10.5005/jp-journals-10015-1358

REVIEW ARTICLE

Articulators through the Years Revisited: From 1900 to 1950—Part II

Ashish R Jain

ABSTRACT

This article continues an historical review, begun in the last issue, of landmark clinical investigations that advanced the profession's understanding of the nature of condylar movement. The investigators' unique recording devices, developed for registering and studying the movements of the condyles in human subjects, are described.

Keywords: Articulators, Condylar tracings, Facebow, Movements of condyle.

How to cite this article: Jain AR. Articulators through the Years Revisited: From 1900 to 1950—Part II. World J Dent 2016;7(1):23-31.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Historically, some aspects of jaw physiology have been easy to duplicate mechanically on an articulator, such as the hinge movement, relation of casts to the hinge, and inclination of the condylar path. Undoubtedly, the investigators' interpretations of what they observed varied greatly. This is demonstrable in the features of their articulators. From the inspired to the near-genius and from the 'ridiculous to the sublime,' these articulators simply reflected what was perceived to be the anatomic and kinesthetic characteristics of mandibular movement. Despite differences in investigators' perception and application of mandibular movement, the complexity of articulators began to evolve as a result of the important work of such scientists as WE Walker, Alfred Gysi and George Snow. By 1910, most inventors had become more systematic in their attempts to reproduce the individual natural movements of the mandible.[1-5]

ARTICULATORS FROM 1901 TO 1950[6-16]

1. Huberty articulator (1901)
2. Kerr articulator (1902)
3. Christensen's articulator (1905)
4. New century and modified new century articulator—George Snow (1906–1907)
5. The Acme articulator (1906)
6. Gysi adaptable articulator (1910)
7. Luce articulator (1911)
8. Eltner articulator (1912)
9. Gysi simplex articulator (1914)
10. Alligator-Rubert Hall (1915)
11. Hall's anatomic articulator (1915)
12. Gysi Dreipunkt articulator (1917)
13. Monson-maxillomandibular instrument (1918)
14. Hagman balancer (1920)
15. Stephan articulator (1921)
16. Hanau articulator (1921)
17. Hanau model M kinoscope (1923)
18. The Homer relator (1923)
19. Wadsworth articulator (1924)
20. Hanau model H110 articulator (1926)
21. Philips student articulator (Model C) or pantographic articulator (1926)
22. Hanau model H110 modified articulator (1927)
23. House articulator (1927)
24. The Stansberry tripod instrument (1929)
25. Gysi Truebyte articulator (1930)
26. Terrell's precision co-ordinator (1930)
27. Hanau crown and bridge articulator (1934)
28. The Phillips occlusoscope (1938)
29. The McCollum gnathoscope (1939)
30. Stephan articulator modified (1940)
31. Stephan articulator model P (1940)
32. The Fournet articulator (1940)
33. Dentatus articulator ARH model (1944)
34. Johnson-Oglesby articulator (1950)
35. Moyer articulator (1950)
36. Coble articulator (1950)
37. Bergstorm articulator (1950)
38. The Galetti articulator (1950–1960)

Huberty Articulator (1901) (Fig. 1A)

This articulator was claimed to provide independent movement of the respective jaw members of the articulator. But, this was a complicated device requiring several adjustments for its function, as intended. It is not known if any of these devices were manufactured.

Research Scholar

Department of Prosthodontics, Saveetha University, Chennai Tamil Nadu, India

Corresponding Author: Ashish R Jain, Research Scholar, Department of Prosthodontics, Saveetha University, Chennai, Tamil Nadu, India Phone: 09884233423, e-mail: dr.ashishjain_r@yahoo.com

Kerr Articulator (1902) (Fig. 1B)

The Kerr articulator was developed by the Kerr brothers in 1902 and distributed by the Detroit Dental Company. It has a fixed protrusive and lateral movement. The hinge is located on approximately the same plane as the occlusal plane of the mounted cast. The concept of this design involved copying the center of mandibular rotation in the translatory opening movement.

Christensen's Articulator (1905) (Fig. 1C)

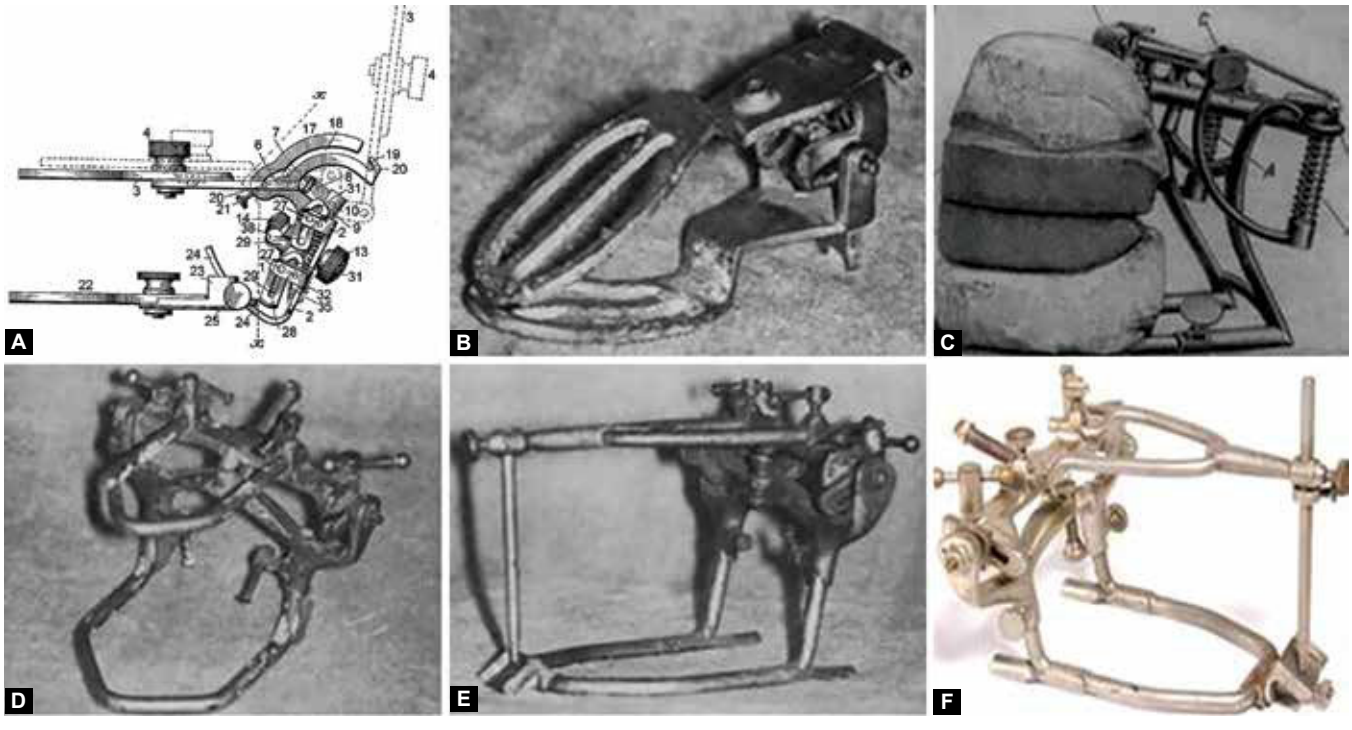
He reported his observation of the space that occurs between the maxilla and mandible during protrusion. Christensen introduced an adjustable articulator similar to walker's but simpler in design. He suggested the use of a protrusive interocclusal wax record to measure the angle of the condylar paths that he believed corresponded to the observed space, and to use this record to set the condylar controls of an adjustable articulator. Christensen's procedure was a major contribution and is likely the origin of the intraoral (checkbite) method for recording mandibular movement.

New Century and Modified New Century Articulator by George Snow (1906–1907) (Figs 1D and E)

The New Century articulator has been credited to George B Snow of the University of Buffalo. In 1906, he improved on the Gritman articulator of 1899 by converting the fixed condylar paths to adjustable condylar paths and adding a tension spring, which allowed a greater range of movement without compromising the stability of the frame. The rotation centers were placed 4 inches apart in accordance with Bonwill's theory. Snow developed a number of articulators, the modified version of the New Century instrument incorporates the incisal pin. Gysi, who has been credited with the invention of the incisal pin, illustrated one on the Gysi Adaptable articulator in an article published in the January 1910 issue of Dental Cosmos. In addition, CE Lute of Stuttgart, Germany, applied for a patent on the incisal pin in September 1910. Because of these circumstances, it is assumed that Snow introduced the model shown at about that time or modified the instrument later to include an incisal pin.

The Acme Articulator (1906) (Fig. 1F)

The Acme articulator was manufactured by the Snow Dental Company Tonawonda, NY, about 1910. The Acme articulator which also was made by George B Snow, is an elaboration of his 1906 New Century instrument. It includes three models of different widths that accommodate three ranges of intercondylar distance. The condylar paths are straight, and the condylar inclination is adjustable, the incisal pin rests on a changeable incisal guide. The Bennett movement is provided for arbitrarily. This lightweight, somewhat flexible articulator has a posterior adjustment for increasing the distance between the upper and lower members. However, as it is in a number of the early articulators, this adjustment space is limited. The guiding mechanisms are on the upper member.



Figs 1A to F: (A) Huberty articulator, (B) Kerr articulator, (C) Christensen's articulator, (D) new century articulator by George Snow, (E) modified new century articulator by George Snow and (F) Acme articulator

The Gysi Adaptable Articulator (1908–1910) (Fig. 2A)

Gysi introduced the Gysi Adaptable articulator in 1910, but apparently it was beyond the technical ability and finances of most dentists. For this reason, the Gysi Simplex was introduced as a mean value articulator in 1914.

Gysi Simplex Articulator (1914) (Fig. 2B)

The Gysi Simplex was introduced by Alfred Gysi of Zurich, Switzerland, in 1914, through the Dentists Supply Company of New York. It was competitively priced and did not require great technical ability to operate. The condylar guidance of the Gysi Simplex is fixed at 33°. For this reason, the Gysi Simplex was introduced as a mean value articulator in 1914. The first articulator to use this path was an English instrument introduced by JB Parfitt in 1902 to 1903. The incisal guide is not adjustable.

Luce Articulator (1911) (Fig. 2C)

By CE Luce of Germany, he received the first patent for an articulator with an incisal pin and guide assembly. He was also one of the first to describe the downward and forward movements of the condyles. Luce articulator was the first scribing type, i.e. it had posterior and incisal path controls that were functionally generated in modeling plastic.

Eltner Articulator (1912) (Fig. 2D)

By Ernest Eltner of Switzerland. This was the second articulator patented with incisal pin and guide table. It was constructed on the theory that the temporomandibular joints (TMJ) have two horizontal axes, one running through the condyles and the other through the articulator eminences. It has a horizontal incisal guide table with an adjustable posterior vertical flange that limited protrusive movements. The incisal pin had a chevron shaped blade tip. The purpose of this unusual design was not explained.

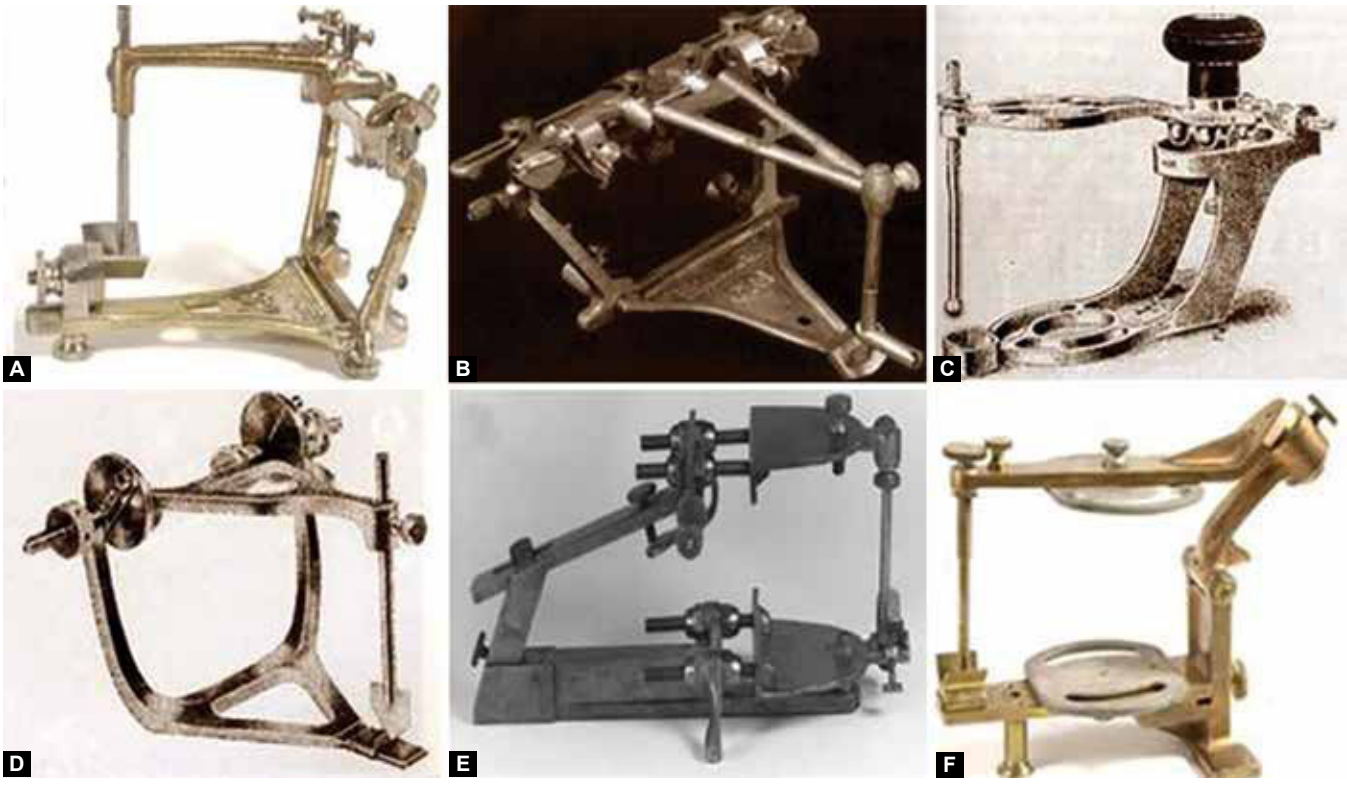
Halls Alligator (1915) (Fig. 2E)

Hall's Anatomic Articulator (1915) (Fig. 2F)

Devised by Hall in 1915, based on Hall's conical theory of occlusion. Theory says lower teeth move over the surfaces of the upper as over the surface of a cone, with a generating angle of 45° and the central axis of the cone tipped at 45° to the occlusal plane. Forty-five degree cusp teeth were necessary for constructing dentures on this type of articulator. It is a mean value arbitrary articulator.

Gysi Dreipunkt Articulator (1917)

Similar to the tripod or positional articulator, it had fixed 33° condylar cusp to accommodate mandibular styli. Gysi retained the same fixed 40° protrusive incisal guide table that he had used in previous articulator design.



Figs 2A to F: (A) Gysi adaptable articulator, (B) Gysi simplex articulator, (C) Luce articulator, (D) Eltner articulator, (E) Halls alligator and (F) Hall's anatomic articulator

Maxillomandibular Instrument (Monson's Articulator) (1918) (Fig. 3A)

The Maxillomandibular instrument was designed in 1918 by George Monson, an orthodontist from Minneapolis. It was distributed by the MF Patterson Supply Company, it was based on the spherical theory. According to this theory, which evolved from concepts of Monson and a German anatomist, Graf yon Spee, the mandibular teeth move over the maxillary teeth as over the surface of a sphere with a diameter of 8 cm in radius, the center of which is located in the region of glabella and the surface of the sphere passes through the glenoid fossa along the articulating eminences or concentric with them. Monson considered that the cuspal guidance were much more influential than the TMJ in regard to the jaw movements. This instrument permits eccentric motion.

Hagman Balancer (1920) (Fig. 3B)

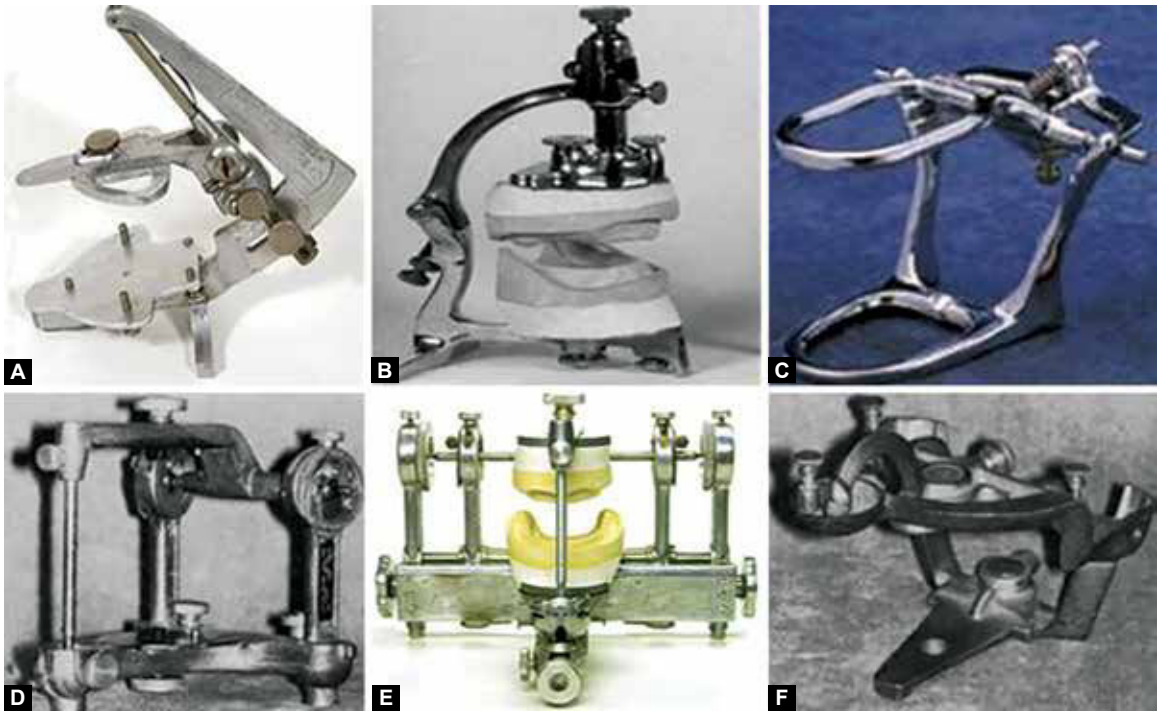
The Hagman Balancer, designed by HC Hagman in the 1920s, was manufactured by the Hagman Balancer Company of Minneapolis, Minn. It opens and closes on a hinge that is in the center of the upright support but requires no facebow or interocclusal records for mounting. A centering device transfers the maxillary and mandibular impressions from the patient to the articulator in one step. It is based on the spherical theory of occlusion. The technique directs reconstruction of the mandibular teeth to the curve of Spee using a balanced occlusal guide. The maxillary teeth are constructed secondarily to conform to the mandibular teeth. Three arcs of various radii can be used, depending on the arch form and the desired anterior relationship needed to provide balance.

The Stephan Articulator (Fig. 3C)

The Stephan articulator developed in 1921, is similar in design to the Gariot hinge articulator of 1805, except that it has a fixed condylar inclination and allows for an arbitrary lateral movement. A posterior set screw holds the upper and lower members of the articulator at a fixed vertical dimension.

Hanau Model H110 (1926) (Fig. 3D)

The Hanau Model H110, which was introduced by Hanau in 1926, was designed primarily for complete dentures. The articulator evolved from the Model Hl15 that was manufactured in 1922 and 1923. These instruments were developed because Hanau realized, as had Gysi and others that the dental profession and the laboratory industry would not accept the more complicated Kinoscope instrument. The Hanau Model H110 was designed to encompass mechanical averages of many previous concepts. It has individual condylar guidance adjustments in both the sagittal and the horizontal planes. Rather than using lateral positional records, the lateral setting is calculated by dividing the horizontal condylar inclination by 8 and adding 12. This formula is given on the base of the articulator as:



Figs 3A to F: (A) Monson's articulator, (B) Hagman balancer, (C) Stephan articulator, (D) Hanau model H110, (E) Hanau model M kinescope and (F) Homer relator

L equals H/8 plus 12

The Hanau Model M Kinescope (1923) (Fig. 3E)

Rudolph L Hanau, an engineer, was influenced by Dr Rupert E Hall to study the design of articulators. Early in 1921, he developed a research model called the Hanau Model C articulator. In 1923, he developed another research instrument, the Hanau Model M Kinoscope articulator. It has double condylar posts on each side. The inner posts serve two purposes, they act as the horizontal condylar guides, and they have variable rotation centers when the posts are moved inward or outward. The Bennett angle is adjusted by rotating an eccentric cone located on the outer posts against the intercondylar axis.

Homer Relator (1923) (Fig. 3F)

The Homer Relator was introduced in 1923 by Joseph Homer of Boston, Mass. The Homer Relator principle is the same that Luce of Germany used in his 1911 articulator. In accordance with that principle a plastic material rather than mechanical guides is used to preserve articulator positions. Three cups in the lower member filled with plastic material (usually modeling compound) capture the record and guide the tripoded upper member into the recorded positions. This same principle has been used more recently in the Irish duplifunctional and TMJ instruments.

The Wadsworth Articulator (1924) (Fig. 4A)

The Wadsworth articulator was developed by Frank Wadsworth of Los Angeles, California, in 1924 and was manufactured by the SS White Company. Wadsworth believed in Monson's spherical theory, but he could not accept bilateral condylar symmetry. In the Wadsworth articulator, the casts were mounted with a facebow and the Wadsworth T attachment, which determined a third point of reference. A divider was used to measure the distance from the median incisal point to the condyle center on one side. This arc length was described first from the condyle and then from the median incisal point to a flag located on the instrument's upper member. The intersection of these arcs located the rotational center for the measured side. The center then was used to design a spherical plane of occlusion. In this way, an individual rotational center for each side was established; with the Wadsworth articulator the centers rarely coincided. The flag feature has subsequently been marketed by other articulator manufacturers. Wadsworth's instrument had an adjustable intercondylar distance as well. This measurement was determined by using the distance between the facebow condyle pointers minus a 0.75" skin condyle distance on each side. The condylar paths of the instrument are slightly curved.

Gysi Trubyte or Trubyte Simplex (1926) (Fig. 4B)

In 1926, Gysi introduced a non arcon instrument with fixed intercondylar distance. Horizontal condylar inclinations are individually adjustable. This particular instrument can be used as fully adjustable or as mean value articulator. This articulator lends itself readily to various adjustments. It may be used as a simple plain line articulator, an average articulator, or an adjustable instrument adaptable to either extraoral or intraoral records. It has changeable inclined plane for the incisal rod, and a more accurate means of reproducing both the rotation centers in lateral movements and he so called Bennett movement, as well as individually changeable condylar paths.

Phillips Student Articulator (Model C) Or Pantographic Articulator (1926) (Fig. 4C)

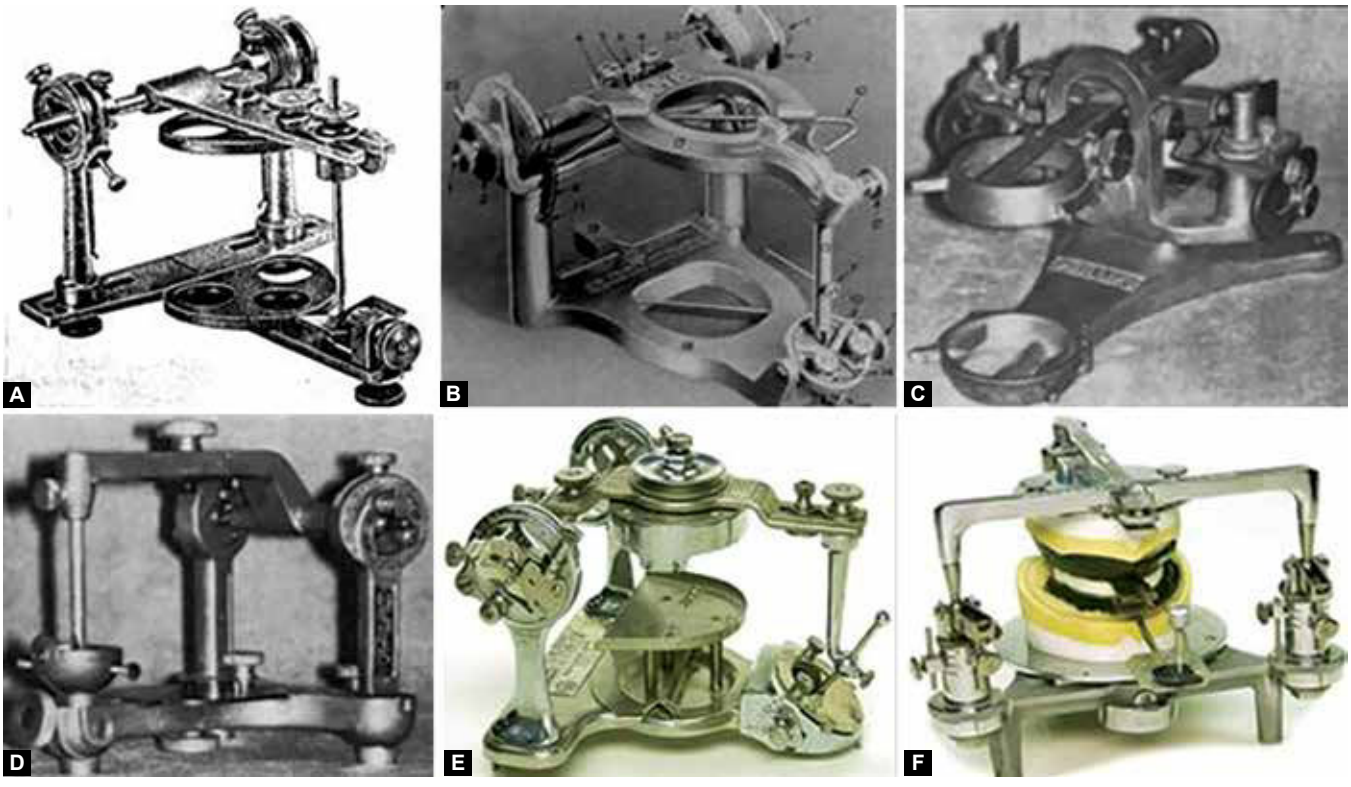
The Phillips Student articulator (Model C), or the Pantographic articulator, was developed by George P Phillips around 1929 and manufactured by the Babson Dow Mfg Co of Boston, Mass Phillips demonstrated a prototype of the Student Articulator in 1926 before the National Society of Denture Prosthetists in Philadelphia. The articulator is classified as fully adaptable in that its developer claimed that it would follow any graphic record. The Phillips graphic recorder was designed to trace in one step the Gothic arch (needlepoint tracing) and the inclinations of the glenoid fossa. The articulator could reproduce mechanically the movements of the graphic recorder through the use of two vertical pins that follow the horizontal inclination of the glenoid fossa on adjustable horizontal planes and two horizontal pins that retraced the needlepoint tracing with the aid of two lateral controlling planes.

Hanau Model H110 Modified (1927) (Fig. 4D)

A modified Hanau Model H110 articulator appeared on the market in 1927 and introduced the incisal guide table. The original incisal guide cup with its fixed curvature could be moved only as a unit, and it did not have calibrations for resetting. The improved table appeared on Hanau articulators manufactured from 1927 to 1972 and allowed for adjustments in three dimensions through a considerable range.

The House Articulator (1927) (Fig. 4E)

The House articulator was developed by MM House in the early 1930s and distributed by the Dentists Supply Company of New York. The Needle House intraoral chew in or other positional records can be used to set the house articulator, developed in the 1920s, hooks that



Figs 4A to F: (A) Wadsworth articulator, (B) Gysi trubyte or trubyte simplex, (C) Phillips student articulator (model C) or pantographic articulator, (D) Hanau model H110 modified, (E) House articulator and (F) Stansberry tripod instrument

can slide along the intercondylar bar are used to vary the intercondylar centers of rotation without moving the lateral posts that support the condylar elements. The lateral condylar guidance is controlled by the Bennett guide, which is a wing attachment lateral to the condylar guide slot. There is a rotary milling device on the upper member that mills retrusively 0.02", with the starting position being on the circumference of a circular milling movement. The incisal guide table can control horizontal and vertical movement. Lateral plates in the guide table create a mechanical Gothic arch. Two interconnected movable pins serve the same mechanical function as a curved incisal pin.

The Stansberry Tripod Instrument (1929) (Fig. 4F)

The Stansberry articulator was developed by CJ Stansberry of Los angeles in 1929. It is a positional articulator that was manufactured by the Cleveland Dental Mfg. Company. Before 1929, articulators could not accept all positional records, therefore the Stansberry Tripod articulator was designed without a hinge to facilitate the reproduction of any positional relationship. In this instrument there is no mechanical equivalent or representation of condyles. The articulator reproduces positions, not movements. Interocclusal positional records of centric, protrusive, right lateral, and left lateral positions are used to set three individual turrets and slots of the tripod, with the slots forming a straight line to centric position. Originally, the mandibular cast was mounted by using a placement jig suspended from the upper member of the tripod; however, a later modification accepts a facebow. If the vertical dimension of occlusion is altered new records must be made and the casts remounted. There is a milling device on the lower member with an eccentric pulley. The anteroposterior or protrusive milling is constant within a 0.04" (or 1 ram) range, whereas the lateral range is variable, ranging from 0 in the condylar region to 0.02" in the molar region and 0.04" (or 1 ram) in the incisal region. This combination of movements can be demonstrated with the arm by moving the elbow back and forth while making a circular movement with the hand.

Terrell's Precision Coordinator (1930) (Fig. 5A)

The Precision Coordinator was developed by WH Terrell, who was at the California Institute of Technology in the early 1930s. It was manufactured by the Precision Dental Manufacturing Company of Pasadena, California. The Precision Coordinator is an arcon type of articulator that has curvilinear condylar guides. Twin parabolic cams control vertical and horizontal anterior guidance. The incisal pin is curved to allow for changes in the vertical dimension. A milling device, built into the articulator, can be varied from 0 to 0.04". It mills circularly in the molar region, elliptically in the premolar region, and laterally in the incisor region. This provides freedom

of movement in centric relation, which is located in the center of the milling region. It was an example of Broken axis articulator. It is fully adjustable.

Hanau Crown and Bridge Articulator (1934) (Fig. 5B)

The Hanau Crown and Bridge articulator was manufactured by the Hanau Engineering Company in Buffalo, New York from 1934 to 1971. (Source: Private correspondence with Hanau Company). The Hanau Crown and Bridge articulator is a small articulator, but unlike with other hinge articulators, a posterior pin and cam guidance mechanism can be set to simulate working and balancing side excursions of 15°. The mechanism can be set to L for restorations in the patient's left quadrant, R for restorations in the patient's right quadrant, or A for anterior restorations or for equalizing right and left excursions. Its fixed protrusive movement is 30°. No facebow is needed.

The Phillips Occlusoscope (1938) (Fig. 5C)

The Phillips Occlusoscope articulator was developed by George P Phillips of Washington, DC, in 1938. It was manufactured by the Dental Engineering Corporation of Waltham, Mass. The maxillary cast on the Phillips occlusoscope articulator is mounted without the use of a facebow. The articulator is adjusted by either intraoral or extraoral records. The lower member of the occlusoscope has two adjustable units that represent the two temporomandibular joints. Within each adjustable unit is a circular disk that can be tilted anteroposteriorly and laterally. This represents the two distinct inclinations found in the concavity of the glenoid fossa; the working inclination is controlled by the laterally tilted position and the balancing inclination is controlled by the anteroposterior tilted position. Each adjustable unit also has two Gothic arch forming blades that reproduce the Gothic arch tracings. The articulator does not have an adjustable incisal guide. The incisal pin rests on a flat plane, because Phillips believed that an incisal guide pin serves only to prevent closure and should not serve as a third temporomandibular joint.

The McCollum Gnathoscope (1939) (Fig. 5D)

McCollum, a devoted student of gnathology, developed a mandibular movement recorder and an articulator in 1939. It is a complex instrument with a choice of condylar path elements. The inventor explains that the instrument will reproduce not only the positions on movement paths but the actual path themselves. It was designed for use with the gnathograph, an extraoral device for tracing mandibular movements.

Stephan Articulator Modified (1940) (Fig. 5E)

The Stephan articulator as modified in 1940 is a simple hinge joint articulator that has a fixed condylar path of 30° (Class II Type). It is similar in design to the 1921 model, except that the upper and lower mounting arms on this model are longer. An adjustable set screw in the posterior region holds the upper and lower members in a fixed vertical position.

Stephan Articulator Model P (1940)

The additional features of the Stephan articulator Model P are an incisal pin and a vertical height adjustment. Another version of this articulator was manufactured to include a fixed 10° incisal guidance.

The Fournet Articulator (1940) (Fig. 5F)

The Fournet or Fournet Dual check, articulator was developed around 1940 and distributed by the Dentists Supply Company of New York. The Fournet articulator is a one dimensional articulator that has no lateral movement. The maxillary cast is positioned horizontally by (1) the two maxillary central incisors, which are oriented by esthetics and which in turn rest on a Spee curve template anteriorly, and (2) the Cook mounting jig, which fits into the depth of the hamular notch and orients the casts posteriorly. Some operators restore only the maxillary teeth on this articulator and subsequently complete the mandibular phase either on a hinge axis instrument or with functionally generated path techniques.

Dentatus

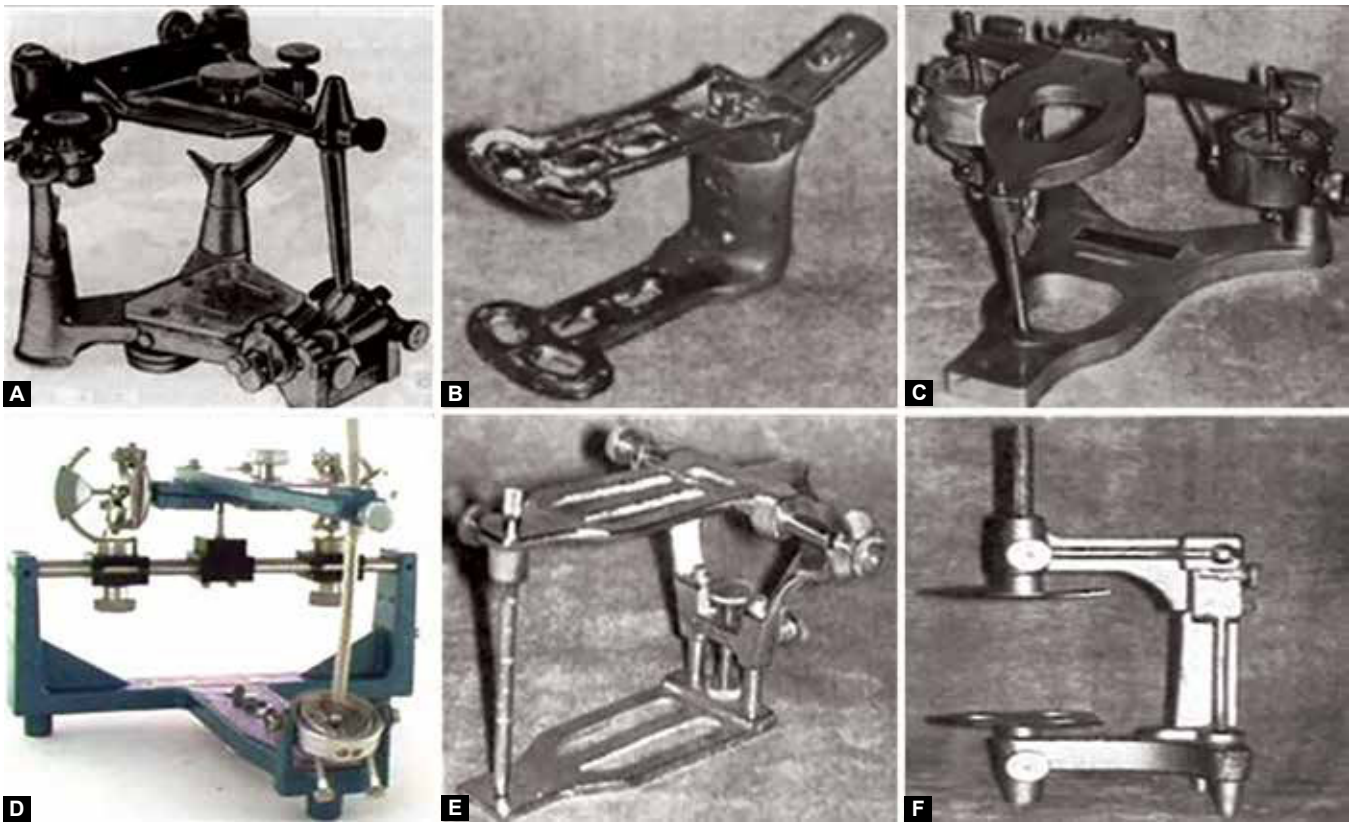
This brand of articulators is manufactured in Sweden. All the models are axis type instruments with a slot in the condylar assembly for the condylar element to make rectilinear movements. The ARH, ARL, ARS, and ARD models have the condylar elements as part of the upper frame and the condylar guidance on the lower frame.

Dentatus the ARH Model (1944) (Fig. 6A)

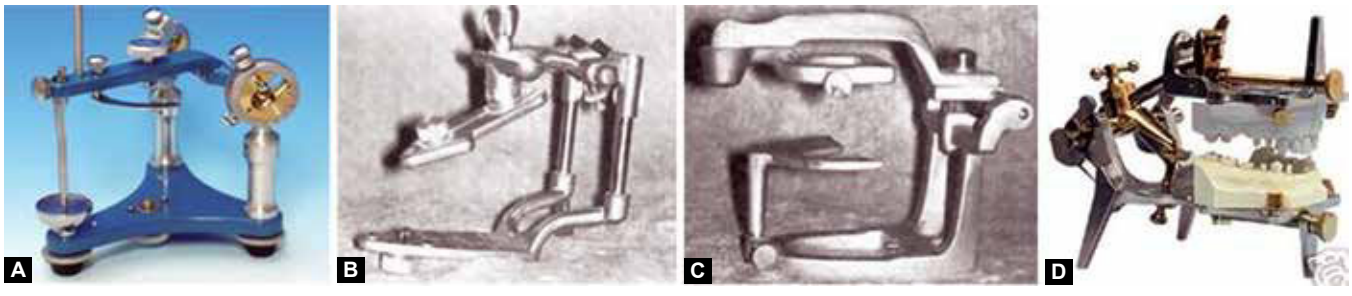
It has all the features of the ARH model plus a gauge block to ensure basic measurements for coordinating work between dentist and laboratory articulators. The ARH is the original Dentatus articulator. It has orbital indicator, adjustable condylar guidance from –60° to +60° and has a sideshift adjustable from 0° to 40°.

Johnson-Oglesby Articulator (1950) (Fig. 6B)

It is a small, nonadjustable, flexible articulator made in Denver, Colo. The Johnson-Oglesby articulator and the Moyer articulator were developed around 1950.



Figs 5A to F: (A) Terrell's precision coordinator, (B) Hanau crown and bridge articulator, (C) Phillips occlusoscope, (D) McCollum gnathoscope, (E) Stephan articulator and (F) Fournet articulator



Figs 6A to D: (A) Dentatus—the ARH model, (B) Johnson-Oglesby articulator, (C) Coble articulator and (D) Galetti articulator

The Johnson-Oglesby instrument has limited use, and the restorations produced with it may require major adjustments intraorally. The Moyer instrument is a mean value articulator. The Moyer articulator, developed around 1950 was manufactured by the JB Moyer Company. The upper member has a ball and socket adjustment.

Coble Articulator (1950) (Fig. 6C)

The Coble articulator maintains centric relation and vertical dimension but does not allow for functional movements. It is a hinge articulator in which the maxillary cast is mounted with a mounting jig that corresponds to the occlusal plane. All maxillary anterior teeth are set to the mounting jig with the exception of the lateral incisors, which are raised 0.25 mm. The mounting jig is attached to a slot that the incisal guide table normally occupies. The mandibular cast is positioned with an interocclusal record. The articulator can be inverted and held by a stand for mandibular cast fixation. At delivery the occlusion is finished with the Coble Balancer.

Bergstrom Articulator (1950)

Bergstrom in 1950 designed an arcon articulator. He was the first to use the term 'Arcon' (Ar-articulator, con-condyle). In this articulator condylar guides are on upper member and condylar elements are on lower member. It can accept facebow record, uses protrusive interocclusal record and has curved condylar guides.

The Galetti Articulator (1950–1960) (Fig. 6D)

The Galetti articulator was first manufactured about 1950 in Italy. It was advertised in this country in the

early 1960's and is distributed by John O Luongo of Brooklyn, New York. For this reason, some call it the Galetti Luongo articulator. In the Galetti articulator, each cast is held mechanically without plaster by two fixed posts anteriorly and one adjustable post posteriorly on each member. The upper member can be adjusted extendable arm and a universal ball and socket joint to achieve the desired relationship of the maxillary cast to the mandibular cast. This feature permits rapid cast mounting. The articulator has a fixed condylar path and a vertical stop that is in the posterior region. It will not accept a facebow.

Part III of this article, to be published in a later issue of the journal and will be devoted to a discussion of articulators introduced from 1951 to 1970.

REFERENCES

1. Jain AR, Jain SA. Textbook on articulators and facebows in dentistry. 1st ed. Saarbrucken, Deutschland/Germany: LAP Lambert Academic Publishing; 2014 (ISBN: 978-3-659-47633-4).
2. Sheldon W. Essentials of complete denture prosthodontics. 2nd ed. USA JEA; 1996. p. 142-182.
3. Boucher's. Prosthetic treatment for edentulous patients. 11th ed; 1997. p. 220.
4. Cm H Jr, Ao R. Syllabus of complete dentures. 4th ed. Philadelphia: Lea and Febiger; 1986. p. 51.
5. Cm H Jr, Ao R. Textbook of complete dentures. 5th ed. Philadelphia: Lea and Febiger; 1993. p. 59.
6. Cabot LB. Using articulators to enhance clinical practice. BDJ 1998;184:272-276.
7. Wilkie ND, Mitchell DL. Articulators through the years: Part—I. J Prosthet dent 1978;39:140-141.
8. Noel DW, Mitchell DL. Articulators through the years: Part—II. J Prosthet Dent 1978;39:168-181.
9. Rihani A. Classification of articulators. J Prosthet Dent 1980; 43:344-347.
10. Thomas CJ. A classification of articulators. J Prosthet Dent 1993;30:11-14.
11. Toolson LB, Smith DE. Clinical measurement and evaluation of vertical dimension. J Prosthet Dent 1982;47:236-241.
12. Weinberg LA. Arcon principle in the condylar mechanism of adjustable articulator. J Prosthet Dent 1963;13:263-268.
13. Weinberg LA. An evaluation of basic articulators and their concepts: part II—arbitrary, positional, semiadjustable articulators. J Prosthet Dent 1963;13:645-663.
14. Weinberg LA. An evaluation of basic articulators and their concepts: part IV—fully adjustable articulators. J Prosthet Dent 1963;13:1038-1054.
15. Weinberg LA. An evaluation of basic articulators and their concepts: part III—fully adjustable articulators. J Prosthet Dent 1963;13:873-888.
16. Weinberg LA. An evaluation of basic articulators and their concepts: part I—basic concepts. J Prosthet Dent 1963;13:622-643.