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

Edgar N. Starcke, DDS[1]

THIS ARTICLE continues an historical review of "Scribing" articulators, beginning with Warnekros' description of the "engraving" method of recording mandibular movement in 1892 and concluding with a discussion of Joseph Homer's third "Relator," introduced in 1927.[1] Scribing articulators are considered to be those with functionally generated guide controls. The custom pathways of Scribing articulators are usually created by following a "functionally generated path" or "chew-in" intraoral record.

After Joseph Homer received a patent for his third (and final) Relator articulator in 1927, the US patent records indicate that through the 1980s, at least 14 more patents relating to Scribing articulators were issued. Many of these are obscure, but deserve mentioning, primarily because of their interesting design concepts. Others, however, are more noteworthy, because they have by some measure contributed to the profession's understanding of mandibular movement.

Scribing Articulators of the 1920s Through the 1950s

It is likely that the only common thread running through the early Scribing articulators was the shared notion that the physiologic movements of the mandible should be imitated in an articulator. This is evident in that they exhibited quite a remarkable variety of functional designs, even into the early 1960s.

[1]*Clinical Professor, Department of Prosthodontics, University of Texas, Houston, TX 77030.*

Correspondence to: Edgar N. Starcke, DDS, University of Texas, Health Science Center—Houston Dental Branch, 6516 M.D. Anderson Blvd., Houston, TX 77030. E-mail: Edgar.N.Starcke@uth.tmc.edu

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The US patent history of Scribing articulators of the 1920s and 1930s is largely represented by those invented by Joseph Homer, Marcel Darcissac, David Highkin, Delbert Bennett, and Charles Reith.

In 1926, Marcel Paul Darcissac of Paris, France, received a patent[2] for an articulator that, not unlike Joseph Homer's second Relator, provided the custom guide control in a box-like housing at the rear section of the upper member. This design is illustrated in Figure 1 of Darcissac's patent (Fig 1). The Darcissac's articulator utilized small conical projections (10), while Homer's second Relator engraved the patterns of mandibular movement with multiple slot guides.[1] Homer's choice for the tracing material was modeling plastic, while Darcissac preferred acrylic resin. Although the Darcissac articulator had a sturdier design, it was likely prone to the same anterior stability (sagging) problems that plagued Homer's first two Relator articulators.

The Highkin Articulators: A Family Affair?

The next Scribing articulator to appear in the patent records is that of David S. Highkin of Baltimore, Maryland, in 1928[3] (Fig 2). The design of the articulator was new and unique in that the entire controlling mechanism (see *patent* Fig 1) was located on the upper member, while the hinge joint was located at the rearmost position on the base of the lower member (12).

David Highkin also included the first patented intraoral stud tracing device in his patent. This device consisted of 2 V-shaped metal "arch plates," the mandibular (38) with 3 tracing pins (39), and the maxillary (31) on which soft metal sheets (24) were attached for scribing the areas representing the functional movements of the mandible.[3]

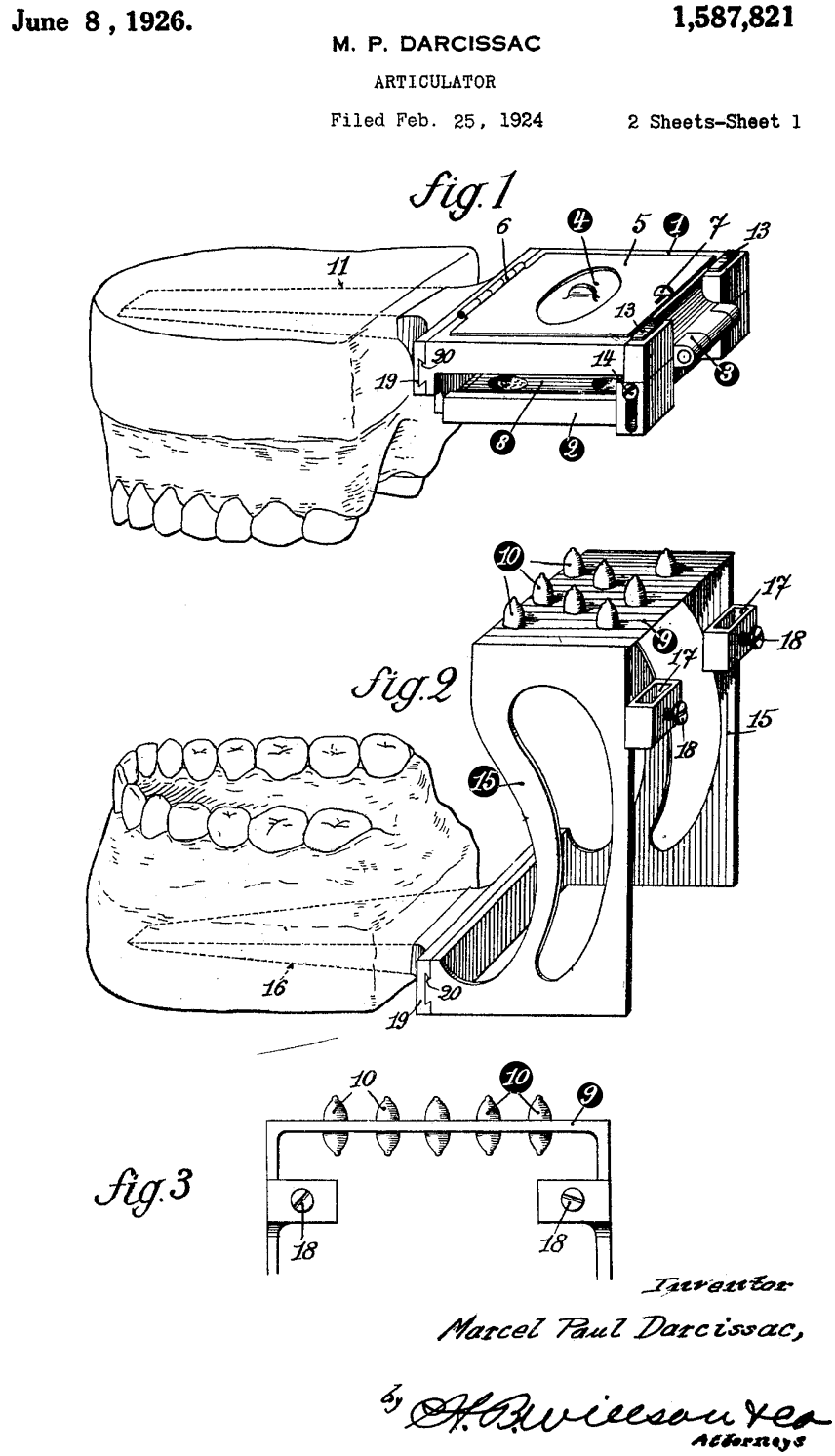

Figure 1. The Darcissac Articulator, 1926. The upper member is comprised of 2 rectangular frames (1 and 2) that are hinged at (3). Within these frames are 2 small metallic trays (4) filled with an auto-polymerizing acrylic resin. Between the frames is a space (8) in which the rectangular plate (9) of the lower member (15) is placed. Conical projections (10) mimicking the pathways of mandibular movement in the acrylic resin are provided on the superior and inferior surfaces of the rectangular plate. (Reprinted from Darcissac MP: 1926 US Patent.)[2]

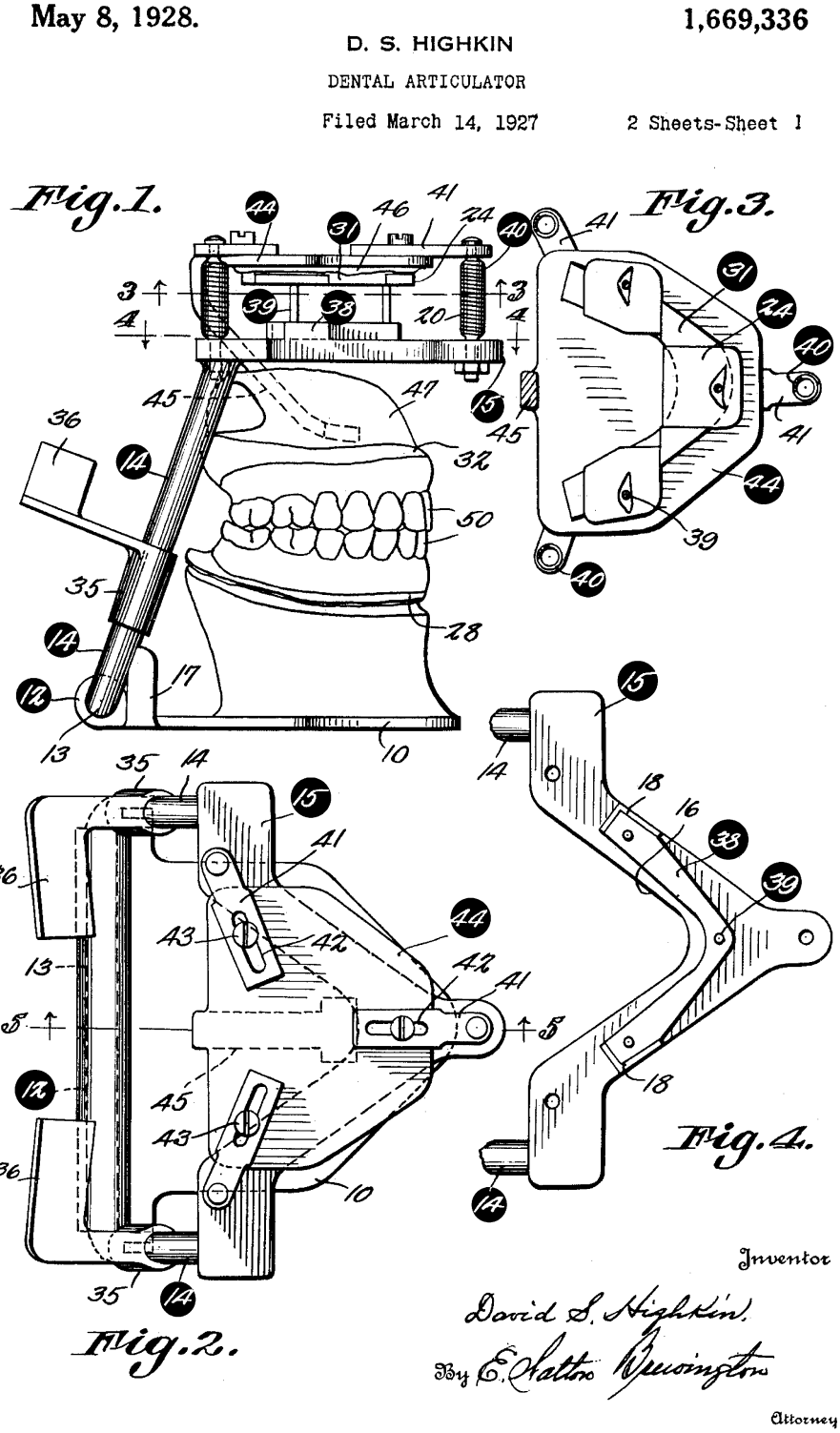

Figure 2. The David S. Highkin Articulator, 1928. Following the "chew-in" procedure, the lower V-shaped plate (38) with pins (39) is attached to carrier plate (15), and the upper V-shaped plate (31), with tracings in soft metal (24), is attached to carrier plate (44). The controlling device for the upper cast is then assembled by attaching the upper and lower carrier plates with cushion springs (40). (Reprinted from Highkin DS: 1928 US Patent.)[3]

After the "functionally generated path" record was obtained from the patient, the casts were mounted in the articulator with a special mounting jig utilizing the V-shaped arch plates of the tracing device. The arch plates were then removed from the mounted casts and attached to support plates (15 and 44). The support plates were connected at their 3 corners by "elastic and flexible" posts (40). This assembly was then attached to the superior end of the hinge rods (14). With the 3 flexible posts allowing the support plate (44) to be movable within the range of the functional tracings, the assembly became the controlling mechanism of the articulator.[3]

On August 22, 1928, A.Y. Russell read a paper before the Section on Full Denture Prosthesis of the American Dental Association in Minneapolis, Minnesota.[4] In this presentation he proposed that recording "the individual habitual movements of the patient" would increase the efficiency and decrease the trauma produced by complete dentures. He proposed that a practical method to accomplish this would be the use of the "metallic, dynamic bite" [intraoral stud tracing device] originated by Dr. David S. Highkin.[4]

Russell also demonstrated Highkin's "new model" articulator (Figs 3A and B). Based on the same principles as the patented model (see Fig 2), it had been redesigned with the entire controlling mechanism now located on the lower member. The functional record generated with the tracing device was used to set the articulator controls that consisted of 3 tracing pins and recording cups.

About 30 years later, in 1956, Joseph Highkin received a patent[5] for an articulator and method for making dentures that had a remarkable resemblance to David Highkin's tracing device and "new model" articulator introduced by Russell.[4] In his patent letter, Joseph Highkin cited David Highkin's 1928 US patent and essentially gave him the credit for having originated the design of the intraoral stud tracing device (Fig 4) that served as the guide to establishing the functional form of the controlling elements of the articulator (Figs 5A and B). Joseph Highkin's articulator consisted of 3 major parts: the upper hinged member (75), the movable lower frame (80), and the stationary base (71). There were 5 functional controls of the articulator associated with the movable frame and the stationary base: 2 in the position of the condyles (100 and 101) and 3 below the

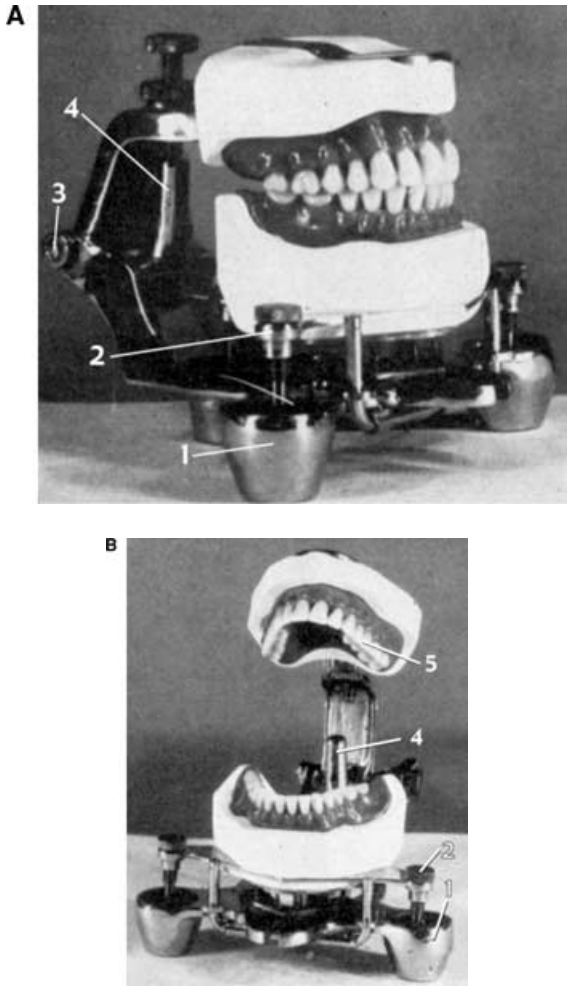

Figure 3. (*A*) The "new model" Highkin Articulator, 1928, lateral view with mounted casts and the denture teeth set in centric occlusion. There are 3 recording cups (1) and corresponding tracing pins (2) on the lower member. (3) *hinge;* (4) *vertical stop.*[4] (*B*) The new model David Highkin articulator, 1928, front view with instrument in open position. Russell suggested using the Sears "Channel Tooth" (5) for constructing dentures by this method. (1) *recording cup*; (2) *tracing pin*; (4) *vertical stop.* (Reprinted from Russell AY: 1929, p. 644.)[4]

position of the mounted mandibular cast (102). The stationary base carried the receptacles (89, 90, and 82) in which wax was placed for scribing the functional pathways. The wax records were converted to metal to create the 5 "cam control discs." The corresponding "pivot pins" or "cam followers" (95, 96, 97, 98, and obscured 99) are located on the movable frame (80). In order to hold the stationary base and the movable frame within

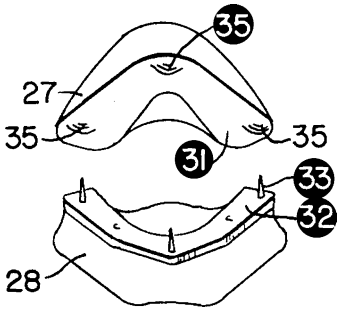

Figure 4. Joseph Highkin's intraoral tracing device, 1956. The lower V-shaped tracing plate (32) was much like that of David Highkin's patented model with 1 anterior and 2 posterior tracing pins (33).[3] However, Joseph Highkin used a V-shaped plate (31) constructed of all soft metal for the upper tracing plate. Lines (35) represent the functional tracings in the soft metal. (Reprinted from Highkin J: 1956 US Patent.)[5]

"a predetermined limited range of movement, and to give appropriate relief or relative separating movement between the two [dentures] during the grind-in operation, the [mandibular frame] (80) is pivotally floated on the base (71) by two helical springs (104 and 105), one on each side of the frame" and "by the compressible spring (88) at the bottom of the front spacing pin (77)."[5]

The use of springs in this manner was also an idea that first appeared in David Highkin's 1928 patent. [3]

The Bennett and the Reith Articulators: Two for the Show

In the 1930s, 2 patents were issued for Scribing articulators, the first to Delbert Bennett of Detroit, Michigan, in 1931,[6] and the second to Charles A. Reith of Pittsburgh, Pennsylvania, in 1936.[7] It is doubtful that either one was manufactured for sale.

Delbert Bennett took a rather novel approach to providing functionally generated controls in an articulator. He believed that to record normal positions of the jaws and to secure accurate results, there should be only a single pair of "mounting members" carrying a modeling "compound" for scribing functional condylar pathways. This was to ensure that the operator had control of the temperature and therefore, the consistency of the aggregate of compound material (Fig 6).

The controlling mechanism was located on the posterior extensions of the maxillary and mandibular cast holders of the articulator. Secured on a pedestal (8) on the mandibular cast holder was what Bennett called the "projecting mounting member," or "head" (9). This device was made of porcelain, and from its center (13) it had extending pairs of radial arms with hemispherical ends (14).[i] Correspondingly, the metal "cupped mounting member," (5) the center of which (10) had "extending pairs of radial channeled [dome shaped] arms," (11) was secured on the maxillary cast holder. The "head" was sufficiently smaller than the "cupped mounting member" to provide for engaging the "head" within the modeling plastic material. As was true with the previous Scribing articulators up to this time (with the exception of Homer's third Relator), Delbert Bennett's articulator lacked any type of anterior support or guidance.

At this point, perhaps a relevant question may be: If the porcelain "head" is considered the "condyle," and the "cupped mounting member" carrying the tracing material is considered the "glenoid fossa," is this Bennett instrument the first *arcon* Scribing articulator? Yes, but of course, that may be a stretch.

In 1936, Charles A. Reith of Pittsburgh, Pennsylvania, received a patent[7] for the first Scribing articulator that embodied the basic design and many of the established features associated with contemporary "adjustable" articulators. One of these features was an incisal pin and guide, although it was not referred to as such (Fig 7).

Reith's method of recording the functional movements of the mandible was to use wax occlusion rims with an abrasive material on each occlusal surface. The patient was instructed to "press the plates together during various movements... and thereby produce contours on the mutually engaging surfaces... that are the result of the various excursions of the jaw in many curved paths extending in various directions."[7] Reith did not discuss how he controlled the vertical dimension or how he secured the casts in centric relation when employing this type of functional record.

The posterior functional controls of the articulator (Fig 7) were located in the area of the condyles where scribing pins (19), on the upper member (2), record the functional pathways (26) in recording "pockets" (14), on the lower member (1). Likewise, forward scribing pin (22)

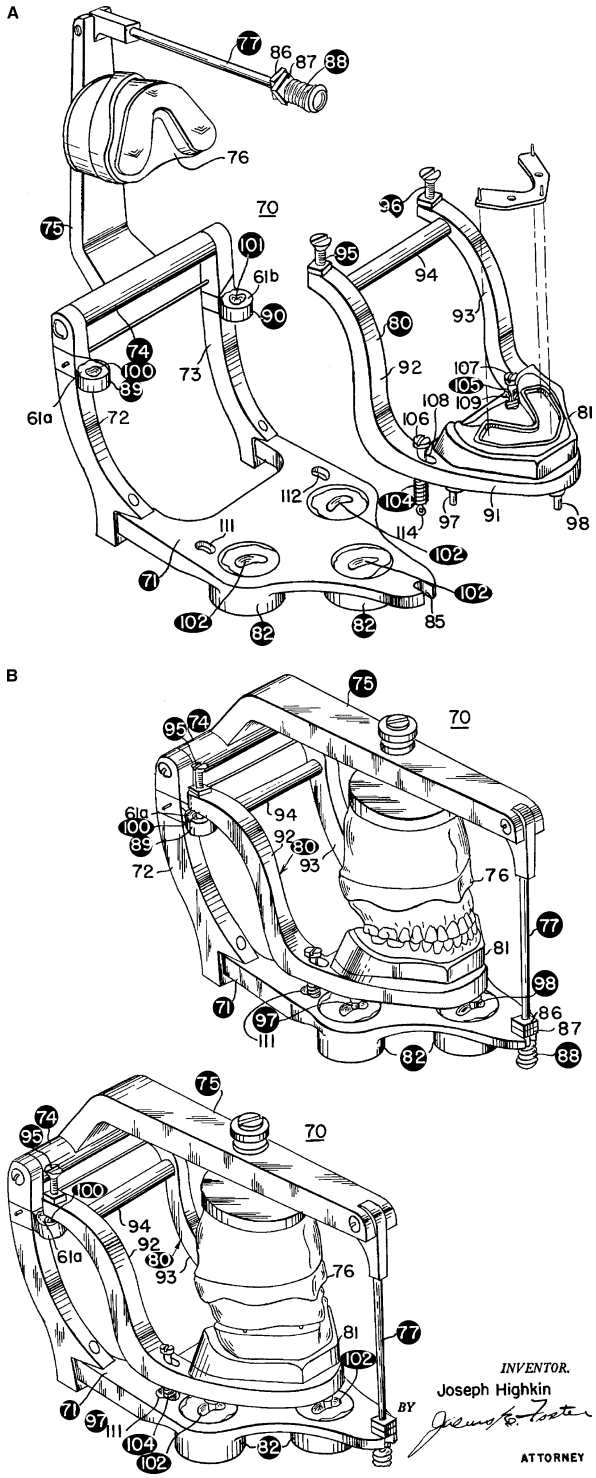

Figure 5. (*A*) Joseph Highkin Articulator. A disassembled view of the three major parts, the upper member (75) hinged at (74) to the stationary base (71) and the lower movable frame (80). Two (100 and 101) of the 5 controls, representing the mandibular functional pathways, are in the position of the condyles, and 3 (102) on the stationary base below the position of the mandibular cast.[5] (*B*) Joseph Highkin Articulator. These 2 patent figures demonstrate the assembled articulator having maxillary and mandibular casts mounted with the stud tracing device (below) and with complete dentures (above) in position. (Reprinted from Highkin J: 1956 US Patent.)[5]

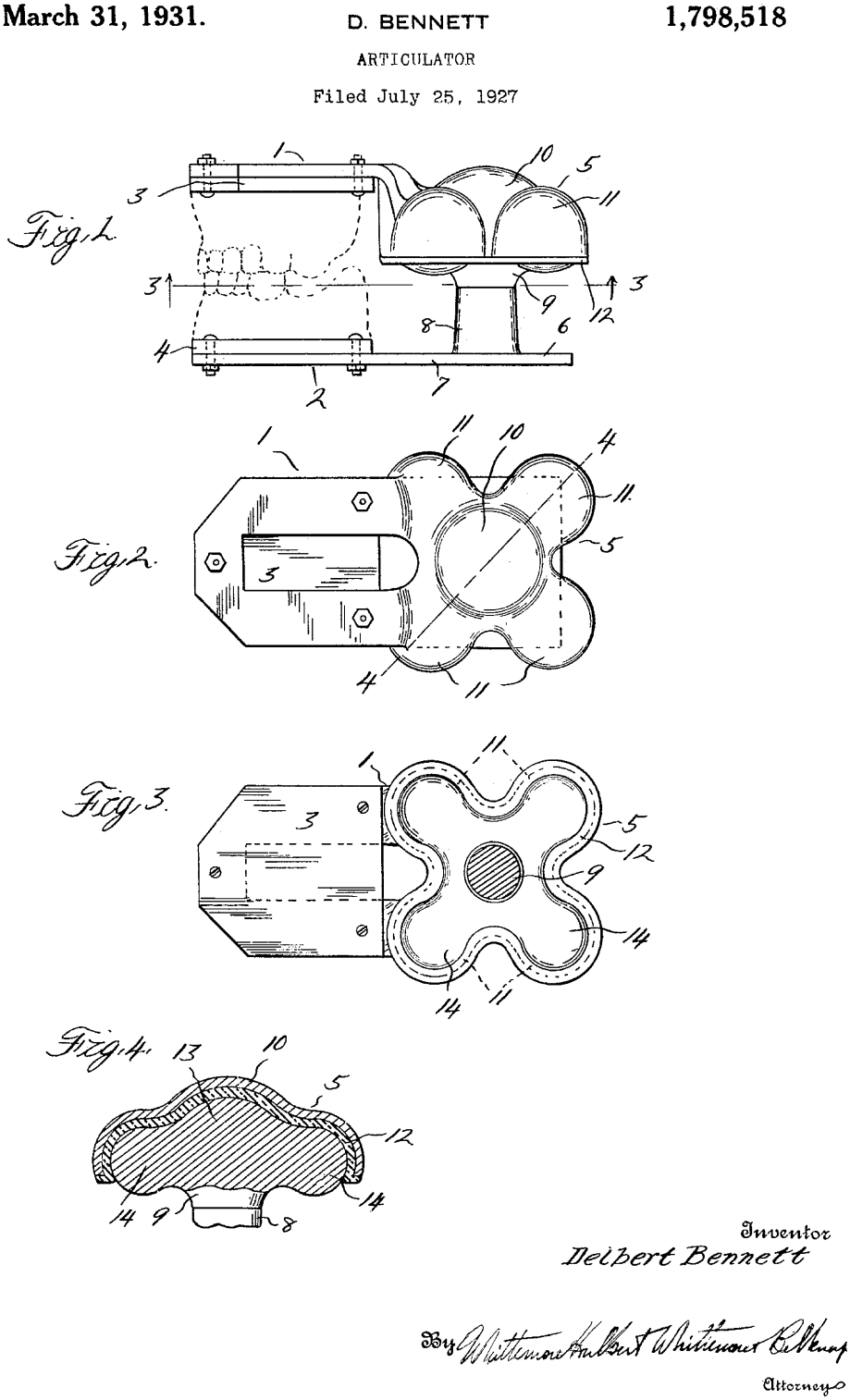

Figure 6. The Delbert Bennett Articulator, 1931. The articulator controls consist of the porcelain "projecting mounting member" or "head" (9) with 4 radial arms (14) extending from the center (13). The "head," articulated with the functionally displaced compound modeling plastic (12), attached to the inner surface of the metal "cupped mounting member," (10) which had 4 corresponding radial channeled arms (11). (Reprinted from Bennett D: 1931 US Patent.)[5]

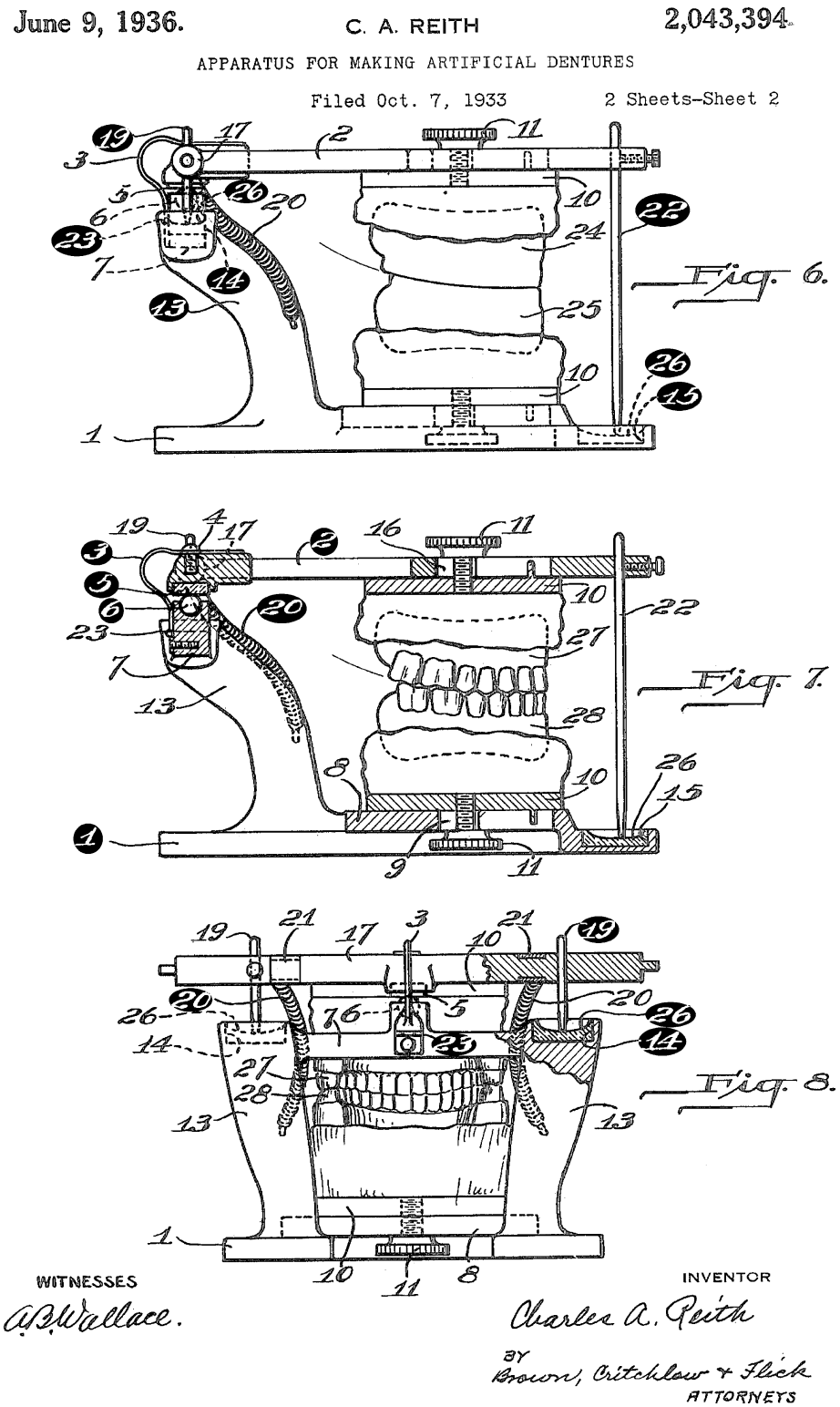

Figure 7. The Reith Articulator, 1936. The condylar posts (13) were contoured to mimic the shape of the mandible. The posterior functional controls were in the area of the condyles. Scribing pins (19) recorded the functional pathways in recording pockets (14). The anterior control, scribing pin (22), recorded the functional pathways in recording pocket (15). The recording material was silver amalgam (26). (Reprinted from Reith CA: 1936 US Patent.)[7]

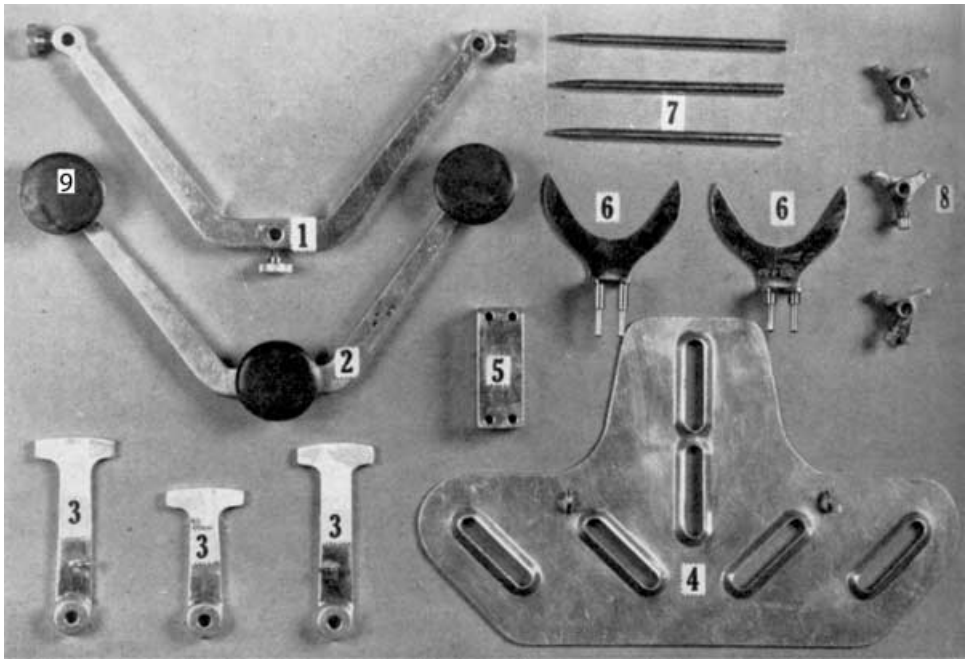

Figure 8. The disassembled Kile "Dentograph." (1) *upper tracing arch*; (2) *lower tracing arch*; (3) *upper plaster arms*; (4) *lower perforated plate*; (5) *assembly jig*; (6) *bite forks*; (7) *tracing pins*; (8) *centric tripods*; and (9) *wax pans.* (Reprinted from *Journal of Prosthetic Dentistry*, Vol. 5, Kile CS, The Kile Dentograph, p. 170, Copyright (1955), with permission from the Editorial Council of the *Journal of Prosthetic Dentistry*.)[9]

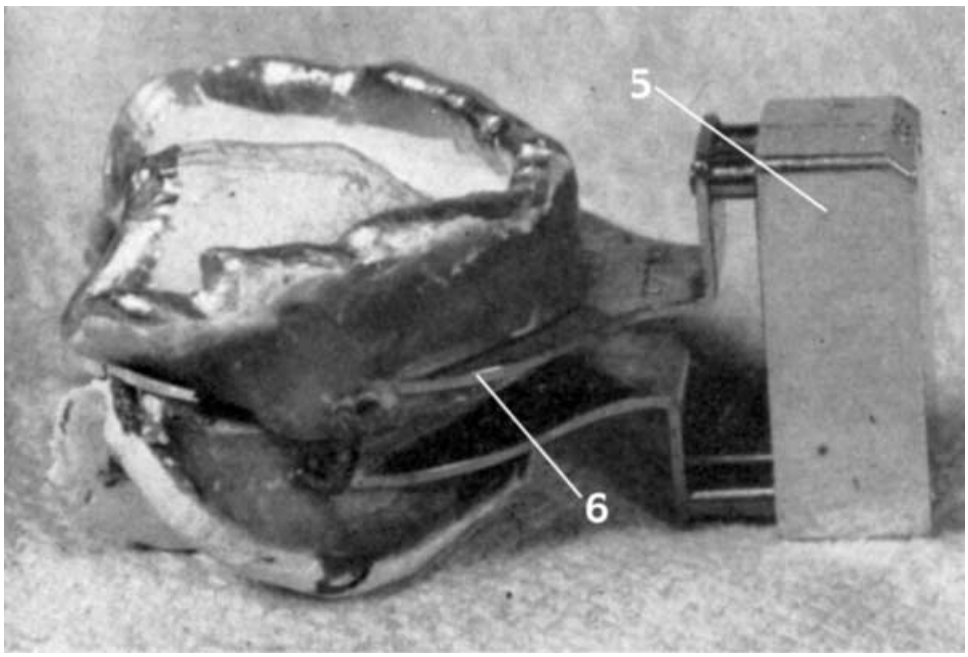

Figure 9. The Kile assembly jig (5) and bite forks (6). These devices, along with the impression bases and functionally formed rims, created the clutch for the tracing arches. (Reprinted from *Journal of Prosthetic Dentistry*, Vol. 5, Kile CS, The Kile Dentograph, p. 171, Copyright (1955), with permission from the Editorial Council of the *Journal of Prosthetic Dentistry*.)[9]

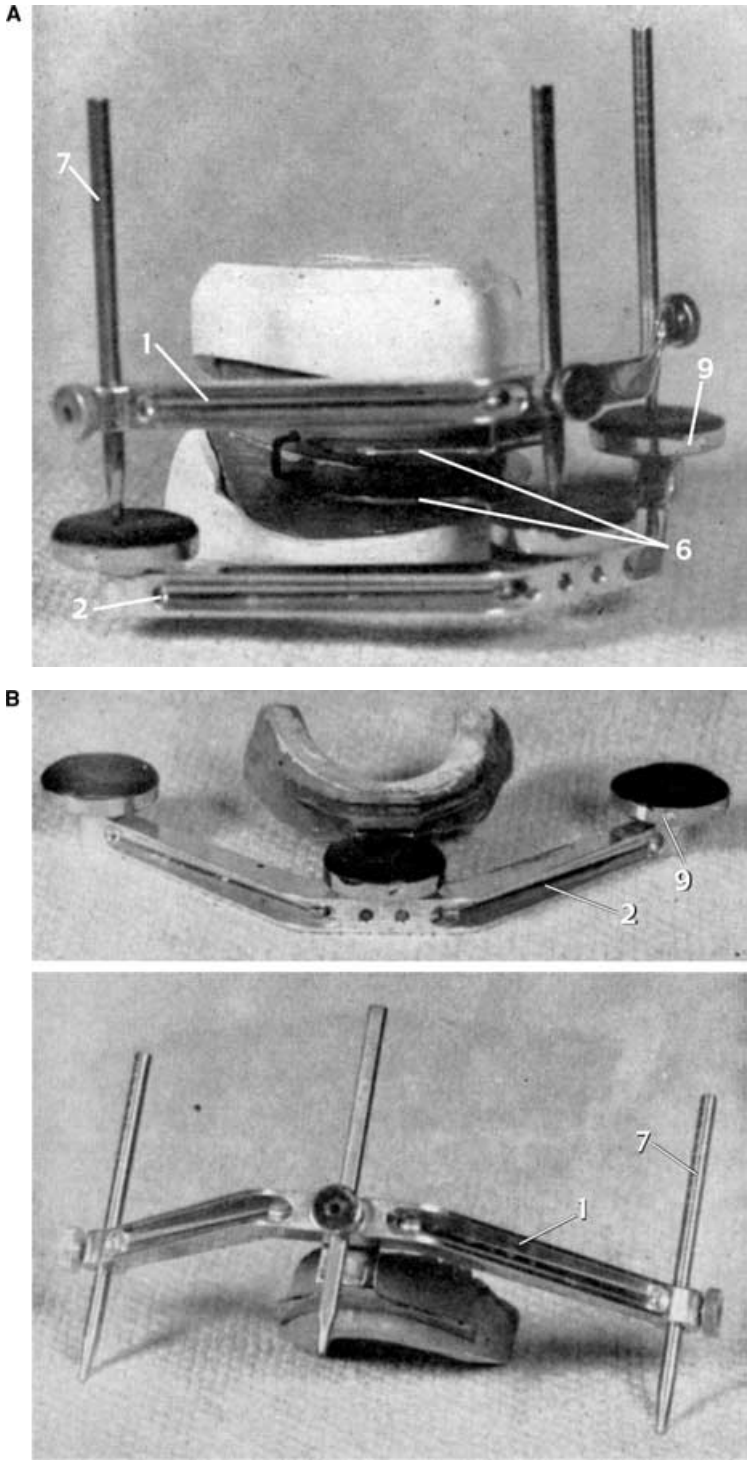

Figure 10. (*A*) The Kile tracing arches. The upper (1) and lower (2) tracing arches were attached to the bite forks/clutch (6) and the tracing pins (7) were adjusted to touch the center of the wax in the wax pans (9). (Reprinted from *Journal of Prosthetic Dentistry*, Vol. 5, Kile CS, The Kile Dentograph, p. 171, Copyright (1955), with permission from the Editorial Council of the *Journal of Prosthetic Dentistry*.)[9] (*B*) The upper and lower tracing arches ready to be inserted in the mouth for tracing the mandibular movements in the wax pans. (1) *Upper tracing arch*; (2) *lower tracing arch*; (7) *tracing pin*; and (9) *wax pan.* (Reprinted from *Journal of Prosthetic Dentistry*, Vol. 5, Kile CS, The Kile Dentograph, p. 172, Copyright (1955), with permission from the Editorial Council of the *Journal of Prosthetic Dentistry*.)[9]

recorded the functional surface (26) in recording "pocket" (15). A suitable plastic material (indicated by 26) that "is capable of hardening to form a substantially hard, rigid mass" was placed in the recording "pockets." Reith chose silver amalgam for that purpose. Accordingly, the lower ends of pins (19 and 22) were shaped in the form of a blunt chisel to "shape the material in the pocket."

Other features of the Reith articulator included a centrally located posterior band spring (3) along with 2 lateral coil springs (20) to maintain the connection between the upper and lower members while allowing both hinge (at 23) and lateral movements. To maintain spacing between the members and to provide a "pivotal rest" for the upper member, a bearing ball (6) was attached to the lower member above the hinge (23) to rest on a rubber cushion (5). Also appearing for the first time in a Scribing articulator was the provision for a facebow; however, Reith did not discuss its use.

The Kile "Dentograph"

In 1948, Clifford S. Kile, of Hutchinson, Kansas, patented the Dentograph,[8] the first Scribing instrument that was an extraoral tracing device convertible to an articulator. The Dentograph, Kile said, "is, in reality, two instruments in one. It first records the lateral and protrusive jaw movements in three-dimensional form in a special tracing wax. Then these tracings are reproduced in stone, and the instrument is transformed into a tripod articulator. By employing these stone three-dimensional tracings as guides, the lateral and protrusive *jaw movements are reproduced accurately in a similar manner to that employed in reproducing sound on a phonograph*."

Kile made these comments, including this interesting analogy, in a paper read before the New Orleans Dental Conference on November 13, 1951.[9] (Undoubtedly, Kile's office must have been alive with the sound of music.)

Kile utilized the procedure suggested by Paterson[10] for establishing the functional mandibular movements and curves of occlusion. This method is similar to that reported by Reith,[7] except that the occlusion rims were channeled and then slightly overfilled with the abrasive mixture. Unlike Reith, Kile emphasized the importance of preserving the vertical dimension, and he suggested using staples for securing the occlusion rims in centric position.

Kile described his techniques for assembling the tracing arches, recording the functional mandibular movements, and building the instrument in his 1955 article.[9] The disassembled Dentograph is shown in Figure 8. The individual parts are numbered, and for the convenience of the reader, these numbers are used for the subsequent figures.

Kile designed an assembly jig (5) and special bite forks with handles offset at right angles (6) to attach the mounted "chewed-in" rims to the tracing arch assembly (Fig 9).[ii] The assembly jig was to assure correct alignment of, and adequate distance between, the upper and lower tracing arches (Fig 10A). With the occlusion rims placed on the master casts, the upper (1) and lower (2) tracing arches were attached to the bite forks. The tracing pins (7) were lowered to touch the center of the wax in the wax pans (9). Figure 10B shows the upper and lower tracing arches with the attached occlusion rims more clearly. The lower tracing arch (2) carried 3 wax pans (9), and the

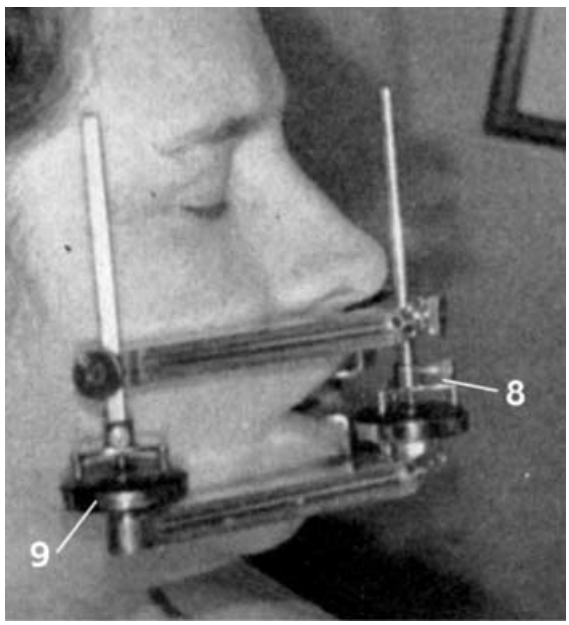

Figure 11. The Kile tracing arches on the patient. After the functional tracings had been made in the wax, the centric tripods (8) were lowered into contact with the wax in the wax pans (9). They were gently pressed into the wax and locked in position. (Reprinted from *Journal of Prosthetic Dentistry*, Vol. 5, Kile CS, The Kile Dentograph, p. 173, Copyright (1955), with permission from the Editorial Council of the *Journal of Prosthetic Dentistry*.)[9]

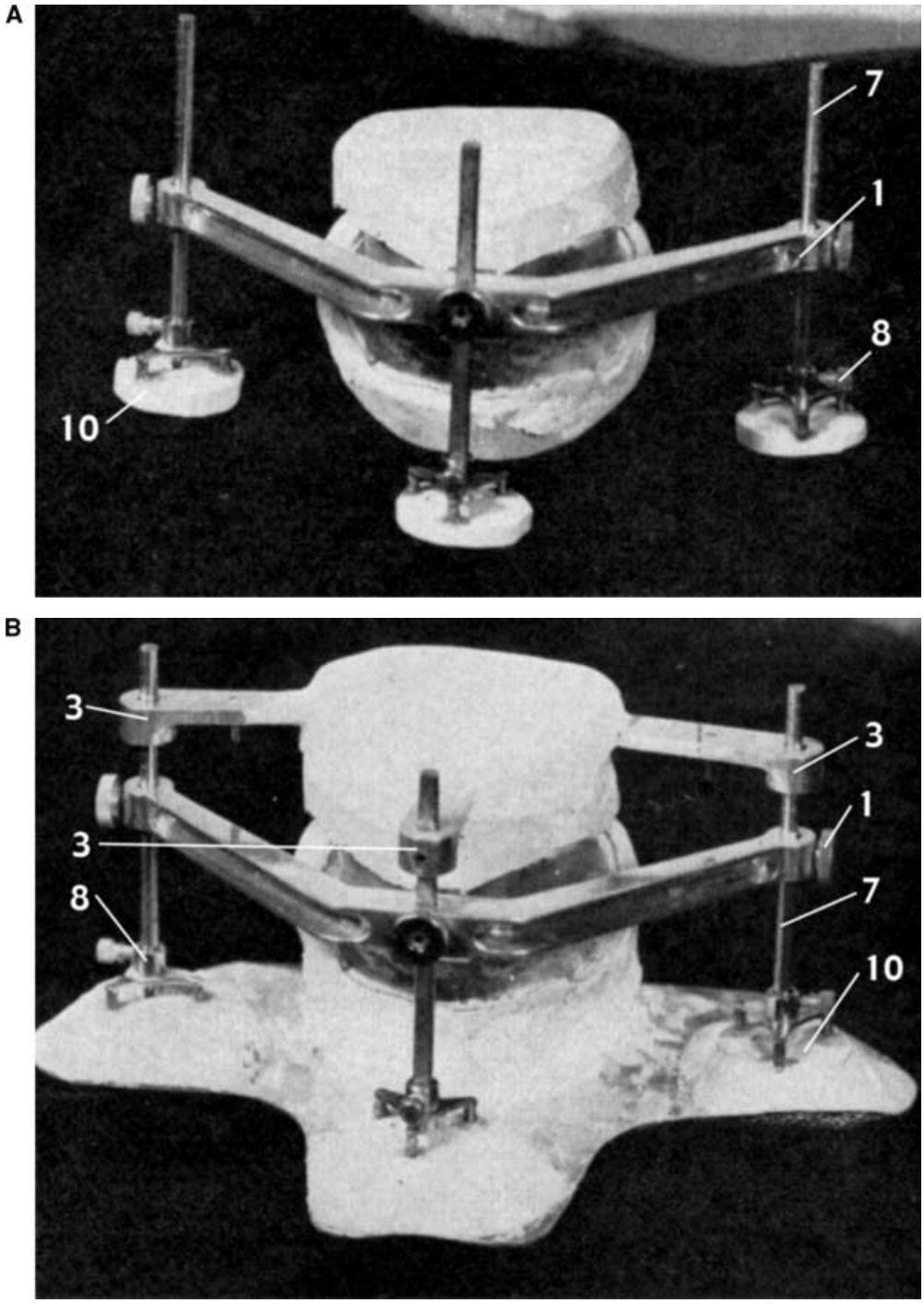

Figure 12. (*A*) The lower tracing arch removed and the stone tracing blocks in position. The wax tracings have been reproduced in stone and attached to the centric tripods (8) on the tracing pins (7). The tracing pins were lowered until the stone tracing blocks were resting on a flat surface in preparation for mounting.[9] (*B*) The mounted maxillary and mandibular casts. The mandibular cast and stone tracing blocks are mounted in plaster on the lower perforated plate (see Fig 7, No. 4). The maxillary cast is mounted with the upper plaster arms (3) attached to the tracing pins (7). (Reprinted from *Journal of Prosthetic Dentistry*, Vol. 5, Kile CS, The Kile Dentograph, p. 176, Copyright (1955), with permission from the Editorial Council of the *Journal of Prosthetic Dentistry*.)[9]

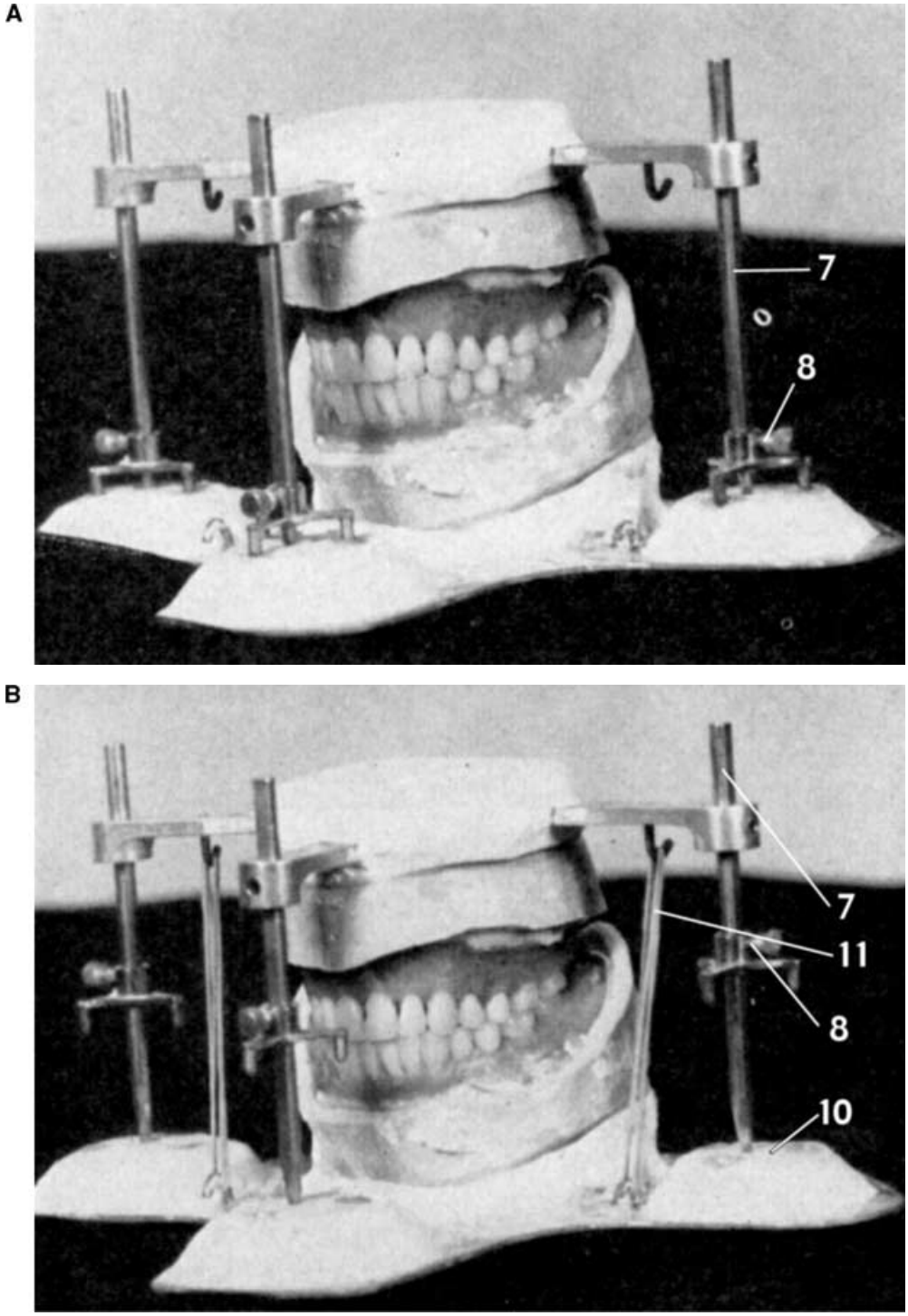

Figure 13. (*A*) The Kile "Dentograph." The upper tracing arch is removed and the maxillary and mandibular member of the Dentograph can be freely separated. The teeth were set in centric relation with the centric tripods (8) being returned to engage the stone tracing blocks during the procedure.[9] (B) The Kile Dentograph. With the centric tripods (8) lifted on the tracing pins (7), the teeth were made to conform to the functional stone tracings. The rubber bands (11) assisted in holding the tracing pins in the stone tracings while the "occlusion is perfected by milling with [an abrasive paste.]" (Reprinted from *Journal of Prosthetic Dentistry*, Vol. 5, Kile CS, The Kile Dentograph, p. 177, Copyright (1955), with permission from the Editorial Council of the *Journal of Prosthetic Dentistry*.)[9]

upper tracing arch (1) had 3 corresponding tracing pins (7).

After the functional tracings were completed in the wax, located in wax pans (19), centric tripods (8) were placed on the tracing pins. With the patient guided into centric relation, the tripods were lowered and gently pressed into the tracing wax until each leg of the tripod made a shallow indentation in the wax (Fig 11). The wax tracings were then reproduced in a hard stone, producing stone tracing blocks. The occlusion rims were again stapled together with the patient in centric relation.

The next step was the construction of the articulator. The tracing arch was removed from the mandibular rim and the impression trays were returned to the master casts. The stone tracing blocks (10) were then attached to their respective centric tripods (8) with sticky wax (Fig 12A).

The mandibular cast and the centric tripods were mounted with plaster on the lower perforated plate (see Fig 7, No. 4) and the maxillary cast was attached to the tracing pins (7) with the upper plaster arms (3) (Fig 12B).

The upper tracing arch (2) was removed, and with the centric tripods in position in the stone tracing blocks, the denture teeth were set in centric occlusion (Fig 13A). The centric tripods (8) were then lifted up and locked on the tracing pins (7), and the teeth were balanced by following the tracings in the stone blocks. Small hooks on the right and left plaster arms and on the lower perforated base were provided to attach rubber bands (11) to assist in holding the tracing pins in the stone tracings while "milling in" the occlusion (Fig 13B).[9]

"This entire procedure is unorthodox and may seem weird and complicated," Kile said, "but, in practice, it is quite simple and will result in balance, comfort and efficiency of dentures."[9] Weird and complicated or not, the Kile Dentograph is considered an important innovation and, indeed, was commercially available, albeit short-lived. (Of course, it probably would never have worked without the rubber bands).

There will be more on Scribing articulators in a future issue of the *Journal of Prosthodontics*.

(i) Mrs. Bennett may still be looking for that faucet handle missing from the bathroom sink. (There are no coincidences.)

(ii) After the original impressions were removed from the casts, Kile used them as record bases for recording the mandibular movements. In fact, Kile said, "the original impression bases were carried through to the flasking stage in the construction of the dentures."[9]

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