
essential for the rapid success and growth of radiology worldwide following its birth in 1895. Contremoulins'
contribution to radiology and surgery was enormous but was lost because of turf battles.

Opposed Reviewers:

Etienne-Jules Marey and Gaston Contremoulins, from chronophotography to Radiology.

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[Title] : Etienne-Jules Marey and Gaston Contremoulins, from chronophotography to Radiology.

[Headline, if needed] : Because of characters like Etienne-Jules Marey and his photographer, Gaston Contremoulins, radiology has been a science, an art, an industry and a business since its origin providing an early example of successful translational technology to medicine and conversely.

"I urge the radiographists to work altogether on a unique and consensual method providing reliable images earnestly comparable one to another.[1]*"*
Etienne-Jules Marey, Académie Nationale de Médecine, 8 January 1901 [1].

Etienne-Jules Marey (1830-1904), Gaston Contremoulins (1868-1950), Félix Guyon (1831-1920), Charles Rémy (1851-1918) belong to a group of French scientific personalities who made important contributions to the early growth of the new medical field produced by the discovery of X-Rays [[Fig.1a, b, c, d]]. In France, they were overshadowed by the imperial character of Antoine Béclère [2,3,4,5]. For the whole of the twentieth century, their work was ignored by the English-speaking authors publishing their books on history of radiology [6,7,8]. There is no doubt that Antoine Béclère (1856-1939) is the official father of French medical radiology, although he didn't react when the X-rays were used for radiographies only. He was convinced by the first demonstration of chest radioscopy that Toussaint Barthélémy and Paul Oudin gave in the fall 1896 in their private office close to the *Hôpital Saint-Louis* in Paris [2,3,4]. Like most of the pioneers, Béclère bought his first equipment with his own money. He was the first to teach radiology in the academic unit he opened in 1899 at the *Hôpital Saint-Antoine* in Paris and he wrote most of the medical volume in the first French textbook dedicated to radiology edited by Charles Bouchard and published in 1904 [9]. At the famous *1900 Exposition Universelle de Paris*, he took the opportunity to bring together a hundred dedicated individuals from all over the world to participate at what was called the *Premier Congrès International d'Electrologie et de Radiologie Médicales* [6]. They agreed upon the creation of two words still officially used to define a science, *radiology*, and a job, *radiographer*. The latter split into two kinds of subspecialists: the medical doctors had become *radiologists*, while *radiographers* remained linked with the practice of the technical work. The universal turf war between radiologists and radiographers started in France in 1901. Antoine Béclère was the head of the medical camp that ultimately won leadership, but not before 1935. The radiographer who resisted the most, Gaston Contremoulins, founded the first laboratory of radiology at the *Hôpital Necker* in 1898, from

[1] "*Cela ne suffit pas. Il faut qu'une entente parfaite s'établisse entre les radiographistes pour qu'une méthode unique donne, dans tous les cas, des images fidèles et comparables entre elles.*" [1].

which he retired in 1934. Béclère was the third President of the *International Society of Radiology* (ISR) after the British Thurstan Holland and the Swedish Gösta Forssell and before the Swiss Hans Schinz and the American Arthur Christie. There was a Béclère stamp [[Fig. 2]] and a *Hôpital Antoine Béclère* opened in 1969 in the city of Clamart, a suburb of Paris. The biennial *Béclère Medal* and *Béclère Lecture* are the highest ISR awards and are funded by a donation of his daughter, Antoinette Béclère, to the ISR before she died in 1981.

And what about Etienne-Jules Marey? Marey was elected in 1878 to the *Académie des Sciences*, as the successor to Claude Bernard (1813-1878). Both of them were brillant A.I.H.P.[2] medical doctors, who had trained at the hospitals of *L'Assistance publique à Paris* and both are sacred cows of French physiology of the nineteenth century. Bernard was mainly a chemist, while Marey was a physicist and an artist [9]. Marey soon had a passionate interest in the physiology of the movement of the fluids[3] and of living beings [11,12,13,14]. He was professor of physiology at the *Collège de France* where he developed chronophotography and pioneered cinematography with his assistant Georges Demenÿ [14]. Parallel work was undertaken by Eadweard Muybridge, photographer to Leland Stanford, governor of the state of California, USA, and founder of Stanford University in Palo Alto [15]. Both of them worked together fruitfully when Muybridge visited Marey's *Station physiologique* for several months in 1881. Marey was such a prestigious scientist that in 1895 he presided over the centennial of the creation of the *Institut de France*, which encompasses the five greatest National Academies including the *Académie des Sciences*. 1895 was a notable year because of the foundation created by Alfred Nobel in Paris and the discovery of X-rays[4]. Marey used his speech on 23 December 1895 at the end of his presidency to express his sorrow over the recent death of Louis Pasteur [16]. He could not mention the discovery of X-rays because Wilhelm Roentgen only publicized the information worldwide on 5 January 1896. Before then only Roentgen's wife, whose hands were imaged twice on the 9 November and 22 December 1895, and the Wurzburg Physico-Medical Society who Roentgen informed on 28 December 1895 were aware of it. According to E.R.N. Griggs [6], Roentgen mailed his reprint and some pictures on 2 January 1896 to Franz Exner (Vienna) who was inintentionally at the origin of the publication on 5 January 1896 of the news in the Austrian daily newspaper *Neue Frei Presse*, Friedrich Kolhrausch (Gottingen), Henri Poincaré (Paris), and Sir Arthur Schuster (Manchester); Kevless has added Lord Kelvin (UK) to that list which didn't encompass American names [8]. The news was broadcasted worldwide by cable and many people quickly tried to reproduce Roentgen's experiment. A few of them were able to have soon the technological procedure on hand since Roentgen didn't provide enough precise practical details on his own experimental protocol [2,4,6,7].

In January 1896, Poincaré and the seven medical members of the *Académie des Sciences* received the news: Etienne-Jules Marey, physiologist, Charles Bouchard, internist and pathologist, Félix Guyon, urologist, Pierre-Carl Potain, internist and cardiologist, Arsène

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[2] Claude Bernard in 1839 and Etienne-Jules Marey in 1854 von the elitist contest termed *Internat des Hôpitaux de Paris* (IHP) offering a four-year residency program in the hospitals of the *Assistance publique à Paris* to the best candidates who have the privilege right to put the acronym *A.I.H.P.* after their names, like F.A.C.R.s may do.

[3] Marey invented sphygmography that was the subject of his medical thesis.

[4] Lumière brothers projected first motion pictures to an audience on 28 December 1895.

d'Arsonval, biophysicist, Odilon-Marc Lannelongue, surgeon, and Paul Brouardel, who was the Dean of the *Faculté de médecine de Paris* [17]. All of them, apart from Brouardel, were early supporters of radiology. On 20 January 1896 the *Académie des Sciences* was told about the first French radiographic trial by Oudin and Barthélémy [18] and their paper was published by the surgeon Lannelongue [19], who produced his own papers later [20,21]. Dr. Toussaint Barthélémy was Poincaré's nephew but, as a subscriber, learnt the news when he read the famous *Frankfurter Zeitung* issue dated 7 January 1896 which announced the sensational discovery. Barthélémy spoke fluent German because he was born in Lorraine, which he left in 1870 after the French defeat by the Prussians [2,4]. He immediately told his friend Oudin, a famous biophysicist, and they successfully repeated Roentgen's experiments by radiographing hands. According to Pierre Pizon [2], the best historian of the early French radiology, and an anonymous reference [22], Toussaint Barthélémy informed Paul Oudin who contacted the physicist-pharmacist François-Pierre Le Roux and his technologist, Séguy, who were able to make the first X-ray tube and the first radiography that Barthélémy and Odin published on 20 January 1896. Morever, on 30 December 1895, at the *Académie des Sciences*, Jean Perrin had just published a paper confirming the validity of Lenart's electron-based theory of the cathodic rays [23]. Both papers of Perrin and of Barthélémy and Oudin stimulated Henri Becquerel who published two papers on *uranic rays* on 24 February [24] and on 2 March 1896 [25], at the origin of the discovery of the natural radioactivity after he and Pierre and Marie Curie later rejected his wrong first hypothesis of a phosphorescent effect produced by uranium. In the same proceedings' volume, D'Arsonval [26] and Lumière brothers [26,27] published their own observations on "*photography through the opaque bodies*".

The physicist Marie-Alfred Cornu was the next president of the *Académie des Sciences* and in his last speech on 21 November 1896 he put great emphasis on the discovery of X-rays and their medical application as the most important scientific event of the year 1896 [29]. One hundred and sixty-one papers on Roentgen-rays or X-rays were presented at the *Académie des Sciences* during 1896 [30]. However at the *Académie Nationale de Médecine* only 25 papers were presented, all reporting medical findings only [31]. Ten of these were presented by Oudin and Barthélémy, mostly illustrating hand disease [32]. All their papers were introduced by the professor of dermatology and venereal disease at the Hôpital Saint-Louis, Alfred Fournier, who expressed his admiration for the way that the authors started with a description of normal radioanatomy before they described a variety of radioclinical patterns, and for the serious efforts to improve the quality of their images. Apart from a few surgeons and the physicist D'Arsonval, the earliest medical academicians who supported radiology were the bacteriologists and the pathologists. Bouchard's approach brought together the French anatomoclinical tradition and a more German-influenced germ theory, notably in tuberculosis [33]. Béclère had pioneered virology and immunology before he became a radiologist [3].

There is no doubt that Marey was the catalyst in promoting radiology through his photographer, Gaston Contremoulins. In the early 1890s, Contremoulins was appointed to the laboratory of microphotography headed by the trio of Félix Guyon, professor of urology at the *Hôpital Necker*, Mathias Duval, professor of anatomy at the *Ecole des Beaux-Arts de Paris* and of pathology at the *Faculté de médecine de Paris*, and Yvon [4]. More precisely, Contremoulins worked with Duval's associate professor, Charles Rémy, who was both a

surgeon at the hospital of the city of Nanterre and a histologist at the *Hôpital de la Charité* in Paris where Potain had installed an X-ray machine too [34]. Who told Contremoulins that Marey was developing microscopic chronophotography? Guyon, who was Marey's close friend? More likely, Georges Demenÿ. In the fall of 1892, Contremoulins mailed a letter to Marey expressing his desire to be his experimenter [14] [[Fig. 3]]. After Marey appointed Contremoulins, under an unknown agreement, he oversaw Contremoulins' experiments on the microvasculature of small animals. Marey and Demenÿ broke their excellent long-term relationship in 1894 because of a financial dispute about the creation of the lucrative *Société du Phonoscope* by Demeny. Contremoulins did not take over his position but he provided an important contribution to Delanglade's medical thesis on chronophotography [12].

Like many photographers in the early years of radiology, Contremoulins quickly became interested in the application of X-rays to medicine and biology. Félix Guyon reported the first description of biliary and renal calculi on 21 April 1896, at the *Académie Nationale de Médecine* [35]. The experiment was done by James Chappuis, professor of physics at the *Ecole centrale des Arts & Manufactures* and a resident in urology, Fernand-Joseph Chauvel, both of whom were also associated with the first radiography of a fetus a few weeks earlier. Guyon quickly bought X-ray equipment with his own money and installed it in the *Clinique Urologique* at the *Hôpital Necker* in Paris and he invited Contremoulins to do his radiography [36]. During the second half of 1896, Marey presented two radiological papers by Rémy and Contremoulins [37,38]. Marey persuaded them to study the vessels of the hand with a radiopaque compound made of metallic powders, generically termed *bronze*, embedded in sealing wax and then dissolved in alcohol [[Fig. 4]]. In 1897, both of them published a method of radiophotography of the soft tissues inspired by histological preparations with silver chromate [39].

Influenced by a report by Bouchard, Dr. Georges Clemenceau, *Ministre de l'Intérieur*, who also covered health affairs, decided in 1898 to create four laboratories of radiology in Paris [4]. One of these was already functioning in 1896 under the direction of Albert Londe, photographer to the famous neurologist Charcot at the *Hospice de la Salpêtrière*. He performed many photographic experiments on movement with Marey, and the layout of his laboratory at the Salpêtrière was similar to Marey's *Station Physiologique* [11,12]. In 1893, Londe published the first book on medical photography, titled *La photographie médicale: Application aux sciences médicales et physiologiques*. In 1898, he published *Traité pratique de radiographie et de radioscopie: technique et applications médicales* which is probably the first in this discipline. Another laboratory was created at the *Hôpital Necker* under the exclusive executive direction of Gaston Contremoulins [2,4]. From 1898 to 1901, Contremoulins built an outstanding laboratory subsidized by the city of Paris which became the reference for the future development of radiological rooms [[Fig. 5 and 6]]. He was not medically qualified but he soon developed excellent relationships with the surgeons who appreciated his meticulous work and his inventive ability, shown in the idea of *métroradiologie* [[Fig. 7]]. With Rémy he had become famous in 1897 with a description of some sophisticated and precise equipment for the detection of foreign bodies, which they called *spectro-trigono-métro-radiographe* [40] and they received the *Prix Monthyon*, an important annual medical award given by the *Académie des Sciences* to compensate the expense of the equipment (2500francs compared to the 2000francs of Demenÿ's annual salary) [[Fig. 8]]. Contremoulins soon became a contributor to journals and newspapers. The

popular weekly magazine, *L'Illustration*, dedicated the cover page of the 22 November 1897 issue to his innovative tool [[Fig. 9]]. Another *Prix Monthyon* was awarded for his paper on the plain film technique used to detect urolithiasis in humans published in 1899 with the urologist Joaquin Albarran [41]. Marey presented one Contremoulins' paper when he was the president of the *Académie Nationale de Médecine* during 1900 [42]. In his speech dated on 8 January 1901 at the end of his presidency, Marey said: "*I urged the radiographists to work altogether on a unique and consensual method providing reliable images earnestly comparable one to another."* (author's translation) [1]. This is likely that he stimulated Charles Bouchard in the edition of the three volumes of his *Traité de Radiologie Médicale* published in 1904 [43]. One century later, a group of scientists directed by Christian Salomon and Pierre Trouilloud of Dijon, Region of Burgundy where Marey was born[5], are comparing the philosophic approach inspiring the physiologist who invented chronophotography, a non invasive technique, with that of the contemporary imagers using digital technologies for functional imaging [44]. According to Mannoni [12], Marey who didn't practice radiology himself congratulated Roux and Balthazard in 1897 because they experienced bismuth subnitrate to study the stomach by radiochronophography. Béclère visited John Macintyre in Britain when he knew that the latter was working on radiocinematography [3].

Contremoulins stopped communicating with the *Académie Nationale de Médecine* after Marey deceased in 1904. Apart from 1901 he had become Béclère's fiercest enemy in a vehement turf battle [3,4,5]. Antoine Béclère had to face opposition both from a medical and a radiographic lobby over four decades:

1) Béclère could not get the *Ministère de l'Education* to create an academic chair of radiology before he died in 1939 [3]. Many medical academic colleagues were angry with him because they believed he was perverting the art of medicine, even though he respected Laennec's anatomoclinical principles and method [45]. Even in the 1930s, they regarded radiology, a photographic technology, with contempt. They disliked the facts that radiology could rapidly provide a precise diagnosis which might contradict their intellectual arguments and that autopsy was no longer the only means to make a diagnosis anatomically. These disagreements were topics for caricaturists until medicine became truly scientific in the second half of the 20th century.

2) Béclère also came into conflict with the non medical radiographers, even when they were respected, like Contremoulins, because of the many scandals relating to incompetent or dishonest practitioners [2,3,4]. When a new deal emerged in 1908, still under Clemenceau's Ministership, Béclère could not obtain the chairmanship of the radiology department exclusively for medical doctors although this was recommended by the *Académie Nationale de Médecine*. Thirty-seven members of the *Académie des Sciences*, headed by Paul Villard who discovered gamma-rays and Gabriel Lippmann[6], Nobel Prize winner in physics in 1908 after he invented coloured photography, signed a letter supporting Contremoulins after they visited his laboratory [2,4, Marie-Josée Watremez, *Ecole de radiologie de Saint-Germain-en-Laye*, unpublished data]. However, neither Bouchard nor Becquerel, who then were respectively *Président* and *Secrétaire perpétuel* of the *Académie des Sciences*, nor the

[5] Marey was born in the city of Beaune, Côte d'Or, Burgundy, France.

[6] Gabriel Lippmann, Nobel Prize winner in physics 1908, protected Contremoulins after Marey's death and presented most of his further papers at the *Académie des sciences.* The same year, Antoine Béclère was elected at the *Académie Nationale de Médecine.*

medical membership with the exception of both physicians, the bacteriologist Emile Roux, director of the *Institut Pasteur,* and the zoologist Yves Delage, co-signed the letter[7]. Contremoulins at the *Hôpital Necker* and Emile Puthomme, his former assistant, at the *Salpêtrière*, kept their positions as the heads of those two out of the eight official laboratories of the hospitals of the *Assistance publique à Paris* created by Clemenceau. Béclère was in charge of the radiological service of the city of Paris during World War 1 [3,4]. Contremoulins refused to be under the control of a doctor and resigned, in spite of his recognized competence in the military aspects of radiology. Looking for foreign bodies was a common radiological investigation. An *ad hoc* committee was nominated in 1917 at the *Académie nationale de Médecine* to evaluate Contremoulins' method since it appeared that the radiographer might have been unfairly denigrated or ignored. Edouard Kirmisson and three other academicians recalled the interest in Contremoulins' metroradiological tool in surgery [46].

Radiology would not have developed without the convergence of three major preliminary inventions : the Crookes' tube, electrical power and photography. In 1901, Roentgen was the first Nobel Prize winner in physics, an honor that his compatriot Phillipp Lenart did not obtain because, unlike Röntgen, he was not a photographer so he could not provide evidence to support his own discoveries [6,7,8]. Contremoulins had all three inventions at hand: he was able to make his own Crookes'tubes, he knew electrical technology, and he was an expert in photography. At the *Ecole des Beaux-Arts* in Rouen, he learnt the basics of multimodality imaging from drawing to architecture. Working with Marey, who was also a painter and a sculptor, he became an inventive master of mechanics and microscopic chronophotography [12]. Working with Rémy at the histology laboratory, he learnt anatomy and pathology in humans and animals. Those who have had the chance to look at his radiographs admire their superb quality. His papers show his outstanding mastery of both technology and diagnosis. He had the privilege of radiographing the first opacification of the subarachnoidal space with Lipiodol by Forestier and Sicard in 1921 [47] [[Fig. 10]]. Early on, Contremoulins studied dosimetry and radioprotection carefully [48,49,50]. He fought against the abusive use of X-rays in humans. Many radiologists died from radiation exposure or suffered terrible radionecroses. Their names are listed in a memorial in Hamburg, Germany, in the hospital where Albers-Schoenberg practiced radiology, and then died prematurely of cancer [6,7,8]. Many pioneers, like his colleague Charles Infroit, successor of Londe who resigned in 1900, died prematurely because they submitted themselves to careless irradiation by the *invisible light* before its harmful effects were clearly shown at the *1910 Exposition Universelle* of Liege, Belgium, which hosted the *2nd Congrès International*

[7] The following members of the *Académie des Sciences* signed the letter supporting Gaston Contremoulins (Marie-Josée Watremez, unpublished data). The initiative was headed by Paul Villard: Alp (not listed in the AS registry), Appell (geometry), E-J. Bertin (geography), G. Bigourdan (astronomy), G. Bonnier (botany), E-J Boussinesq (mechanics), E. Bouty (physics), A. Carnot (agronomics), G. Darboux (geometry), Dr. Y. Delage (zoology), M. Deprez (mechanics), H. Douvillé (mineralogy), A. Grandidier (geography), D. Gernez (physics), E Guyou (geography), C. Jordan (geography), J. Léauté (mechanics), G. Lemoine (chemistry), G. Lippmann (physics), A. Haller (chemistry), J. Haton de la Goupillère (mechanics and geometry), P. Hatt (geography), G. Humbert (geometry), L. Maquenne (agronomics), C. Müntz (agronomics), P. Painlevé (geometry), E. Picard (geometry), H. Poincaré (geometry), E. Prilleux (botany), Dr. E. Roux (agronomics), T. Schlossing (agronomics), J. Tannerie (philosophy of sciences), P. Termier (mineralogy), P. van Thieghem (botany), P. Villard (physics), C. Wolf (astronomy), R. Zeiller (botany). http://www.academie-sciences.fr/membres/in_memoriam/in_memoriam_reperes.htm (access on 7 February 2010)

d'Electrologie et de Radiologie Médicales» [4,6]. Neither Contremoulins nor any member of his staff suffered radionecrosis, cancer or leukaemia; however, unlike the Béclère's school, they didn't practice radiation therapy and they did much fewer fluoroscopy. In the 1920s, he wrote about the necessity to protect the environment of radiological rooms in hospitals and in private offices [50,51]. In 1929, Maurice DeBroglie, physicist and expert in X-rays at the *Académie des Sciences*, was in charge of an official report which supported the validity of Contremoulins' ideas about radioprotection in the structure of radiographic rooms [52,53].

About 2000, while the whole World had just celebrated the centenary of the discovery of X-rays by Roentgen in 1895 [5,7], two new paradigms were emerging almost simultaneously: *Disruptive innovation* at the Harvard Business School [54] and *Translational medicine*, the most common definition of which was given by the Dean of Stanford University, Philip A Pizzo, in 2002 [55]: *« From my perspective, translational medicine can have both a narrow as well as a more general definition. Perhaps the most specific definition is «bench-to-bedside» research wherein a basic laboratory discovery becomes applicable to the diagnosis, treatment or prevention of a specific disease and is brought forth by either a physician-scientist who works at the interface between the research laboratory and patient care or by a team of basic and clinical science investigators. »* Marey and Roentgen were both idealistic scientists who distained financial business in contempt. Marey, who was personally well off, and Demenÿ patented many inventions but they were poor businessmen [14]. Under the auspices of the *Collège de France*, Marey built and managed his *Station physiologique* mostly with government funding and his own money, unlike the modern joint ventures between research centers and private investors. He invested 6000 francs in six chronophotographs but only sold one. Marey owned a house and a laboratory in Naples, Italy, where he was used to stay in the fall and winter seasons. In their correspondence, Demenÿ always complained of financial problems that his boss never tried to solve. In spite of Demenÿ's pressure, Marey was completely reluctant to use his brilliant talent to develop cinematographic entertainment programs that would have subsidized their work. While Demenÿ and his *Société du Phonoscope* were declared bankrupt in 1895, cinematographic programs enriched talented "*plagiarists*" like Gaumont and Lumière brothers in France [56] Roentgen was even stricter since he refused to patent the discovery of X-rays and to enter industrial or commercial ventures [1,2,3]. From an economical standpoint, radiology was a disruptive innovation that could be developed free of charge by all the inventors of equipment, so enabling a new highly lucrative process of translational technology to medicine to occur. At the Hôpital Necker, Contremoulins, who had patented his numerous inventions and charged patients for radiography, was wiser and his laboratory was in positive financial balance throughout his 35-year leadership [Marie-Josée Watremez, unpublished data].

Was Contremoulins an extraordinary character? Studying his life and work, the author's answer is : yes, indeed! Looking at his radiopelvimetric method and tools [Fig. 11 a, b, c], it is easy to imagine his inventive potential if he had lived when computed imaging emerged from the 1960s. His expertise extended beyond the strict boundaries of radiology. With the surgeons Pierre Delbet, then Anselme Schwartz and Maurice Robineau [[Fig.12]], he invented the bone prostheses used in many wounded soldiers after World War 1 [57,58]. He invented a variety of tools for orthopaedic surgery [[Fig. 13 and 14]], which were usually presented by Robineau at both *Académies des Sciences* and *Académie de Chirurgie* [59,60].

Maurice Robineau took advantage of Contremoulins's inventiveness to propose the first treatment in France for fractures of the neck of the femur by bone pinning (osteosynthesis) [61]. In 1935, Contremoulins settled in the city of Saint-Germain-en-Laye where he continued to practice metroradiology at the hospital. He founded the *Ecole de Radiologie de Saint-Germain-en-Laye* there where he taught future radiographers and this school is still in operation. He committed suicide in 1950 because he had become blind [2,4, Marie-Josée Watremez, unpublished data]. There is a "*Rue Gaston Contremoulins*" in a suburb of the city of Rouen in the Region of Normandy where he was born.

In conclusion Contremoulins was the radiographers' and the biomedical engineers' most brilliant French godfather. Because Etienne-Jules Marey was in placed in eminent academic positions while radiology was starting, he could immediately be supportive of the investment and interest of his assistant photographer, Gaston Contremoulins, in the promising radiological specialty. One century later, even though as early as 1901 he was in conflict with the medical construction of radiology spearheaded by Antoine Béclère, the medical community should no more reject Contremoulins and the French radiology is revisiting its reluctance against his most valuable performances [62]. Because Contremoulins was banned from the medical decision makers before World War II, the *Académie universitaire de Paris* and *Assistance Publique-Hôpitaux de Paris* missed its chance to consolidate the core of a future radiological institute of technology where computed tomography programs could have been conceived. His laboratory was destroyed after he retired. The chairman of the Necker's new department of radiology[8] in 1988-99 rebuilt it not knowing this important but forgotten story. "*Had I known it,* he wrote*, instead of destroying the existing combined space which was unsuitable for clinical radiology, I would have conceived of a different department with an additional technological laboratory that would look to the 21st century as molecular radiology has become the major advance in medical imaging."* [Dr. J-F. Moreau, personal communication, author's translation].

[8] The building of the Clinique Urologique of Félix Guyon was destroyed in 1965. A huge new building so-called "Palais du rein" opened in 1968 with both aisles for nephrology and urology and a transversal ground-floor including the new department of radiology.

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LEGENDS OF THE FIGURES

Fig. 1. a) Etienne-Jules Marey in 1894 (Courtesy of Académie des sciences-Institut de France);
b) Gaston Contremoulins (author's collection); c) Félix Guyon (Courtesy of Archives de l'AP-HP); d) Charles Rémy (author's collection).

Fig. 2. Cover of the book by Antoinette Béclère, "Antoine Béclère" [6] (author's collection).

Fig. 3. Excerpt of Marey's letter dated on 14 December 1892 and mailed from Napoli, Italy, recommending Contremoulins to his assistant Georges Demenÿ (Courtesy of Cinémathèque Française) : «*Mr. Contremoulins writes to me that he is highly motivated to work with you in photography. Before I'm back* [in Paris] *when I will show him what I'm doing in microscopic photography, do what you feel is convenient.*» (Author's translation)

Fig. 4. Excerpt of Rémy and Contremoulins' first communication at the Académie des Sciences demonstrating the interest of Marey in the early development of radiology in 1896. "*Professor Marey himself persuaded us to study the vessels of the hand with the injection of a radiopaque compound made of impalpable metallic powders, generically termed* bronze *and widely commercialized in town. We selected such a buffer which we embedded in sealing wax and then dissolved in alcohol. That mixture was injected at cold temperature."* (Author's translation). (Facsimile by courtesy of Académie des Sciences-Institut de France).

Fig. 5. Plan of Contremoulins'laboratory of Radiology at the Hôpital Necker dated 1898, drawn by himself (Courtesy of Dr Patrick Mornet).

Fig. 6. Workroom for technological apparatus (Courtesy of Dr. Patrick Mornet).

Fig. 7. Contremoulins' compass (Courtesy of Dr Patrick Mornet).

Fig. 8. Monthyon-awarded Contremoulins' letter acknowledging the Académie des Sciences written on *Station Physiologique* stationery. (Courtesy of Académie des sciences-Institut de France).

Fig. 9. *Spectro-trigono-métro-radiographe* used for the localisation of intracranial foreign body. Drawing published in *L'Illustration*, 22 November 1897 issue (Courtesy of *L'Illustration*).

Fig. 10. First case of opaque myelography after injection of Lipiodol in the subarachnoidal space in 1921 in human. Dr. Jacques Forestier handwritten comments. Contremoulins signed the radiograph just over the pubic bone (arrow). (Author's collection).

Fig. 11 a,/ Metroradiological table and devices for radiopelvimetric detecting of dystocia. (Courtesy of Dr Patrick Mornet). Fig. 11. b/ Device for radiopelvimetry. (Courtesy of Dr. Patrick Mornet). Fig. 11. c/ Radiopelvimetric results in a normal woman (left) and in a case of dystocia. (Courtesy of Dr. Patrick Mornet).

Fig. 12. Dr Maurice Robineau. (Author's collection).

Fig. 13. Metroradiological device for osteosynthesis of the knee. (Courtesy of Dr Patrick Mornet).

Fig. 14. Elbow prosthesis of the cubitus made of aluminium covered by latex. (Courtesy of Dr. Patrick Mornet).

Figure 1a, b, c, d

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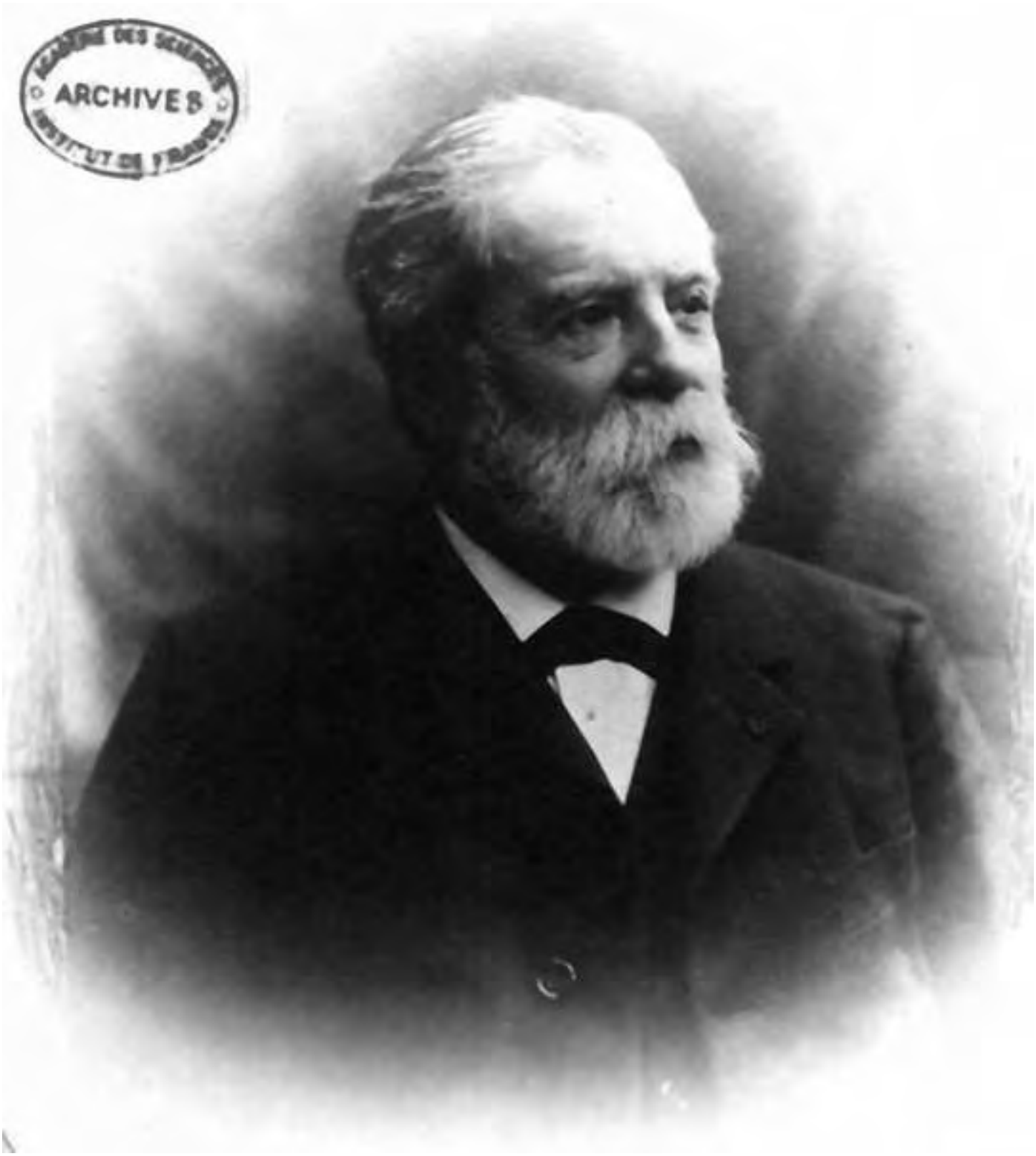

Figure 1a, b, c, d

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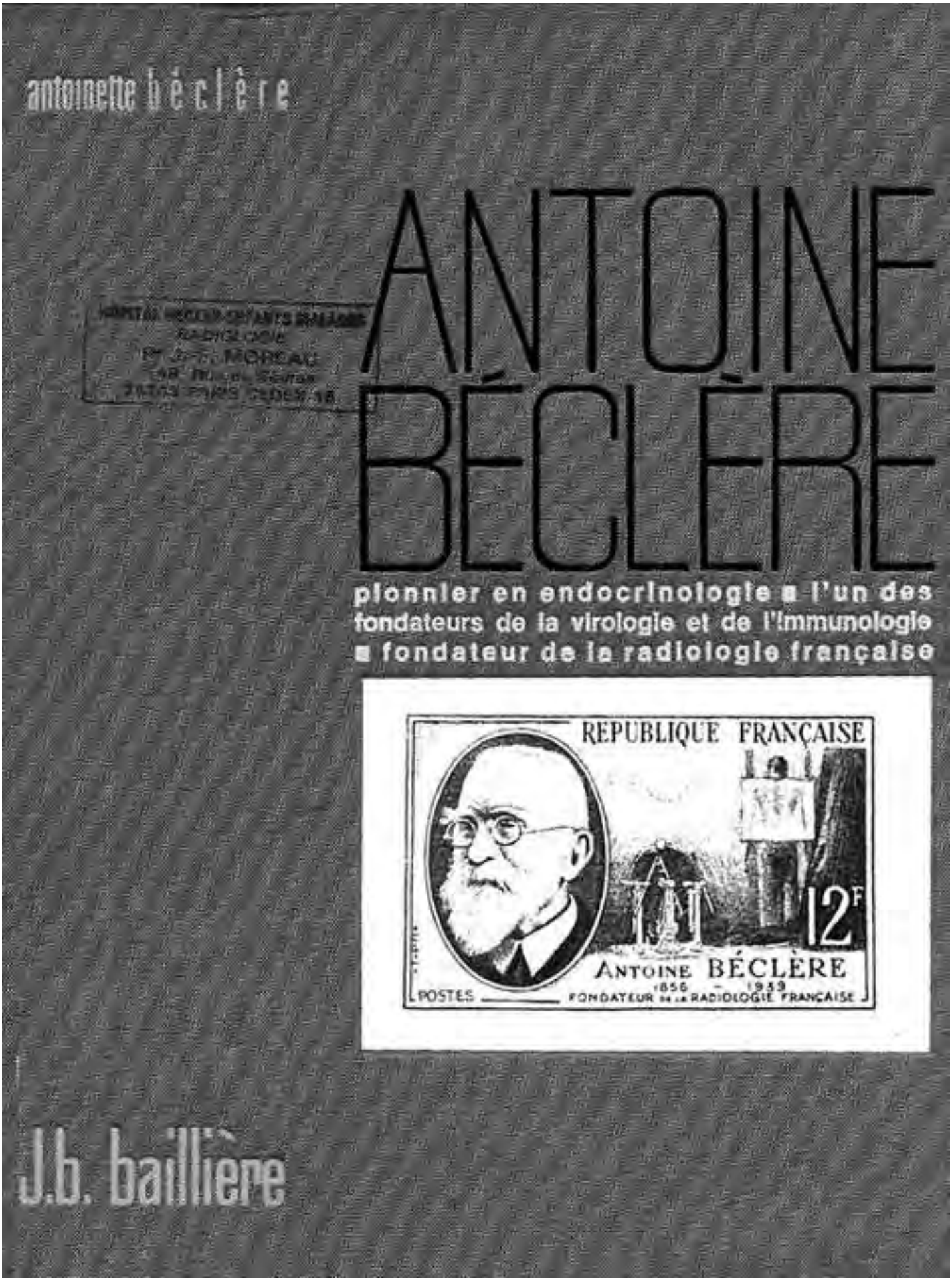

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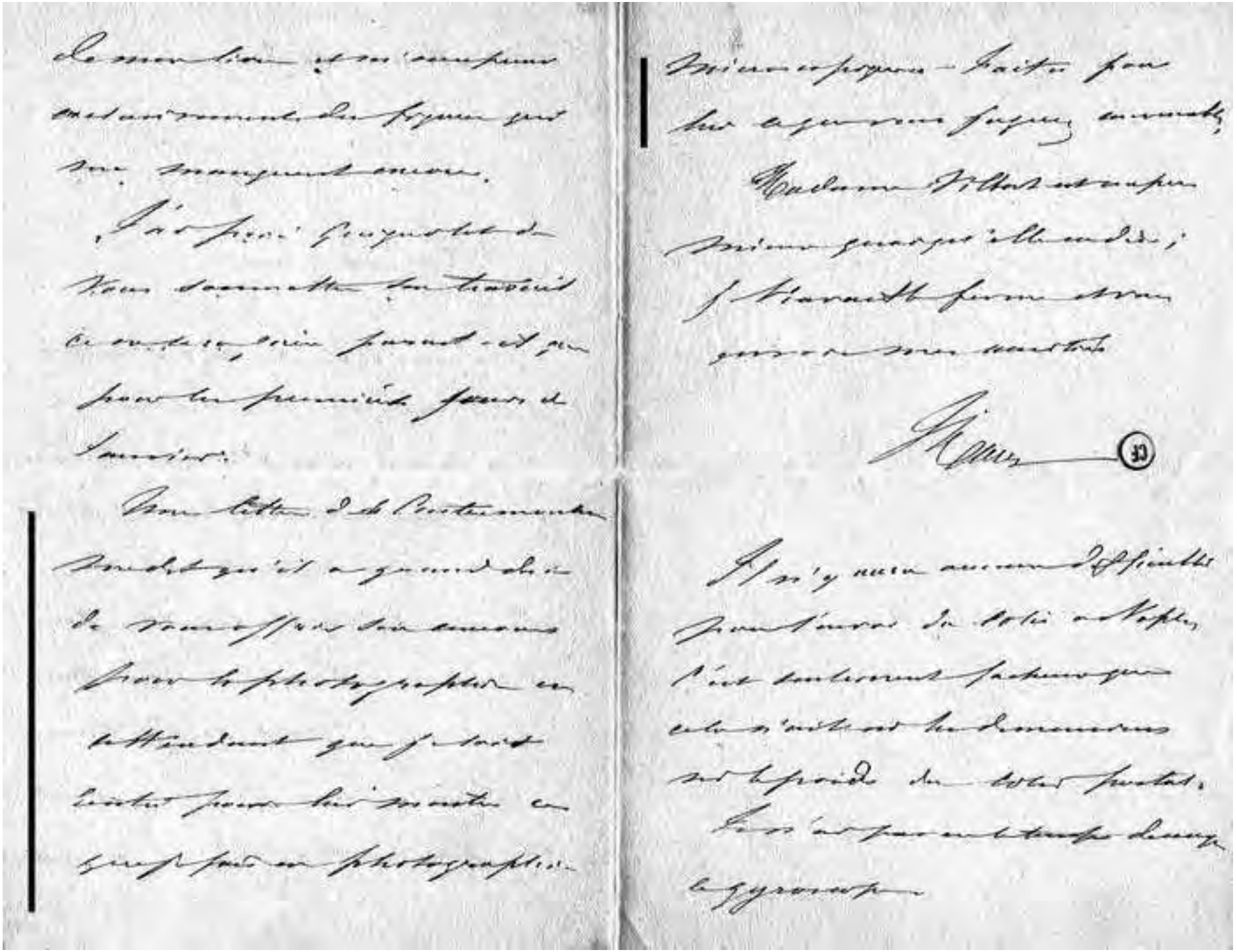

Figure 4
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PHYSIQUE APPLIQUÉE. — *Emploi des rayons X pour les recherches anatomiques : angéiologie, développement, ossification, évolution des dents, etc.* Note de MM. Ch. Remy et G. Contremoulins, présentée par M. Marey.

CR Acad Sci - 1896 - 123:711

» C'est M. le professeur Marey qui nous a suggéré l'idée de rendre le système vasculaire opaque aux rayons X en l'injectant avec une solution qui tienne en suspension des poudres métalliques impalpables. Le commerce livre aujourd'hui, sous le nom de *bronze*, une grande variété de ces poudres de métal. Le véhicule que nous avons choisi est la cire à cacheter commune dissoute dans l'alcool; l'injection se fait à froid.

Figure 5

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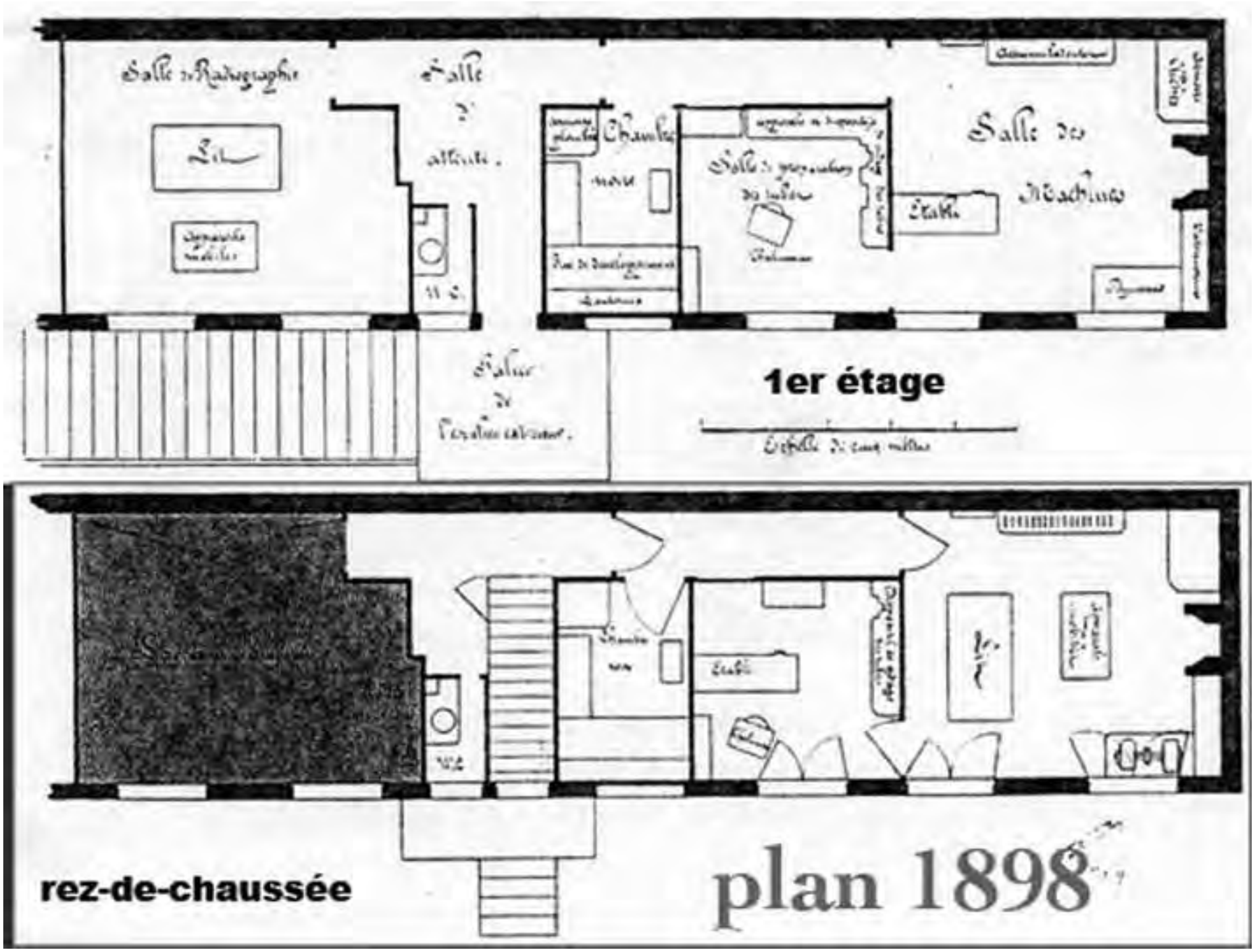

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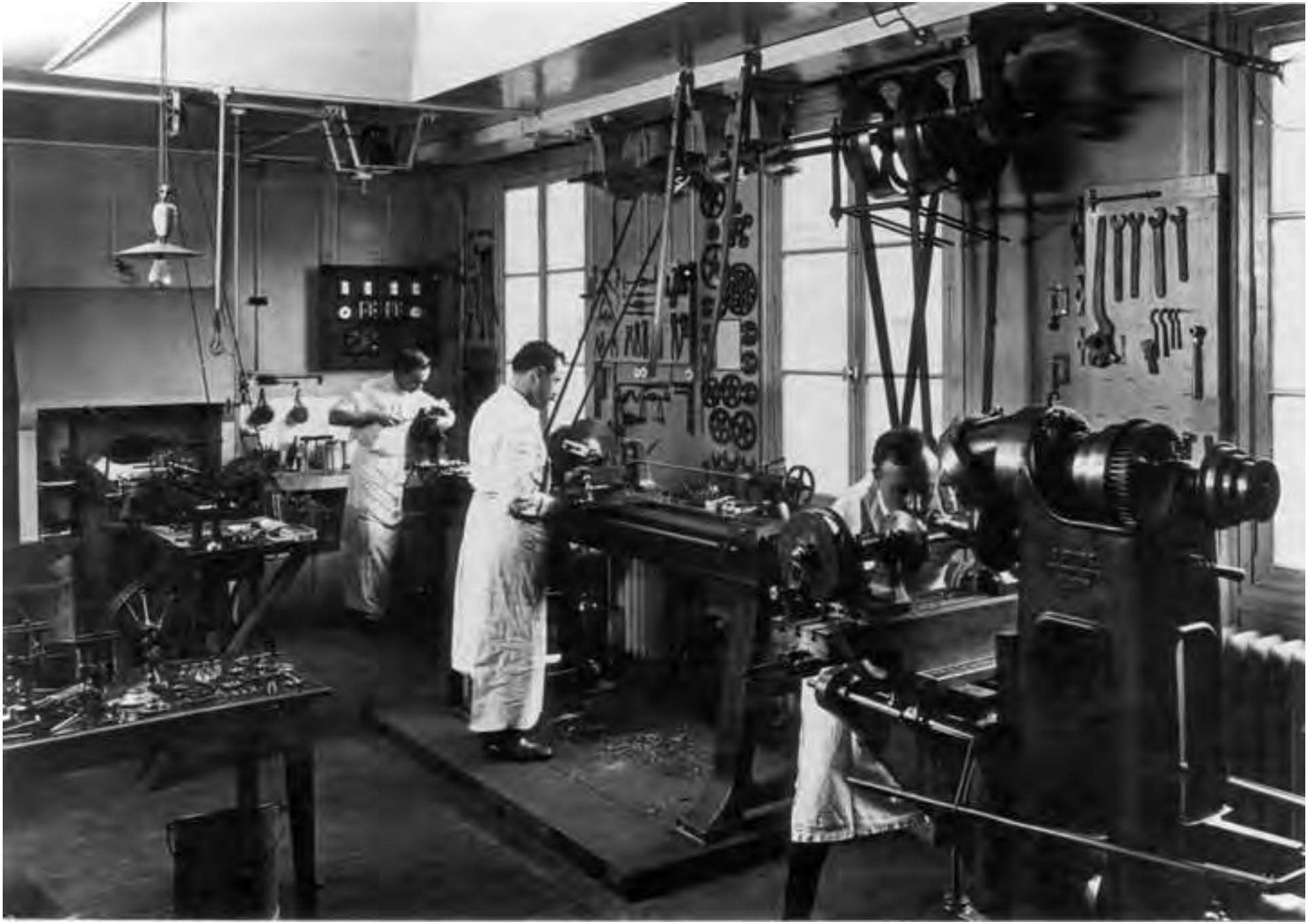

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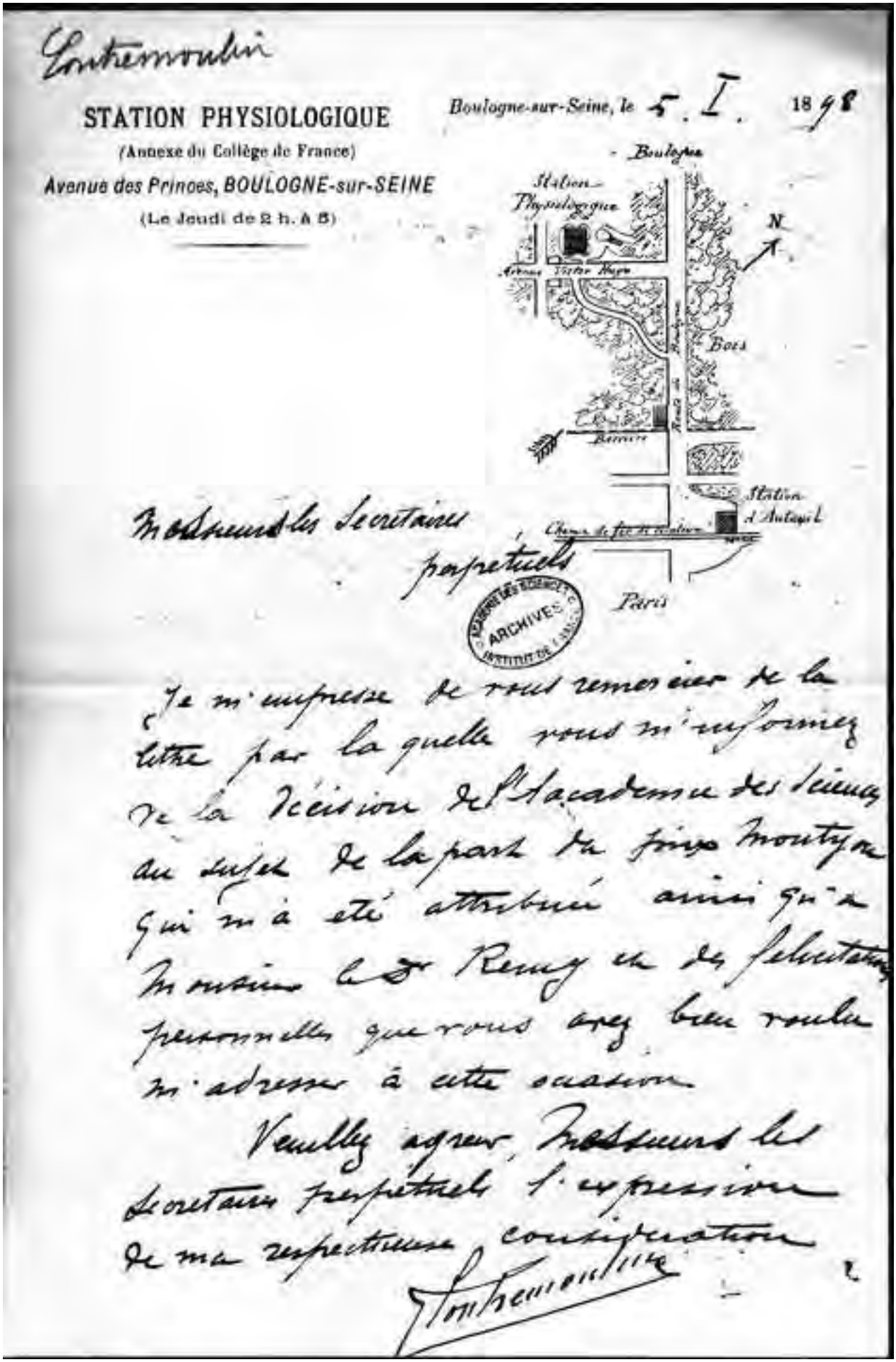

Contenouille

STATION PHYSIOLOGIQUE
(Annexe du Collège de France)
Avenue des Princes, BOULOGNE-sur-SEINE
(Le Jeudi de 2 h. à 5)

Boulogne-sur-Seine, le 5 I 1898

Messieurs les Secrétaires perpétuels

Je m'empresse de vous remercier de la lettre par laquelle vous m'informez de la décision de l'Académie des sciences au sujet de la part du prix Montyon qui m'a été attribuée ainsi qu'à Monsieur Ch. Rémy et de solliciter personnelle que vous avez bien voulu m'adresser à cette occasion

Veuillez agréer, Messieurs les Secrétaires perpétuels l'expression de ma respectueuse considération

Contenouille

Figure 9

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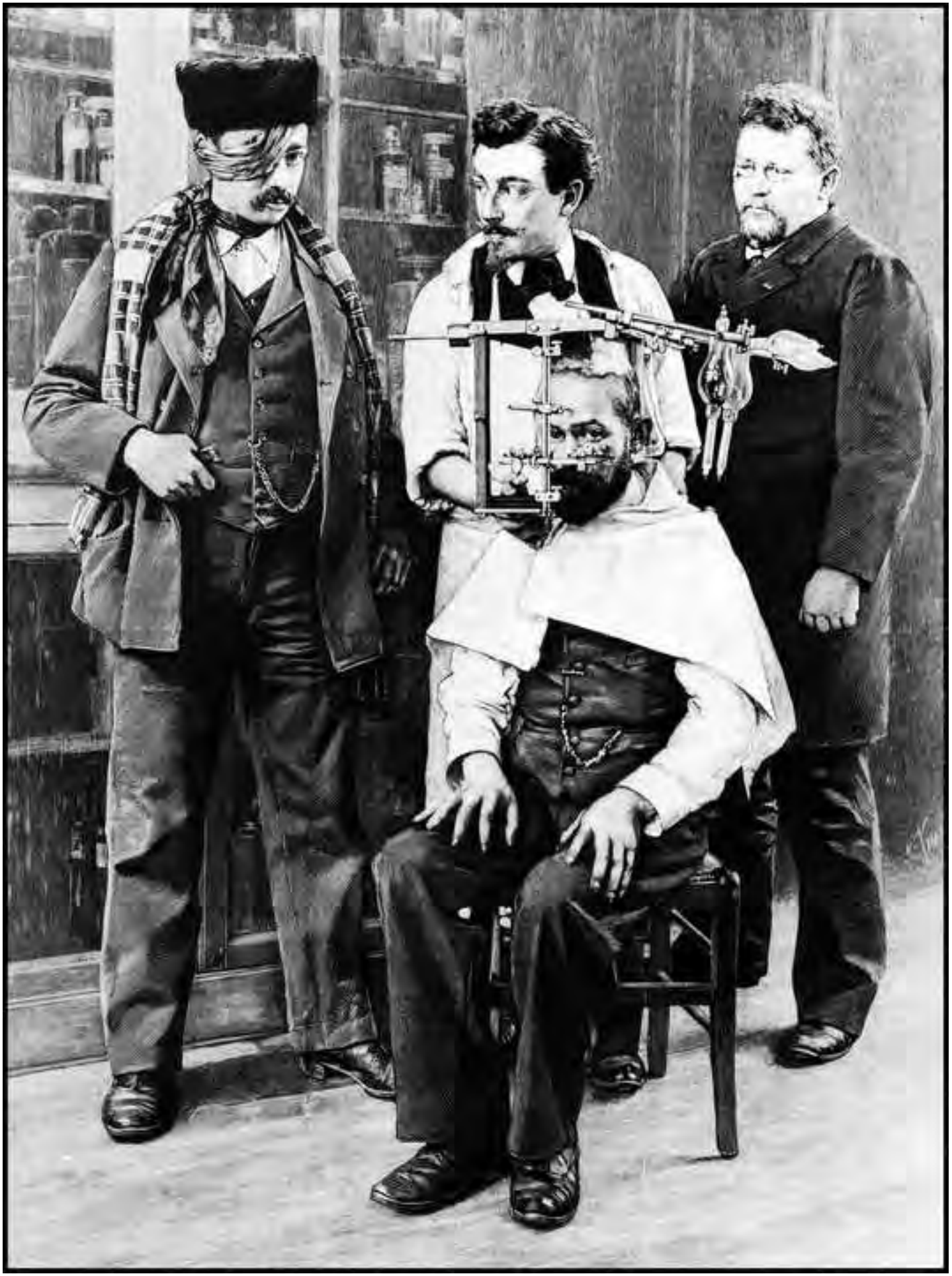

Figure 10

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Figure 11a, b, c

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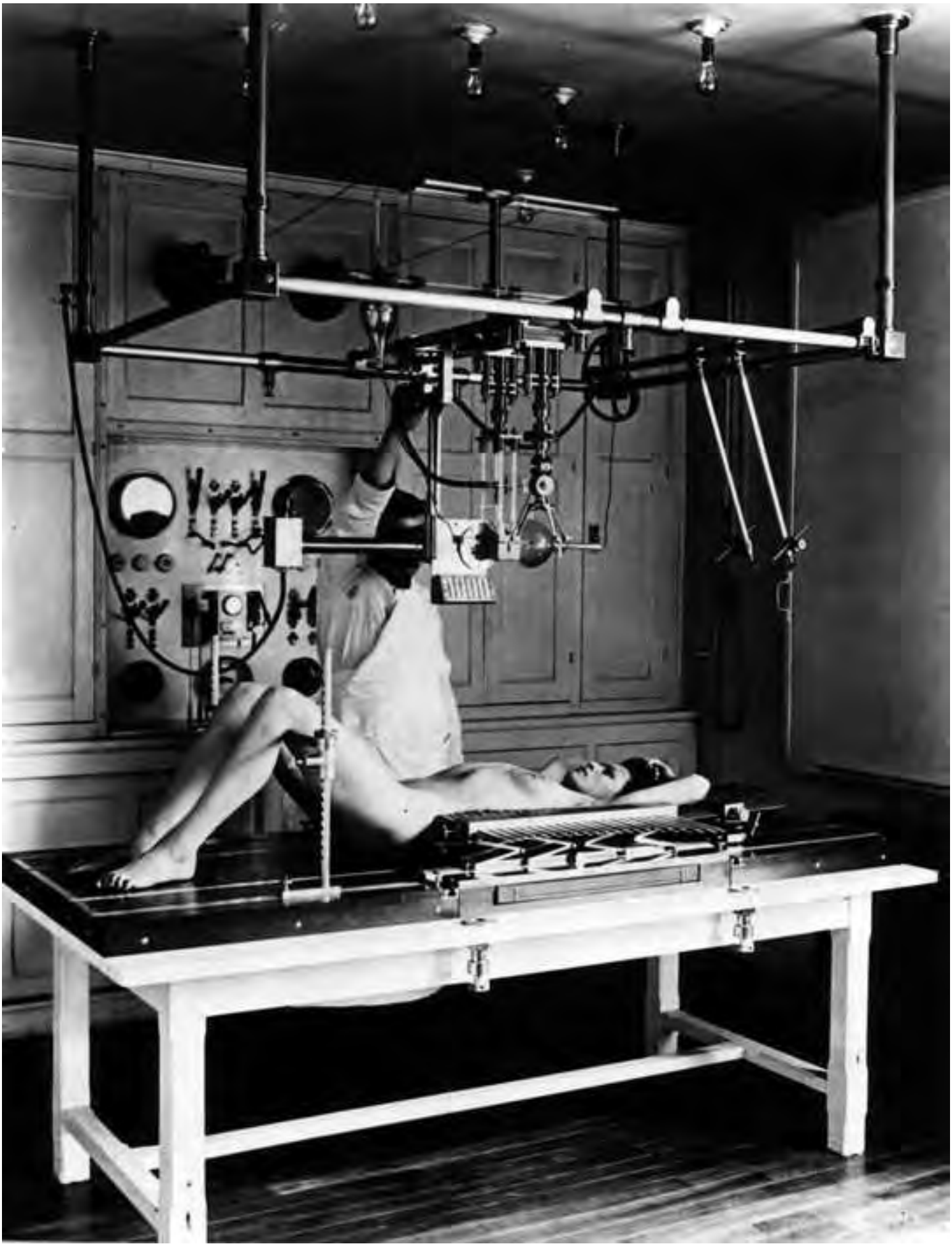

Figure 11a, b, c

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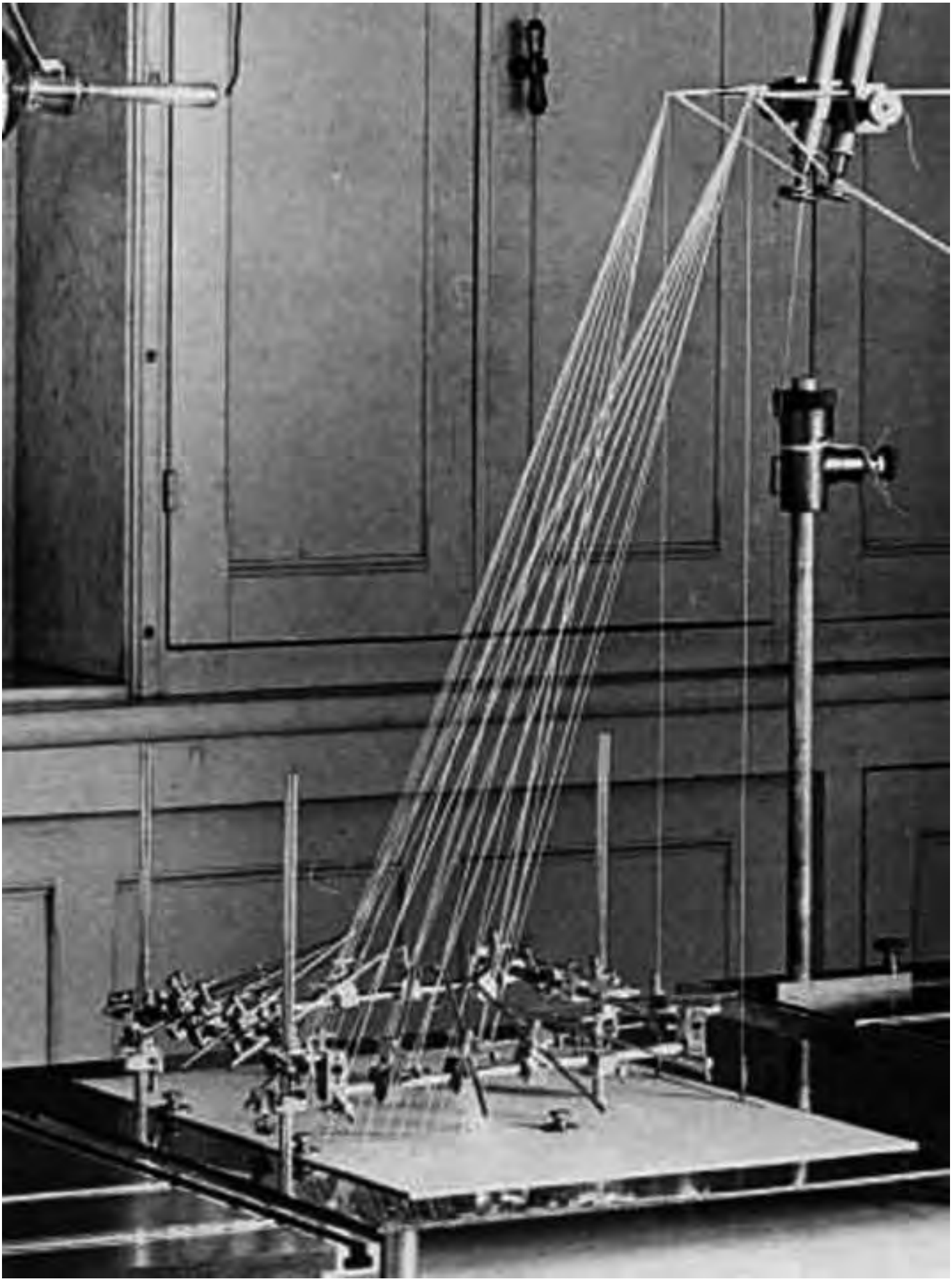

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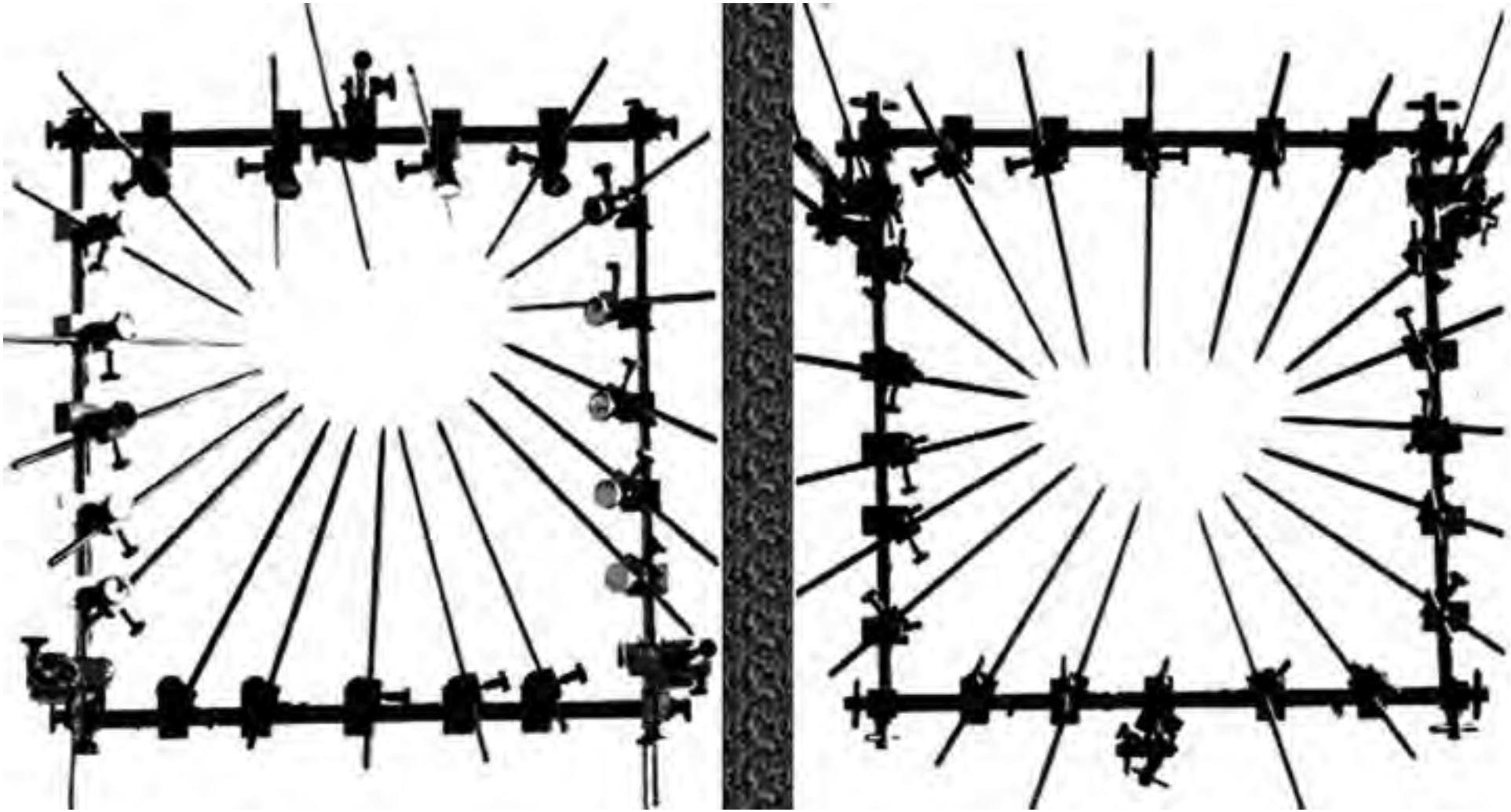

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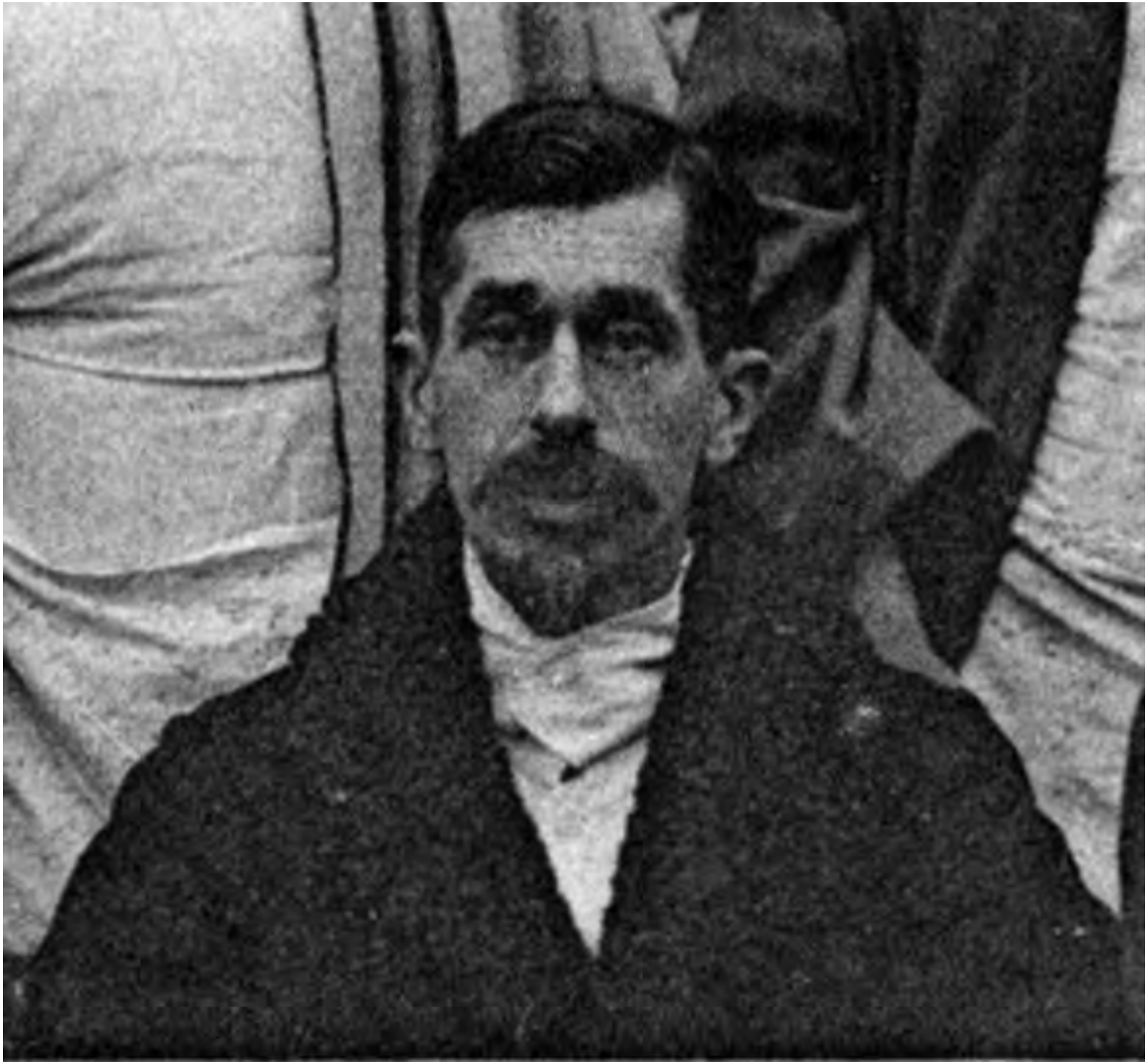

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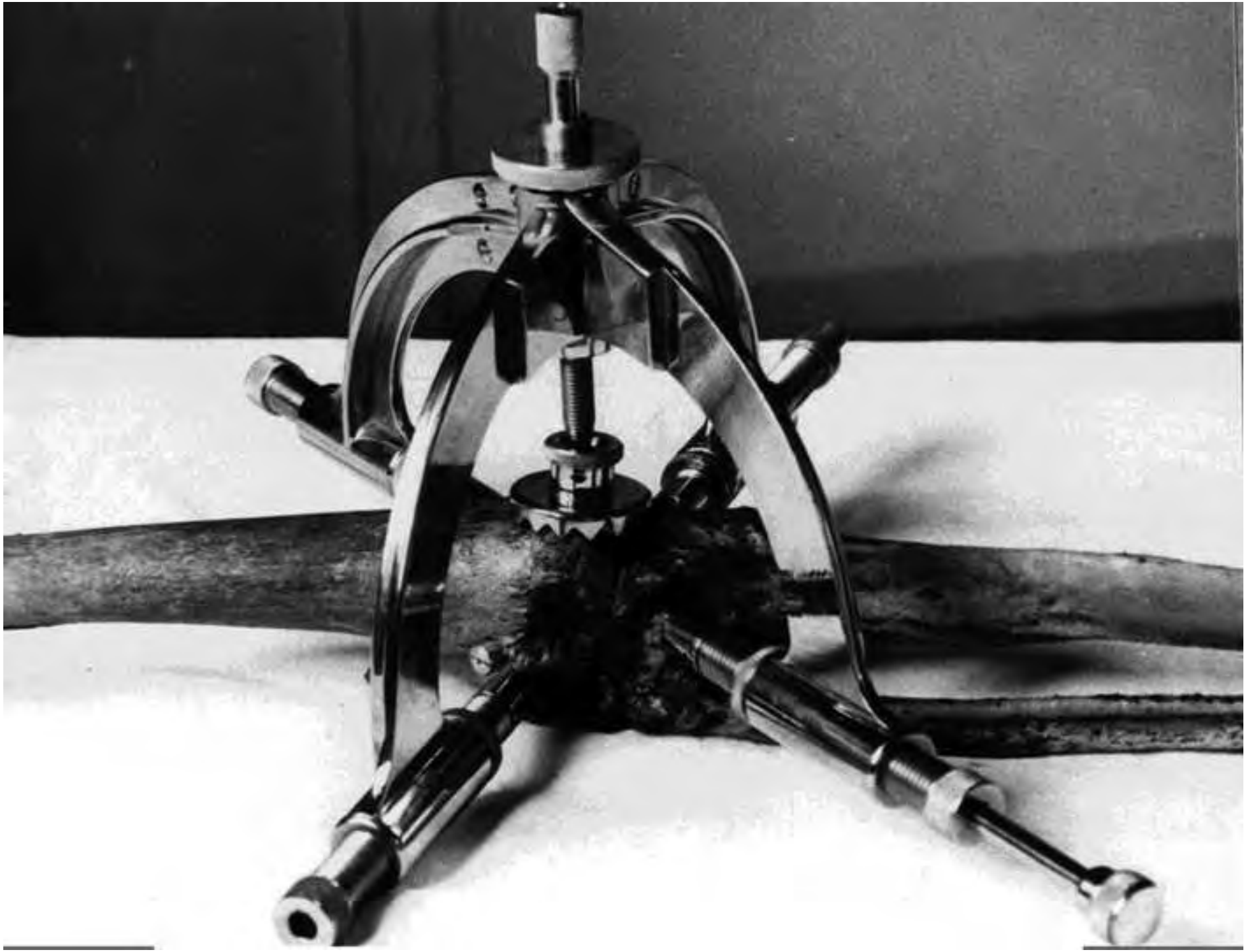

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