The History of Articulators: "Scribing" Articulators: Those with Functionally Generated Custom Guide Controls, Part I

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SCRIBING ARTICULATORS have generally been considered to be those with functionally generated custom guide controls.[1] These articulators have scribing assemblies that usually consist of 2 to 3 cup-like receptacles on the lower member with corresponding tracing devices (in the form of pins, rods, or studs) on the upper member. The receptacles are filled with a soft moldable material (usually modeling compound or acrylic resin) and the tracing devices function to displace the soft material before it solidifies. Hand-manipulating the upper member against the lower member of the articulator by following an intraoral stereographic record commonly known as a "functionally generated path" or intraoral "chew-in" is the technique used to generate the custom guide controls.

The Origins of Functionally Generated Path ("Chew-in") Methods for Reproducing Mandibular Movement

In Europe from as early as the 1890s, the "functionally generated path" technique for recording mandibular movement was known as the "engraving" method.[1] Bergstrom described one "engraving" method as "three points, in the form of metal needles, on one jaw recording their paths in a suitable material attached to the other jaw." Bergstrom believed that this method was first tried "in practice" by L. Warnekros who, in 1892, "employed it only for adjusting the individual lateral movements in his articulator."[2] (Fig 1A). Bergstrom reported that Warnekros and Max Muller had developed a scribing method utilizing a mandibular partial denture to carry 2 pins (a, a), one at each second molar position for scribing gothic arc tracings in the maxillary wax rim. Actually, Warnekros' articulator was a modified Bonwill, and was not a "scribing" articulator. Nevertheless, Warnekros probably was the first to mention a technique that would be first fully described by Charles Luce,[3] modified by several investigators over the years, and would become well known to the profession as the "Needles-House Chew-in."*

Warnekros was also likely the first to describe and demonstrate what is now referred to as the "functionally generated path" technique mentioned by Luce in 1910[3] and later popularized by Paterson and Meyers. In 1895, Warnekros[4] described a procedure for the edentulous patient whereby, after the casts are mounted in the articulator (Fig 1B) with a "bite registration," the mandibular teeth are set against a gutta-percha maxillary occlusion rim. The patient is asked to "chew on a piece of bread" to record the movements of mandibular teeth. "...[W]e adjust the molars so that the teeth of the one side will not cause the loosening of the teeth on the other side. We also make sure that on lateral excursions, the teeth on both sides are touching all the time."[4] The extent of lateral movement is determined by controls (A, A) that were placed adjacent to the condylar rods and springs.

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*According to James House,[1] John Needles and Milus House made a significant improvement in the "chew-in" method by placing the tracing pins on the maxillary rim. Their investigations, conducted in about 1927, showed that when the tracing pins are placed on the mandibular rim the diagrams produced were practically worthless for accuracy.

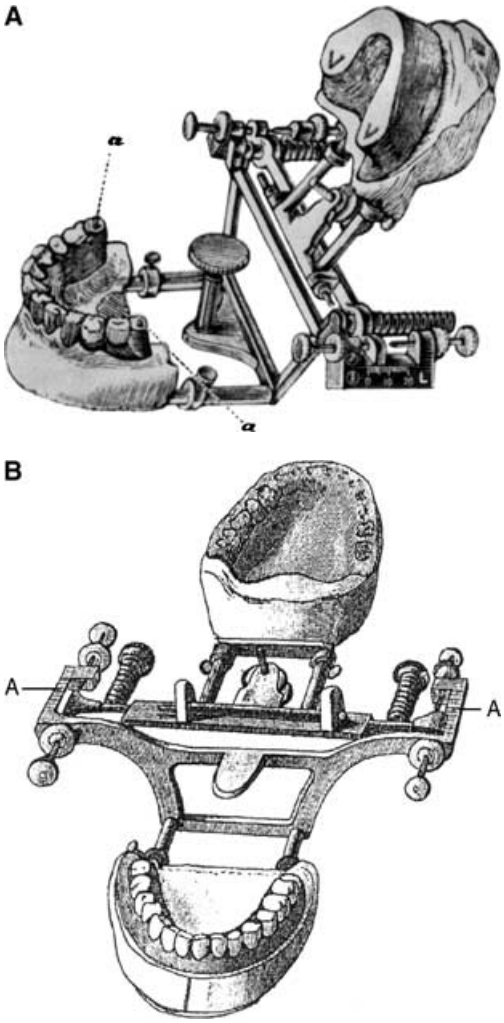


Figure 1. (*A*) The L. Warnekros articulator (1892). This instrument had an adjustable lateral movement feature, but was not a "scribing articulator." It was, in fact, a modified Bonwill articulator with controls to limit the length of lateral movement on each side. Warnekros may indeed have been the first to use scribing pins (a, a) to carve lateral pathways in an opposing occlusal rim. This illustration demonstrates one scribing pin (a, a) placed on each posterior extension of a mandibular partial denture. (Reprinted from Bergstrom, p. 47.)[2] (*B*) A, A are the lateral control features of this modified Bonwill. The arrangement of the mandibular denture teeth and functional tracings evident on the occlusal surface of the gutta-percha maxillary rim clearly indicate a "functionally generated path" procedure.[4] (Reprinted from Warnekros, p. 337.)

The Luce "Simplex Articulator": The First "Scribing" Articulator

Charles E. Luce of Stuttgart, Germany designed the first true "scribing" articulator. Luce introduced his "Simplex Articulator" in a paper read at the 37th annual session of *The American Dental Society of Europe* held in Paris, France, March 23-28, 1910.[3]

Luce began his presentation by reviewing his landmark work at Harvard Medical School in the late 1880s from which he theorized that there was no fixed axis of mandibular movement and that the slope of the condylar path was both forward and downward.[5] He also deduced from his observations that, with respect to articulators, it was necessary to record the actual "masticating relations" of the mandible, and it would be "to a certain extent, indispensable for an accurate articulator [that] can be made to reproduce them . . ."[5] He maintained, however, that it is necessary to record only that movement "that occurs between the closed bite and the articulation between the cusps [of the posterior teeth] in the lateral movements of mastication . . . . An articulator that would reproduce. . .the correct curve of motion between the two would be ideal."[3]

Luce acknowledged that there had been numerous improvements made in articulators "from time to time," but noted that, "from the very excellent work of Professor Gysi, I gather that there is none that is perfect." Luce expressed his admiration for Gysi's work and his "wonderful" articulator "which is a marvel of ingenious mechanism," but he had doubts as to its "perfection and practical applicability." Luce thought that Gysi's method (extraoral gothic arch tracing) of recording condylar movement was "undoubtedly correct," but he did not believe that an articulator, no matter how well designed, could accurately reproduce true condylar movement with a "ready-made slotted condyloid record plate . . . ."[3]

"He is a poor doctor," Luce declared, "who pronounces a disease but offers no remedy." With this brief prologue, Luce introduced his "Simplex Articulator"* and his intraoral recording method that he believed, when used in combination, would make it feasible to record and reproduce "the mandibular relations existing in mastication, absolutely accurate to each individual case."[3] Figures 2A and B are photographs of Luce's original model of the "Simplex Articulator." It is

*As it is not very well known that Luce's articulator was named the "Simplex," it should not be confused with the Gysi "Simplex" produced in 1912. It is not known if Luce and Gysi chose this name for their articulators independently.

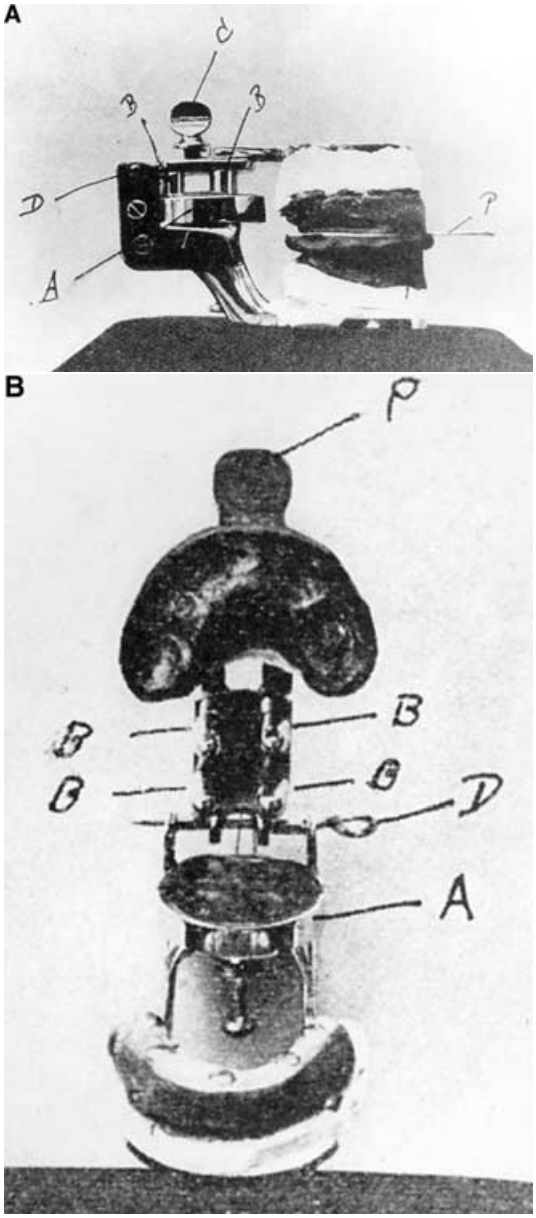


Figure 2. (*A*, *B*) The Luce "Simplex Articulator," (original model), 1910. These are photographs of the model Luce presented to the *American Dental Society of Europe* in Paris, March 1910. Bite plate (P) was used to index centric relation in the occlusion rims. It was then embedded in the maxillary occlusion rim to maintain the vertical dimension during the "chew-in" procedure.[3]

noteworthy that this model had no incisal pin and guide feature.[3]

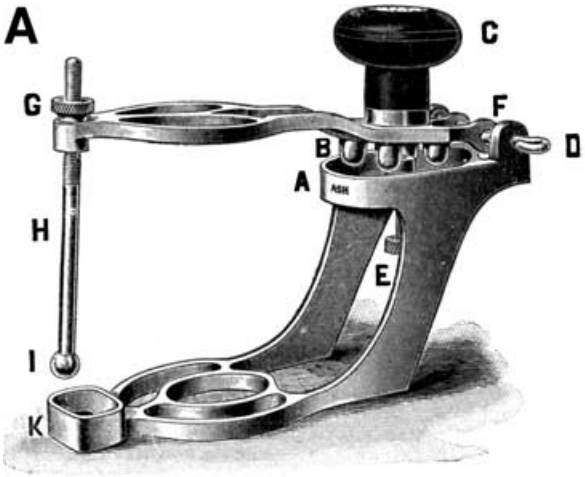
Luce's intraoral recording method for complete dentures was an innovation conceived from his observations of mandibular movement 20 years earlier. The technique that he described actually had 2 versions. His preferred technique was to initially complete the mandibular denture with "care being taken that the [occlusal] curve is correct and the cusps of the posterior molars sufficiently inclined lingually, as found in a normal, natural articulation."[3] The lower denture and maxillary occlusion rim were placed in the mouth, "... and the patient induced to make the actual masticatory movements, the teeth being already inserted in one jaw mold, and by means of these masticatory movements is transmitted as corresponding indentations to the other jaw mold."[6] Luce said that if it is impractical to complete the lower denture first, the occlusion rims should be contoured, "... on the same lines as the finished dentures and this plane of articulation should never be changed. Half round brass head nails [five] are now imbedded in the [occlusal] surface of the [mandibular occlusion rim], taking the place of the teeth that will replace them. These round head nails are used simply to obtain a clear-cut record of the masticating movements on the [occlusal surface of the maxillary wax rim]."[3]

On November 28, 1911, Luce was issued the first US patent for a "scribing" articulator.[6] He applied for the patent on September 28, 1910, just 6 months after his articulator was introduced in Paris. The patented model was his second design and it is interesting to note that it had an additional feature that was also the first to be patented in the United States: the incisal pin and guide, a device that Luce simply called the "adjustable vertical guiding pin."[3] Now, that was a *great* idea!*

Luce's patented model of the "Simplex Articulator" was produced by Claudius Ash and was featured in *Ash's Monthly*, June 1912 issue.[6] The illustrations therein are the most ideal for describing the features of the articulator and Luce's recording method.

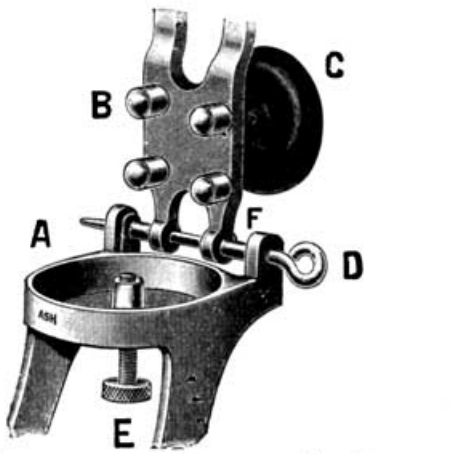
Figure 3A is an anterior-lateral view of the articulator and Figure 3B is a detail of the posterior tracing apparatus. According to Luce's instructions,[7] "The ability of this articulator to reproduce

*Alfred Gysi applied for his first US patent for an articulator in May 1911 and received a patent for his "Adaptable" in October 1912. The Gysi adjustable articulator that preceded the "Adaptable" featured interchangeable curved condylar paths (4) and an incisal pin and guide. It was this articulator Luce was referring to in the presentation of his "Simplex Articulator." Gysi's articulators had the incisal pin and guide feature as early as 1908.



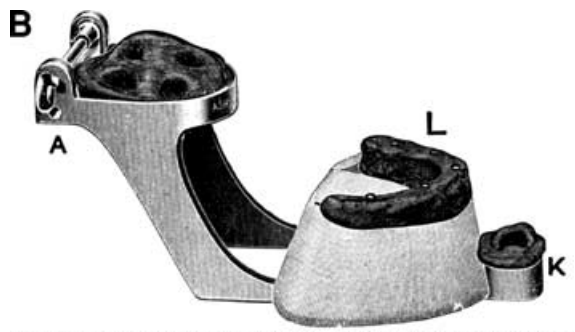
ARTICULATOR COMPLETE.

A—Record Cup. C—Handle.
B—Round Tracing Knobs. D—Hinge Pin.
E—Set Screw.

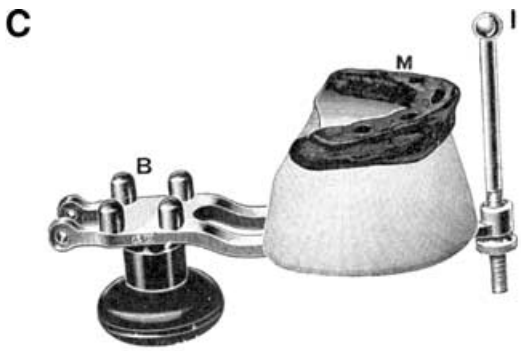


OPEN VIEW OF BACK PORTION OF FIG. 1.

F—Slide Hinge Tubes. H—Guide Pin.
G—Lock Nut. I—Tracing Knob.
K—Record Cup.



Lower part of Articulator with the depressions in cups A and K made by the knobs B and I. The heads L of the brass nails are clearly seen on the bite-block.



Upper part of Articulator with trial-plate and bite-block on model, also the piece of softened wax on the bite-block with depressions M in it, made by the heads of the brass nails L, Fig. 2.

Figure 3. (*A*) The Luce "Simplex Articulator" (patented model), 1911. These 2 views illustrate all the basic elements of the patented version. When comparing this model to the original version, it is quite apparent that the major change in design was the addition of the incisal pin and guide, a feature that was not given much importance by Luce. He also included a posterior vertical stop screw (E) within the record cup (A).[7] The Luce "Simplex Articulator" (patented model), 1911. (*B*) The mandibular member of the Luce articulator demonstrating the nail heads (L) in the occlusion rim as well as the depressions in cup (A) and (K). The depressions were made by knobs (B) and (I) on the maxillary member (3C).[7] (*C*) The maxillary member of the Luce articulator. Depressions (M) can also be seen in the maxillary occlusion rim made by nail heads (L).[7]

the masticating movements of the mandible rests entirely in the record cup (A), which contains a record in Stents impression composition [modeling plastic] of these motions, which has been transferred directly from the bite taken in the mouth. The 4 round tracing knobs (B), which (are tracing the record), are kept in contact by pressure applied with the hand at (C)." To reproduce these movements, removing pin (D) from sliding tubes (F) disengages the hinge joint that is used to maintain centric relation. "A vertically adjustable guide pin" (H) with tracing knob (I) is also provided to "further guide the articulator" when recording masticatory movements by displacing modeling plastic in record cup (K). Luce also included in this model a posterior vertical stop (E) within the record cup (A). These 2 features were probably included to prevent anterior sagging that must have been a problem with the original model.[7] Figure 3B illustrates the depressions

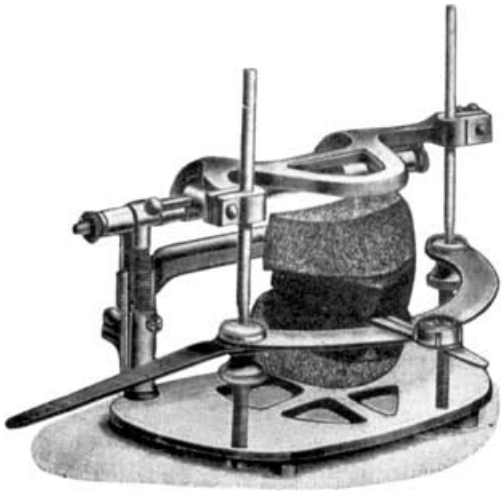


Figure 4. Eichentopf's first articulator, 1914. It was obvious that this design would not function as a "scribing" articulator with only 2 anterior tracing cups and a posterior hinge. (Reprinted from Ishihara, p. 187.)[8]

(masticatory tracings) in the modeling plastic in records cups (A) and (K) by tracing knobs (B) and (I). The nail heads (L) can be seen on the mandibular occlusion rim. Figure 3C illustrates the depressions (M) in the maxillary occlusion rim that represent the functionally generated occlusal paths traced by the nail heads (L).

The Eichentopf Articulators

O. Eichentopf created the next recorded "scribing" articulator in 1914. Between 1914 and 1924 he would produce 5 models of this articulator. His first design, Eichentopf admitted, was poorly conceived because it had only 2 tracing rods and record cups along with a hinge mechanism that was not easy to release (Fig 4).[8]

Eichenkopf's second attempt in articulator design was in 1921. This model had 3 tracing rods and record cups, but still had a complex hinge mechanism, adjustable condyle paths with a type of lateral control (Fig 5).

Eichentopf produced the "Universal-Modell" articulator in 1922 (Fig 6). The adjustable condylar path feature was eliminated, but a somewhat complex hinge joint was retained. It appears, however, that the hinge pin could be removed allowing movements in the record cups. This articulator contained a provision for easily adjusting the vertical height.

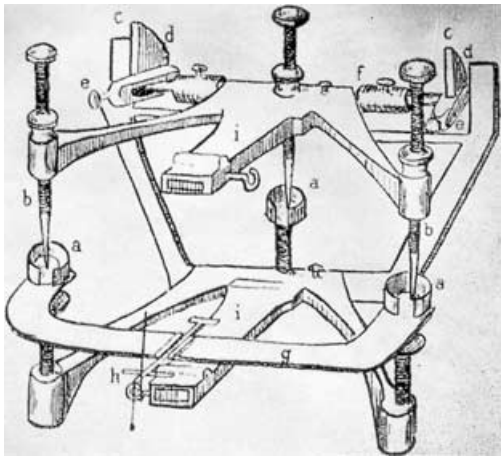


Figure 5. The Eichentopf Articulator, 1921. Even though this model had 3 tracing rods and recording cups, it also had a hinge mechanism featuring straight adjustable condylar paths. Obviously, this would be incompatible with "scribing" articulator concepts. (Reprinted from Ishihara, p. 187.)[8]

In 1923, Eichentopf produced the "Klinic-Modell" (Fig 7) articulator, the first of two. He referred to this articulator as the *simplified* "Universal-Modell." As in all the previous articulators, the record cups were at the level of the occlusal plane. However, an additional feature, accessory supporting rods to maintain the occlusal vertical dimension and centric position, was

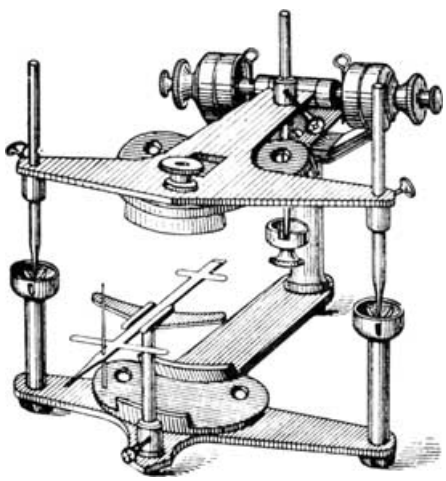


Figure 6. The Eichentopf "Universal-Modell" Articulator, 1922. This model had a removable hinge pin and featured an "easy" vertical height adjustment. (Reprinted from Ishihara, p. 189.)[8]

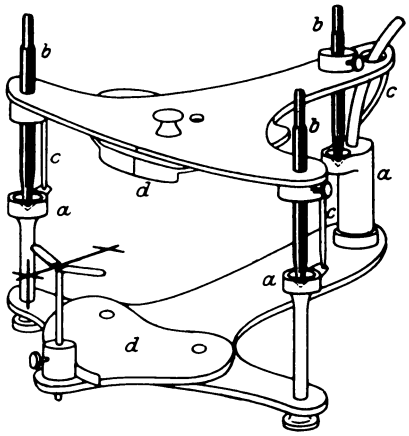


Figure 7. The Eichentopf "Klinic-Modell" (first version), 1923. The hinge was essentially eliminated in this model except for a posterior curved guide rod. This model featured accessory supporting rods (c) adjacent to each tracing rod (b) to maintain vertical dimension. (Reprinted from Ishihara, p. 189.)[8]

added. The "easy" vertical adjustment feature was removed within a year. Even though Eichentopf would not entirely shed a hinge device, all that remained was a posterior curved rod that served as "hinge opening guide."[8]

The *improved* (and certainly, simplified) version of the "Klinic-Modell" was introduced in 1924 (Fig 8). It was solid in construction with essentially no adjustment features. The record cups were lowered for the first time to the level of the lower member. The accessory supporting rods were retained as well as the "curved hinge opening guide." Figure 8A illustrates the occlusal plane relater, a guide for mounting casts; (B) the maxillary and mandibular casts mounted in the articulator; (C) and Eichentopf's functional method of recording mandibular movement.

The Wustrow and the Fehr Articulators: Early Footnotes to "Scribing" Instruments

Two other early European "scribing" articulators of interest were the Wustrow articulator and the Fehr articulator, both produced in 1921. The Wustrow articulator was very simple in design and had 4 tracing cups (Fig 9). The Fehr articulator was designed after the Eichentopf principle with 3 stylus rods and tracing cups (Fig 10). According to Wilhelm Balters, the Fehr articulator is of

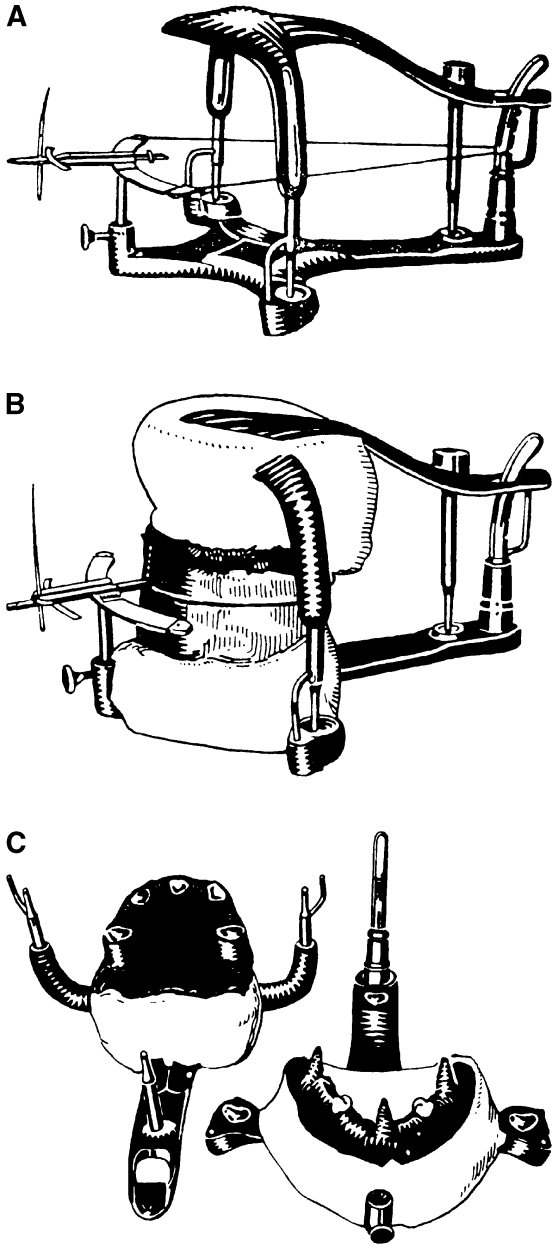


Figure 8. (*A–C*) The Eichentopf "*Improved* Klinic-Modell," 1924. This model appears to be of solid construction with few adjustment features. The recording cups were placed at the level of the articulator base instead of at the level of the occlusal plane. (*A*) This represents the articulator with an occlusal plane relater, a feature that was used with all of Eichenkopf's articulators. (Reprinted from Ishihara, p. 189.)[8] (*B*) This demonstrates the casts and occlusion rims mounted on the articulator using the occlusal plane relater. (Reprinted from Ishihara, p. 191.)[8] (*C*) This illustrates Eichenkopf's intraoral functional registration method. (Reprinted from Ishihara, p. 193.)[8]

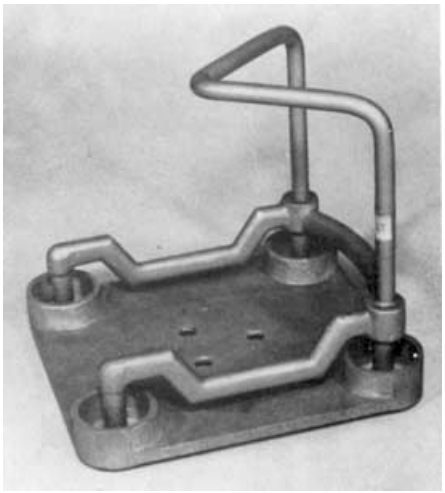


Figure 9. The Wustrow articulator, 1921. This articulator apparently was designed for stability; that is, the 4-legged stool concept. (Reprinted from Ishihara, p. 193.)[8]

tripod design, but with only 2 guide pins. "The function of the third [anterior] pin . . . is taken over by firmly mounted set of incisors." Additional registrations are then needed for protrusive movements and therefore, this articulator is difficult to use.[9]

The Homer "Relator" Articulators

Joseph Homer, of Boston, MA, patented 4 articulators between 1921 and 1927. In 1923, Homer

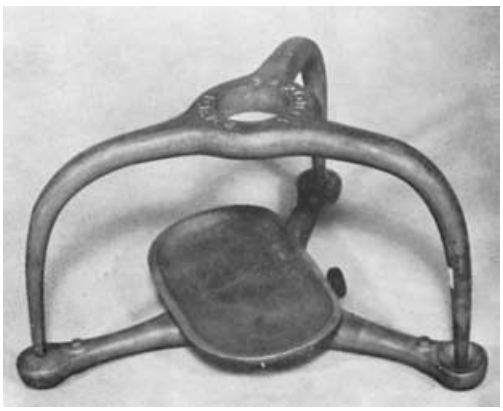


Figure 10. The Fehr articulator, 1921. Fehr's design may likely be the first to employ a single guide pin for anterior (incisal) guidance and two for posterior (condylar) guidance in a scribing articulator. (Reprinted from Ishihara, p. 193.)[8]

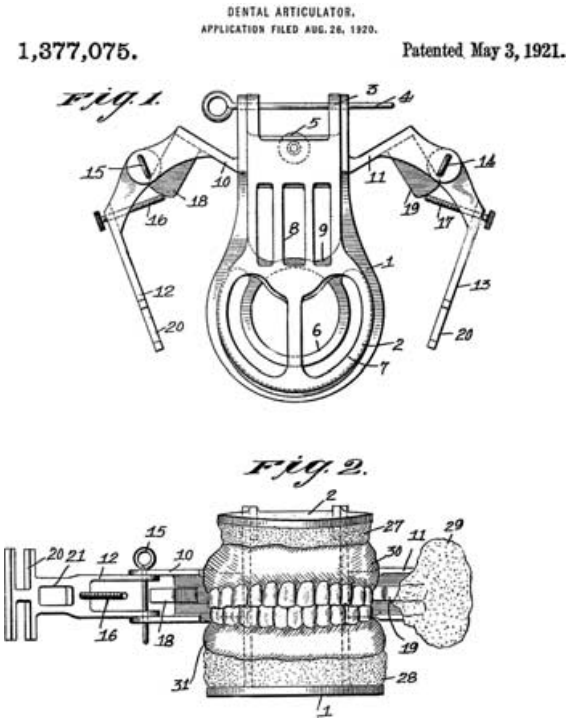


Figure 11. The Homer articulator, 1921. The main emphasis for the design of this articulator was, after establishing the form and contours of the denture bases to maintain the natural appearance of the patient, to index and reproduce these contours with the aid of adjustable side arms. It was a simple hinge articulator.[10]

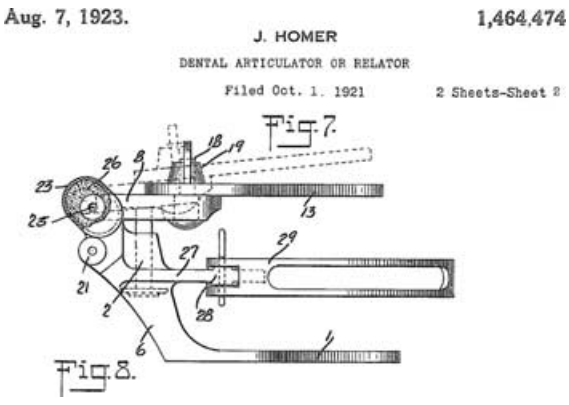


Figure 12. The Homer "Relator" (first patented model), 1923. This illustration shows the relationship between the static hinge position (21) and the functional hinge position (25). Also note the positions of the adjustable indexing side arms (29) and posterior vertical stop screw.[11]

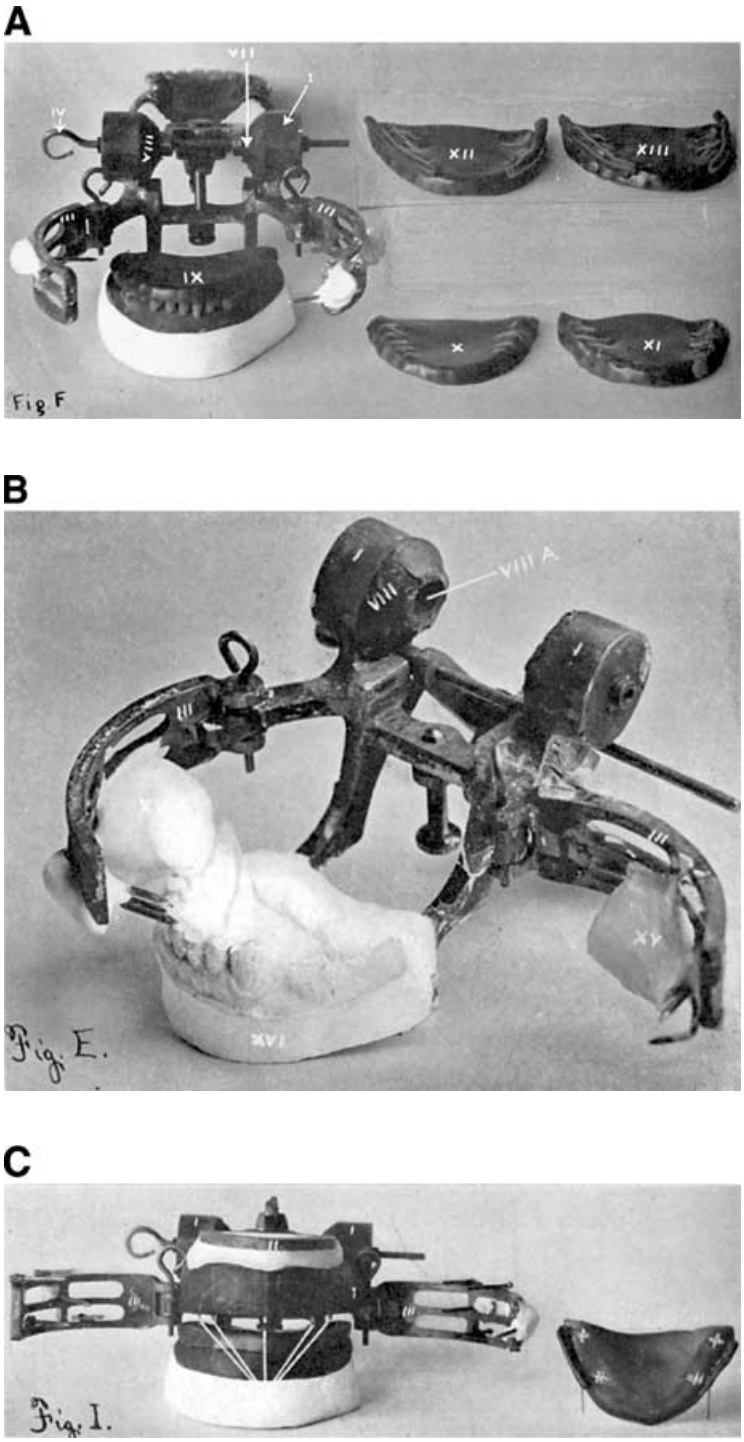


Figure 13. (*A–C*) The Homer "Relator" (first patented model), 1923. These are photographs of the "Relator" that were included in an article published by Joseph Homer on the practical use of his articulator.[12] (*A*) This photograph shows the hinge pin (IV) through the condylar cups (I) filled with modeling compound VII (the "anatomical adjustment position"). A "wax guide path" (IX) is in place on the mandibular denture.[12] (*B*) This photograph shows the hinge pin in the "plain line position" and the area of displaced modeling compound (VIIIA) in cup (I) that was created by following the "wax guide path."[12] (*C*) This photograph shows 4 tacks or finishing nails in a mandibular rim for scribing paths in the maxillary rim.[12]

became the second inventor to receive a US patent for a "scribing" articulator. This was the first of 3 articulators that he called "Relators."

His first articulator,[10] however, was not a "Relator," but was essentially a simple hinge instrument with attached adjustable hinged side arms intended for indexing and preserving the position of the teeth and functionally formed polished surfaces in the final dentures (Fig 11).

Homer included this feature for indexing the denture bases in his first of 3 "Relator" articulators in 1923.[11] This articulator was also a simple hinge device but embodied a modification to include additional "condylar cups" for the functional recording of condylar movement. This is the first scribing articulator with the record cups to be located in the area of the glenoid fossae (Fig 12). Homer explained that when the hinge axis pin is "through the holes in the condyle cups 25, the articulator is in 'anatomical adjustment,' and when the pin is in [hinge] holes 21 immediately below the cups, the articulator is in *plain line adjustment.*"[12] The condylar cups are designed so that the compound cores can be removed for later use. Homer suggested 2 intraoral methods for functionally recording mandibular movement, one utilizing the completed dentures, the other utilizing modeling compound rims with tracing studs. The first method consisted of mounting the completed dentures in the articulator with the hinge pin in the "plain line position." A "wax guide path" was created by placing a layer of base plate wax over the mandibular denture teeth. The dentures were returned to the mouth and the patient was instructed to "close with enough pressure to mark [the] wax, and to slide [the] jaws laterally in both directions until the wax is well marked by the upper cusps" (Fig 13A). The hinge pin (IV) was then removed from the "plain line position" and inserted through the condyle cups ("anatomical adjustment position") (I) and the dentures returned to the articulator. The wax guide path was replaced on the mandibular denture. With the condylar cups filled with soft modeling compound, the maxillary denture is moved in the wax guide path to produce "slots in the compound in each condyle cup . . . thereby indicating where any grinding of cusps is necessary for anatomical articulation"[12] (Fig 13B). The alternative method recommended by Homer consisted of placing "three to five tacks or small finishing nails" in the mandibular rim and instructing the patient

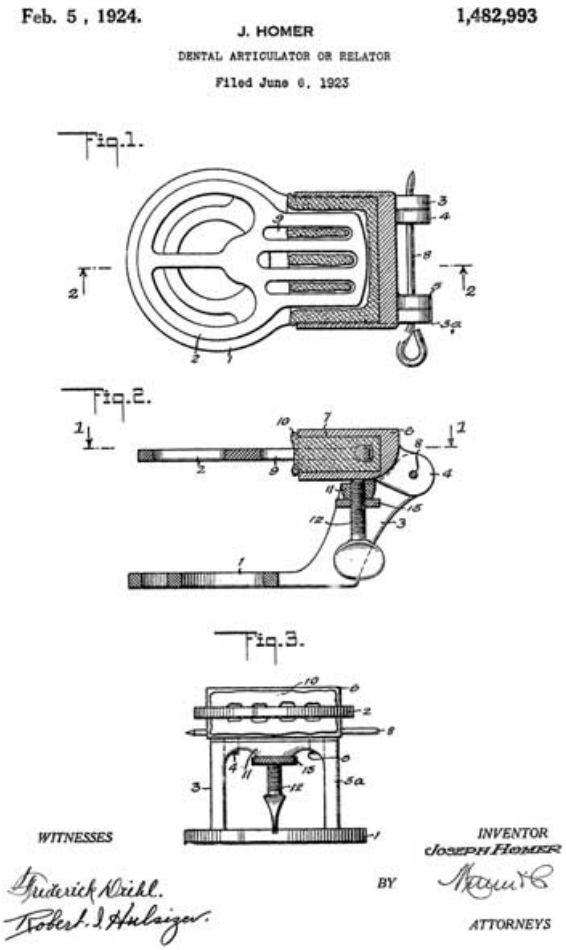


Figure 14. The Homer "Relator" articulator (second patented model), 1924. Posterior guide slots (9) are embedded in softened modeling compound (10) in chamber (7) for establishing the functional paths. Maintaining stability and anterior slumping must have been a problem.[13]

in the same manner in order to carve definite pathways in the maxillary rim (Fig 13C).

Homer's second U.S. "Relator" articulator, patented in 1924, represented a significant departure in design from the previous model[13] (Fig 14). The basic design is that of a plain line articulator with a hinge pin connection and a posterior adjustable vertical stop. The upper moveable member consisted of an anterior (2) and posterior (6) section. The anterior section (cast holder) included a back segment containing 3 guide slots. The posterior section (hinge section) was essentially a hollow chamber (7) that was filled with a modeling compound (10) to produce

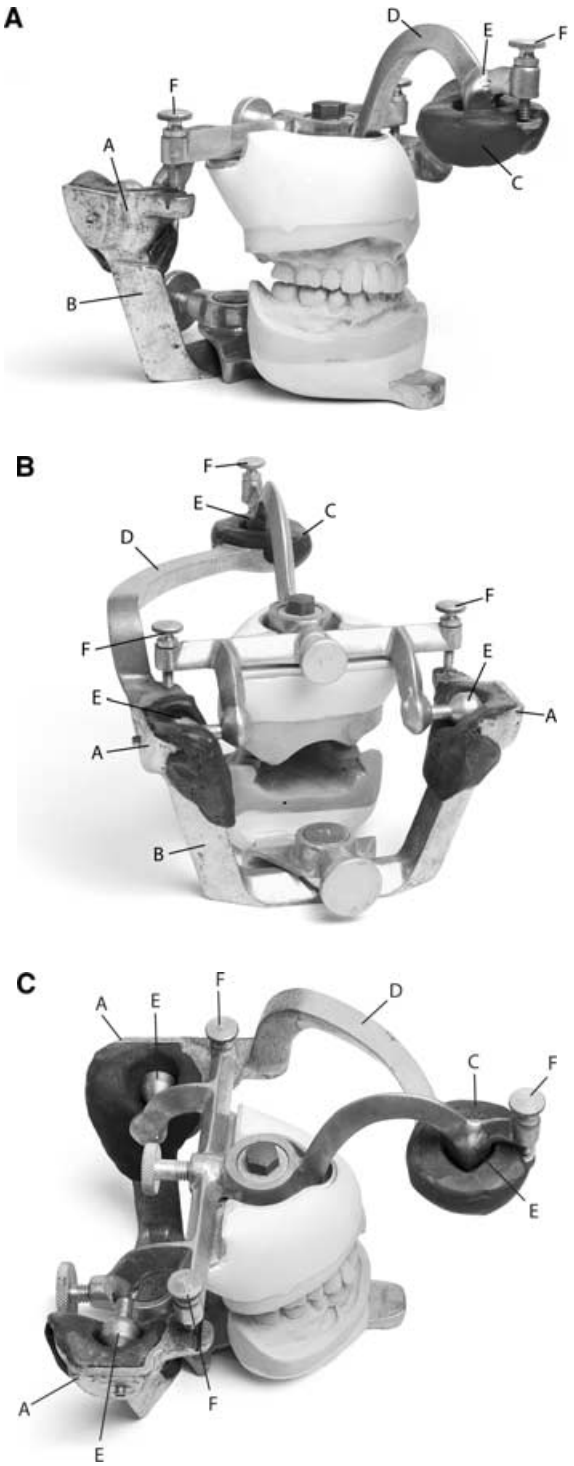


Figure 15. (*A–C*) The Homer "Relator" articulator (third patented model), 1927. Three different perspectives are presented of this model of the "Relator" for the reader unfamiliar with its highly unusual design. (From the collection of the University of Texas Dental Branch, Houston, TX.)

the functional record when the guide slots were placed into the softened material and the articulator manipulated to follow the intraoral chew in registration.

In 1927, Homer received a patent for the third and final version of his "Relator" articulator.[14] This is the Homer "Relator" most commonly encountered in the literature and it is likely that it was produced with some commercial success. Homer made several notable improvements in functional design of this instrument as compared to his 2 previous "Relators." Figures 15A–C are 3 views of the 1927 model Homer "Relator." The 2 condylar bearing cups (A) were again placed in the area of the glenoid fossae by providing 2 supporting pedestals (B) on the posterior section of the "main frame" [lower member]. In addition, Homer provided for an anterior or incisal bearing cup (C) with an arm (D) extending from one of the pedestals forward and upward to a position above and anterior to the maxillary cast. The upper member ("movable frame") had 3 scribing posts (E) corresponding to the bearing cups. Each scribing post had an adjacent adjusting screw (F) to stabilize the articulator in centric position and to preserve vertical dimension. The relative positions of the 3 bearing cups provided a wide triangular distribution of support as well as easy working access to the casts.

(There will be more on the history of "scribing" articulators in an upcoming issue of *The Journal of Prosthodontics*.)

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