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Roentgenocinematography of the Stomach and Cap

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ROENTGENOCINEMATOGRAPHY OF THE STOMACH AND CAP

By LEWIS GREGORY COLE, M. D.
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Numerous attempts have been made to produce Roentgenocinematographs of the stomach, as a means of recording and demonstrating the gastric motor phenomena. To Kaestle, Rieder and Rosenthal belongs the credit of first successfully reproducing on a cinematographic film a series of Roentgenograms, showing the progression of the gastric peristalsis pyloruswards. In 1909 they made 13 Roentgenograms in 22 seconds, describing their method as Bioroentgenography, and defining it as "the true cinematographic representation of the movements of an organ by means of a series of skiagrams taken during a single cycle."[1] There was some doubt as to whether these Roentgenograms, made approximately every two seconds, complied with their own definition of true Roentgenocinematography. As they repeatedly demonstrated the original film and no other, and their subsequent publications mention no further work in Bioroentgenography, it is evident that they failed to take advantage of this valuable method for practical diagnosis. In place of Bioroentgenography Kaestle has adopted the method of making 16 Roentgenograms on a single large plate, by manually moving it about.[2] This procedure affords diagnostic assistance similar to that obtained by serial Roentgenography.

The scientific value of the Bioroentgenographic record of the gastric movements was perfectly obvious. As it was impossible to obtain the apparatus used by Kaestle, Rieder and Rosenthal, or to acquire much information concerning it, the Waite and Bartlett Manufacturing Company built a machine for me, using a moving film and a single intensifying screen.[3] This original model was demonstrated at a meeting of the American Roentgen Ray Society in October, 1910, and described 18 months later in the American Quarterly of Roentgenology.[3] While the design of this apparatus was being evolved, the author also devised and adapted to a table previously described,[4] an apparatus for allowing the rapid manual changing of 8x10 plates. A series of Roentgenograms of different phases of different cycles could thus be obtained, which when reproduced cinematographically, demonstrated the gastric motor phenomena in a graphic manner. To this procedure the term serial Roentgenography has been applied, because it is not true Roentgenocinematography. The wealth of information disclosed by a study of 650 series of Roentgenograms made by this method has been communicated in a number of publications.[5] The author has stated that from a practical diagnostic standpoint serial Roentgenography is as valuable or more valuable than true Roentgenocinematography, and requires much less elaborate

[1]Kaestle, Rieder and Rosenthal: "The Bioroentgenography of the Internal Organs." Arch. of the Roent. Ray, June, 1910. No. 119.

[2]Kaestle: "Vereinfachte Magen-Bioroentgenographie." Muenchener Medizinische Wochenschrift, Feb. 18, 1913, S. 346.

[3]Cole: "Apparatus for Moving Pictures of the Stomach." "The Gastric Motor Phenomena Demonstrated with the Projecting Kinetescope." American Quarterly of Roentgenology, March, 1912.

[4]Cole: Transactions of the American Roentgen Ray Society for 1908.

[5]Cole: "The Complex Motor Phenomena of Various Types of Unobstructed Gastric Peristalsis." Arch. of the Roent. Ray, Dec., 1911.
"A Radiographic Study of the Pylorus and Duodenum, with and without Artificial Dilatation and the Duodenum." Arch. of the Roent. Ray, April, 1912.
"Serial Radiography in the Differential Diagnosis of Carcinoma of the Stomach, Gall-Bladder Infection, and Gastric and Duodenal Ulcer." Arch. of the Roent. Ray, Oct., 1912.
"The Value of Serial Radiography in Gastro-Intestinal Diagnosis." Jour. of the Am. Med. Assn., Nov. 30, 1912.
"Physiology of the Pylorus, Pilleus Ventriculi and Duodenum as Observed Roentgenographically." Jour. of the Am. Med. Ass., Sept. 6, 1913.
"Preliminary Report on the Diagnosis of Postpyloric (Duodenal) Ulcer by Means of Serial Radiography." N. Y. Med. Jour., June 21, 1913.
"The Positive and Negative Diagnosis of Gastric Cancer by Means of Serial Roentgenography." N. Y. Med. Jour., Feb. 14, 1913.

apparatus. It is consequently a readily available and most successful diagnostic method for the Roentgenologist. From a scientific standpoint, however, it seemed worth while to perfect a Roentgenocinematographic apparatus, capable of making at least four Roentgenograms per second. This machine, which will be described in detail, is a perfection of the principle set forth in my original communication in 1910.

The process consists in moving a film of any desired length over the surface of an intensifying screen, which is rapidly excited by instantaneous flashes from a Roentgen tube. The film is propelled from one light-proof magazine into another by an adjustable mechanism.

The following is a detailed description of the apparatus built by Charles E. Dressler under the direction of the author.

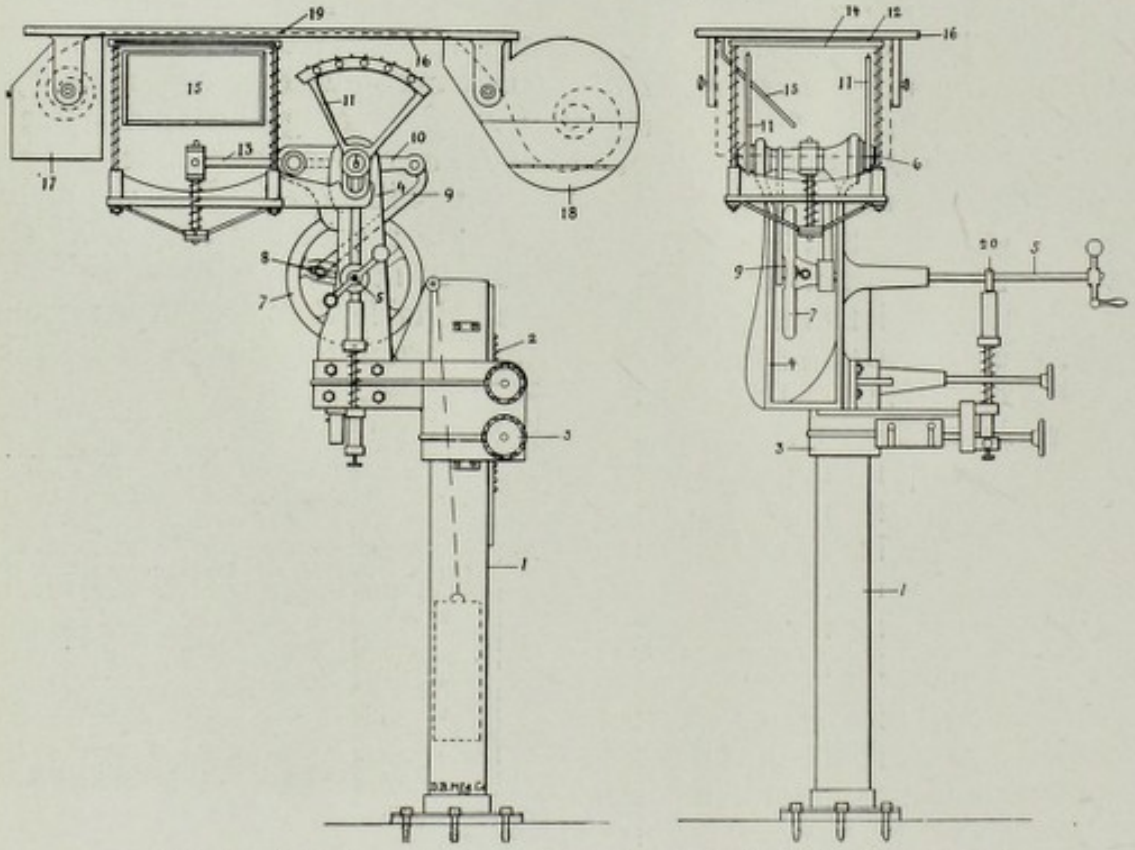

Fig. I. Drawing of Roentgenocinematographic Apparatus.

A weight, acting as a counterpoise for the mechanism, is suspended within a flanged pipe (Fig. 1) of large diameter, fastened to the floor. The mechanism may be moved up or down by rack and pinion (2), or locked at any desired point by the clamp (3) to which it is attached.

The film-shifting mechanism consists of a supporting frame (4), carrying a main or crankshaft (5), and an oscillating shaft (6) above it. Fastened to the further end of the main shaft is a flywheel (7), provided with a slot (8) for adjusting the length of film to be exposed. Next to the flywheel (7) is an eccentric, providing an up and down motion of the oscillating shaft (6), which controls the movement of the sectors (11) bearing the teeth that engage in perforation of the film. The holes of the supporting frame for the oscillating (6) shaft are oblong, allowing the shaft to move up and down. A curved lever (9) is pivoted at one end to the slot in the flywheel (7). Its other end is secured to a short arm (10) connected with the oscillating shaft, giving it a part rotary motion. The rotary motion, combined with the up and down motion, constitutes a rocking movement of the sectors (11), which propel the film forward intermittently.

Fastened to the clamp (3), which carries the film shifting device, is an arm, supporting on four spiral springs a frame, which holds the intensifying screen (12) against the surface of the film (19) during the time of exposure. Free movement of the film, when not being exposed, is obtained by depressing the frame and intensifying screen (12) by means of a lever (13) attached to an eccentric on the main shaft. Beneath the intensifying screen (12) is a fluoroscopic screen (14), face down, which enables the operator to properly center the part to be roentgenographed, and to study the parts fluoroscopically. The screen may be viewed directly or in a mirror (15), placed at an angle of 45 degrees.

Above the mechanism, and secured to the under surface of the table by sliding rails, is an iron frame (16), which carries two magazines (17 and 18). The one on the left houses the unexposed film, and the one on the right the exposed film. They are connected by a lightproof trap, through which the film is propelled by the two sectors (11).

The film (19) is 8 inches wide and of any desired length. It is perforated on both sides like an ordinary moving picture film, and begins with a blank length as a leader. In a dark room the film is threaded through the channels in the iron frame from one magazine to the other, and transported in the lightproof magazine to the operating booth, where it is slid in place on the tracks ready for use.

Near the crank on the main shaft (5) is an eccentric (20), controlling the make and break of the alternating current.

The whole apparatus is mounted under a lead lined table in a dark booth, suitable for perfect fluoroscopic examination. An extra frame, permitting the use of any of the standard cassettes for making individual Roentgenograms, gives great versatility to the machine. One can watch the gastric peristalsis fluoroscopically, and at any time when he wishes to record a series of gastric motor phenomena, he simply turns the crank, which propels the film across the screen. This is done without any jar or noise to frighten the patient, and as many Roentgenograms as one desires can be obtained. Thus satisfactory fluoroscopic observations, serial Roentgenograms, or true Roentgenocinematographs, can all be made with the same apparatus, without moving the patient. Only an instant is required to change from one procedure to another. As a result, the practical value of this method of examination for routine work, has exceeded the most sanguine anticipations.

The Coolidge tube has been of the greatest aid in sustaining a uniform penetration with a high milliamperage during the prolonged exposure necessary for recording a gastric cycle.

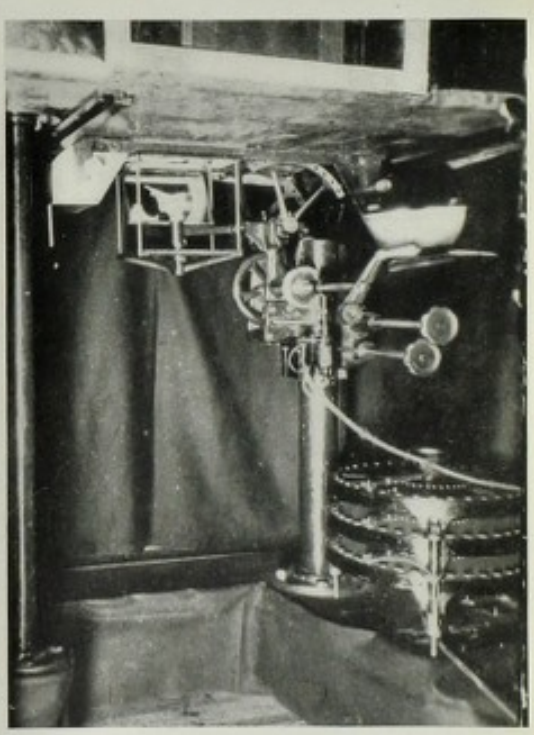

Fig. II.
Photograph of Roentgenocinematographic Apparatus.

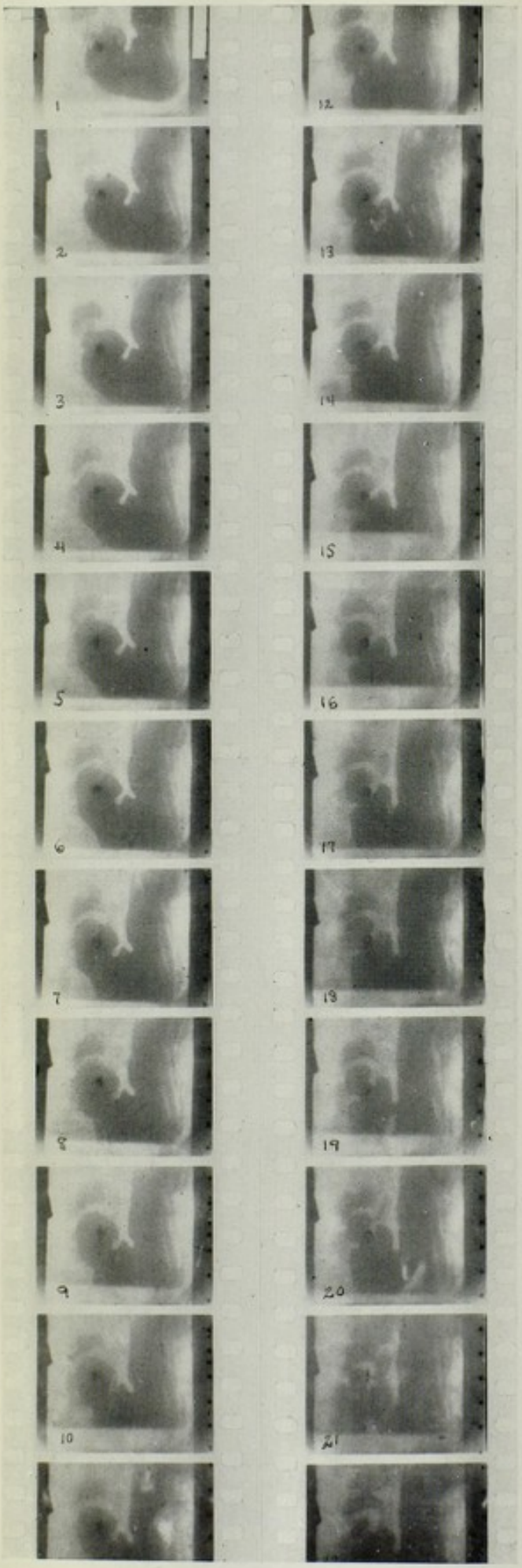

Fig. III. is the first Roentgenocinematographic film made with this apparatus. The 22 exposures were made in about 17 seconds. They show a nearly complete gastric cycle, or the formation and duration of a single antrum. The subject was one of my office assistants, a young woman free from gastric symptoms.

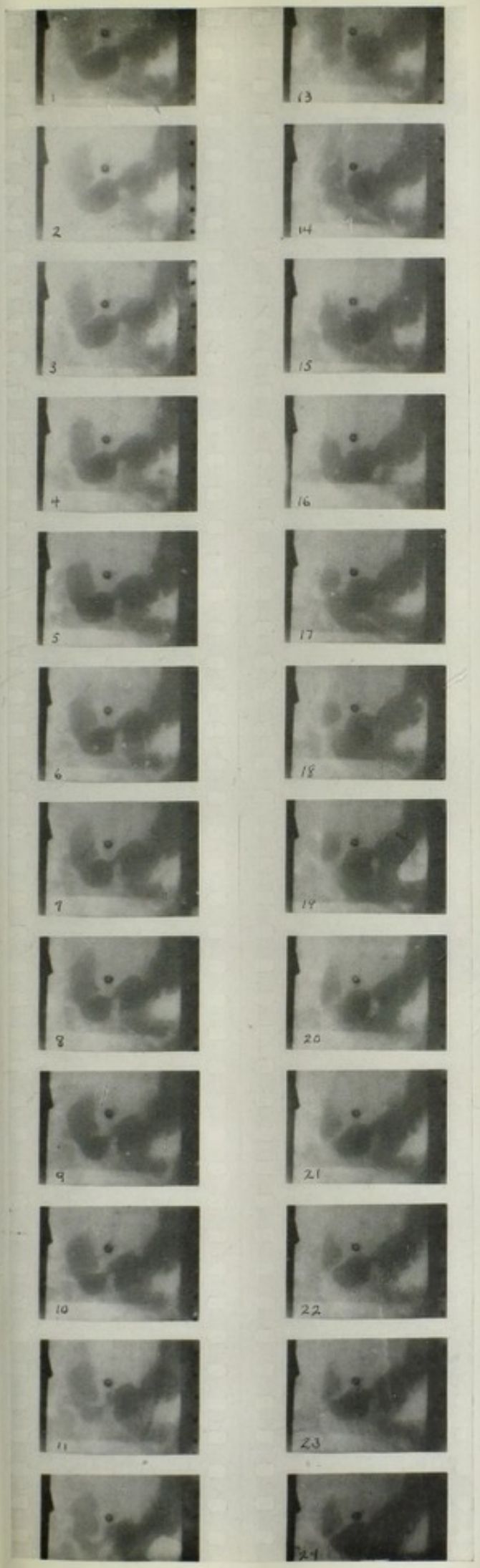

Fig. IV. is the second film, made with this apparatus. The 24 exposures were made in about 18 seconds, showing a complete gastric cycle. The case had been diagnosed by other means as pyloric obstruction. The rapid expulsion of chyme from the stomach, the distention of the cap, the unobstructed peristalsis, and the progression of the chyme through the descending and horizontal duodenum, justify a negative diagnosis of indurated gastric and duodenal ulcer and cancer. Roentgenograms 1 to 10 inclusive show an elongated dilated cap. Roentgenogram 11 shows a beginning constriction halfway up the cap. Roentgenograms 12 and 13 (combined exposure, 1½ seconds) show a contraction of this constriction. Roentgenogram 14 shows the complete broad peristaltic contraction, described and illustrated in a previous article as follows: "During the early stage of digestion the chyme is rapidly withdrawn from the reservoir cap by a rather broad, periodic peristaltic contraction, which propels it through the duodenum, possibly caused by the alternating alkaline and acid reactions in this portion of the intestine." Roentgenograms 15 to 24 show a refilling of the upper part of the cap.

Cole: "Physiology of the Pylorus, Pilleus Ventriculi and Duodenum as Observed Roentgenographically." Jour. of the Am. Med. Ass., Sept. 6, 1913, p. 763, (Figs. 7 and 10).

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