The History of Articulators: The Wonderful World of "Grinders." Part I

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"GRINDERS." They have been called "occlusal grinders," "rotary occlusal grinders,"[1,2] "reciprocal dental grinders,"[3] "denture grinders,"[4-7] "anatomical articulating grinders,"[8] and "dental triturating appliances." [9] James E. House simply referred to them as "milling machines." He grouped them into five categories* based on their cutting action and location;[10] however, he made no distinction as to whether a "milling machine" was an integral part of an articulator, was a device attached to the articulator to produce "milling" capabilities, or was a machine contrived just for the purpose of "milling" the teeth of completed dentures. As will be seen, all these types of devices or features have been produced. The one thing in common with all "milling machines" and "grinding" devices is that some kind of abrasive material was used to produce the wear patterns of the occlusal surfaces.

The Origins of the Concept of "Milling" or "Grinding" of Denture Teeth

It is generally known that the mechanical articulator originated as a simple hinge. The first improvements to the simple hinge came in the form of vertical and horizontal adjustment features. The seemingly endless variety of such features to emerge was undoubtedly inspired by the persistent need to correct in the articulator occlusal problems created by clinical errors. It is logical to assume that as articulators with advanced features such as movable condylar controls became commonplace, the idea of using an articulator to "grind-in" denture teeth to "correct" or "improve" the occlusion would follow. It will also become clear that some of the later contrivances that were suggested or produced actually created more confusion about denture occlusion and articulation rather than solving the problems.

It would seem plausible that one of the early instruments that may have been used for "grinding" purposes was the Bonwill articulator. Although Bonwill claimed to have invented his articulator in 1858, it was not until the late 1880s that it really became available to the profession. It was to become one of the most popular articulators of its time and was produced well into the 20th century.[11]

"Articulator Grinders:" Action by "Hand Power"

Needless to say, the first articulators with features to permit "grinding" capabilities, including those similar to Bonwill's instrument, were operated, not by horsepower, but by "handpower" with the grinding action being generally oscillatory. James House described it as a "seesaw" motion. Naturally, as resourceful inventors began to ponder many aspects of denture occlusion, other modes for "grinding" the denture teeth were soon to be explored.

One of the earliest of the articulators with features to create the so-called "seesaw" motion was patented by T.G. Lewis of Buffalo, NY, in 1900.[12] By using right and left thumb plates, oscillating as well as protrusive movements on the horizontal plane could be achieved. A posterior "return" or tension spring was provided in a casing attached

*House's five basic types of milling machines are: (1) those that produce a seesaw motion; (2) those that produce a vertical bumping action; (3) those that produce a motion of the incisal pin; (4) those that produce a rotary motion of the maxillary dental arch; and (5) those that produce a rotary motion of the mandibular dental arch.[10]

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Figure 1. The Antes-Lewis Articulator (1904) (Side and top views). Reciprocal thrusts of the thumb plates produce an oscillating movement of the upper cast member of the articulator. Simultaneous thrusts produce a protrusive movement. These actions are resisted by the posterior cased return spring that is perpendicular to the condylar crossbar. (From the collection of Donald M. Belles, DDS.)

perpendicular to the yoke. Elements of Lewis' articulator were combined with that of R.H. Antes of Geneseo, IL, (1895),[13] to create the Antes-Lewis articulator (Fig 1). It was manufactured by the Buffalo Dental Mfg. Co. in about 1904.[11]

Twenty years later, Albert Stanley, of Indianapolis, IN, received a patent for his "Anatomical Articulator and Grinder" (Fig 2). It was essentially a simple hinge instrument with the thumb plate feature for producing a horizontal oscillating grinding motion. Stanley, however, added opposing posterior finger plates so that the grinding movements could be better controlled with the use of the thumb and the forefinger. The condylar axle for this articulator was a heavy band spring.[14]

The ""Rite Bite" Articulator (Fig 3), produced in about 1938, had only thumb plates like the Antes-Lewis, but it likely had some type of band spring like the Stanley. It featured 30° fixed condylar guides.[15]

The "Grind-O-Matic" Articulator, with its "universal spring action" condylar posts, undoubtedly speaks for itself. The grinding action was determined by the imagination and dexterity of the operator. It was manufactured by the Coralite Dental Products Company in the late 1930s (Fig 4).[16]

Figure 2. The Stanley "Anatomical Articulator and Grinder," 1924 (Top and back views). The Stanley had both thumb plates and opposing plates for the forefingers, which likely provided better control. A heavy band spring condylar axle was the resistance.

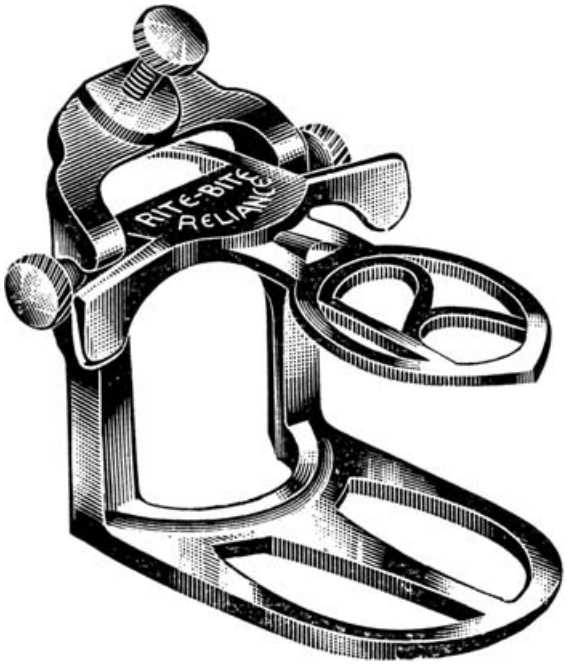

Figure 3. The "Rite Bite" Articulator, 1938, manufactured by the Reliance Dental Manufacturing Company, Chicago, IL. This instrument had 30° fixed condylar controls. (Reprinted by permission.)[15]

Lucien Coble, of Greensboro, NC, received a patent for the "Swallowing Coordinator" in 1960 (Fig 5).[17] The grinding action of this articulator was only a short horizontal anterior-posterior path from the centric position. As Coble explained it, "*In swallowing, the lower jaw moves in relation to the upper jaw approximately one-half millimeter from centric position to an anterior position and one-half millimeter from centric position to a posterior position. This slight movement of the lower jaw… causes discomfort unless the occluded finished dentures move freely [in this manner].*"[17] The "Swallowing Coordinator" was essentially a simple hinge articulator with the lower mounting member designed to allow a 1-mm anterior-posterior movement by which the finished dentures could be adjusted to freely permit the so-called "swallowing movements" of the mandible.[17]

Some inventors (no doubt influenced by Henry Ford's "Tin Lizzie") preferred a hand crank for activating the grinding mechanism of their instruments. Prior to 1920, Homer Mannon, Herman M. Brown, and Robert G. Perkins of Huntington, WV, received patents for two such "grinding" machines. The designs for these devices were incredibly complicated. Undoubtedly, they would have been expensive to manufacture, and the chances of their success would have been small. And, as will be seen, Mannon was certainly not the only inventor of grinders with a proclivity for the mechanical overstatement.

The first of these two devices, patented in 1917,[8] was called the "Anatomical Articulating Grinder" (Fig 6a, b). This machine was intended to ""grind in" the occlusion of existing dentures and was constructed so that the "movement of the lower jaw would be simulated closely." It was described as a stabilized "upper denture carrier and a lower denture carrier for longitudinal and transverse movements." The maxillary denture was carried by an octagonal ring device (64), supported by band springs (57) to the hinge (45). It was secured in place by rod (53) and screws (50, 52, and 60). The lower denture was carried by table (5) that was supported by rotationally adjustable

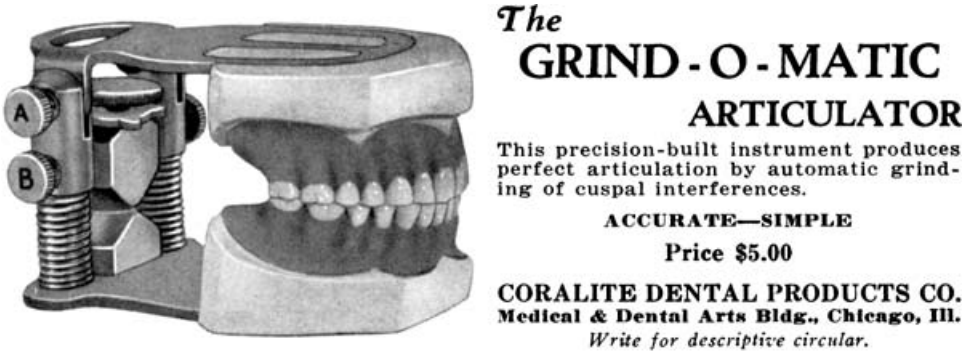

Figure 4. The "Grind-O-Matic" Articulator, 1938, manufactured by the Coralite Dental Products Company, Chicago, IL. The spring-supported condylar posts provided no guidance for specific movements. Perhaps that is no worse than in an articulator where "one guide path fits all."[16]

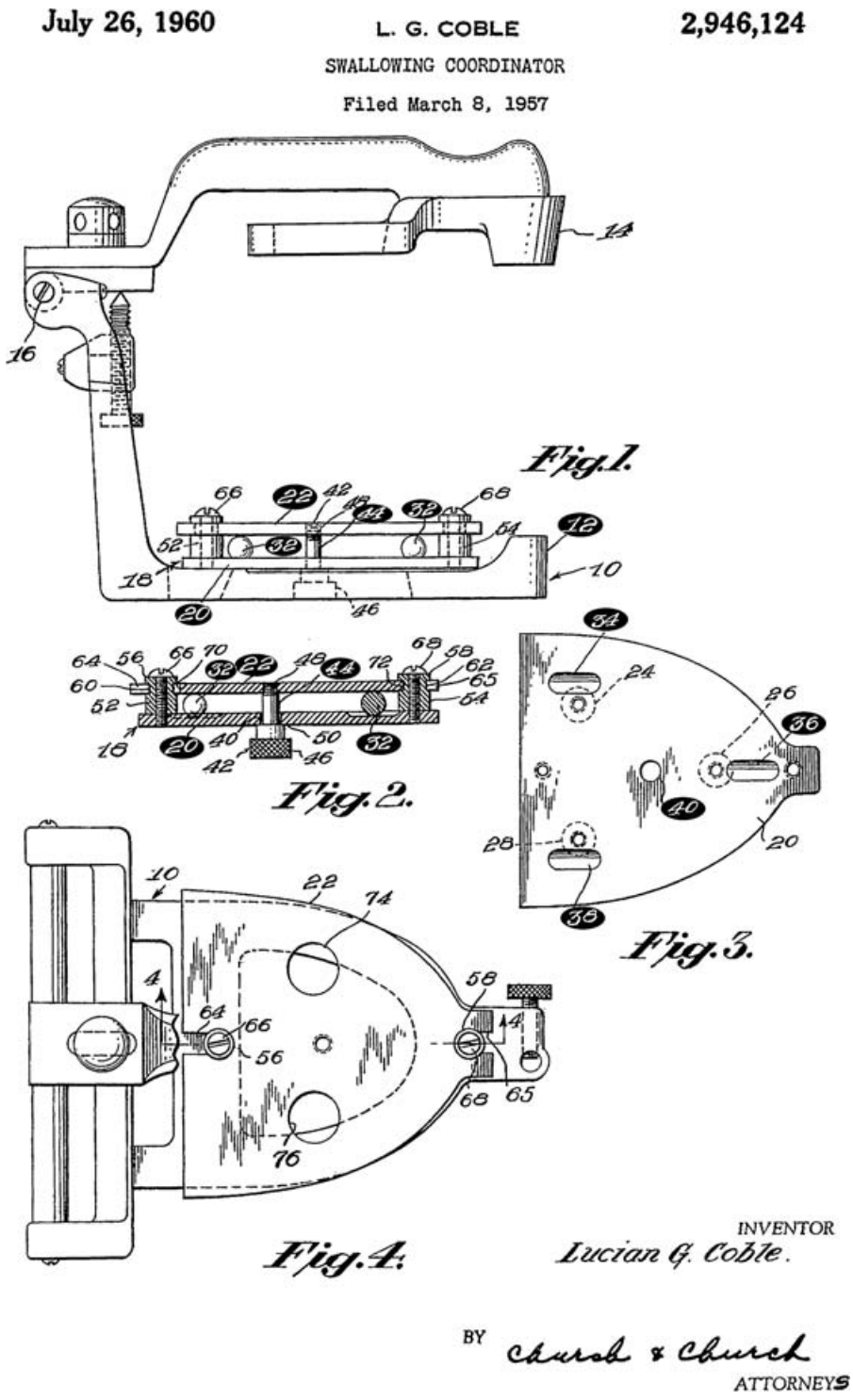

Figure 5. The Coble "Swallowing Coordinator" Articulator, 1960. Essentially a simple hinge articulator, the mechanism of the "swallowing coordinator" was mounted on the lower base (12) and consisted of the base attaching member (20) and a denture supporting member (22). Providing a frictionless 1-mm anterior-posterior movement between these two members were ball-bearings (32) that moved in grooves (34), (36), and (38) of the base attaching member. Centric position could be maintained by turning centering lock screw (44) up to engage threaded opening (40). (Reprinted from the 1960 US Patent.)[17]

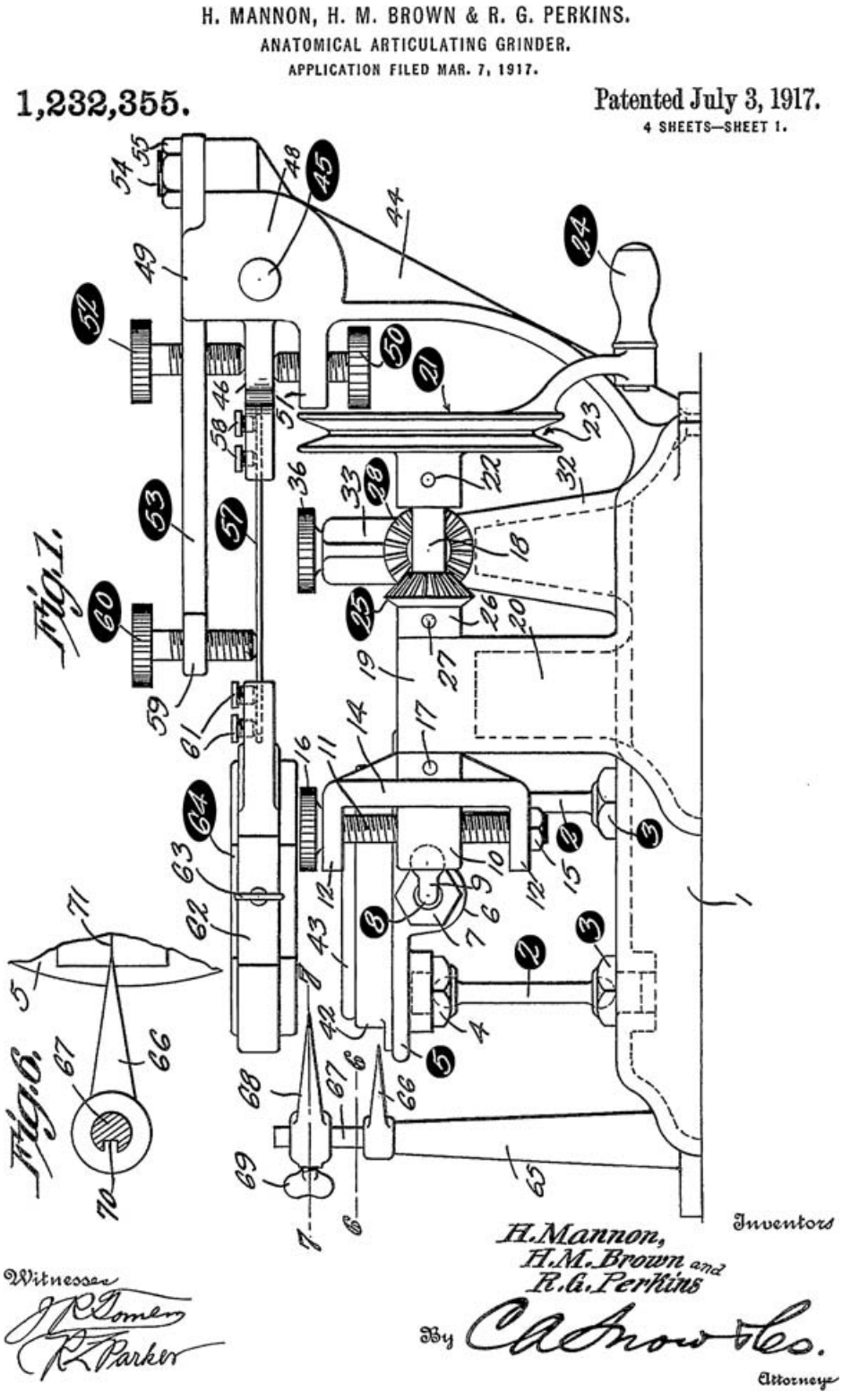

Figure 6a. The Mannon et al "Anatomical Articulating Grinder." The upper denture was carried in an adjustable octagonal ring (64) that was supported by band springs (57). It was stabilized by rod (53). The upper member moved on a simple hinge (45). Table (5) carried the lower denture. (Reprinted from the 1917 US Patent.)[8]

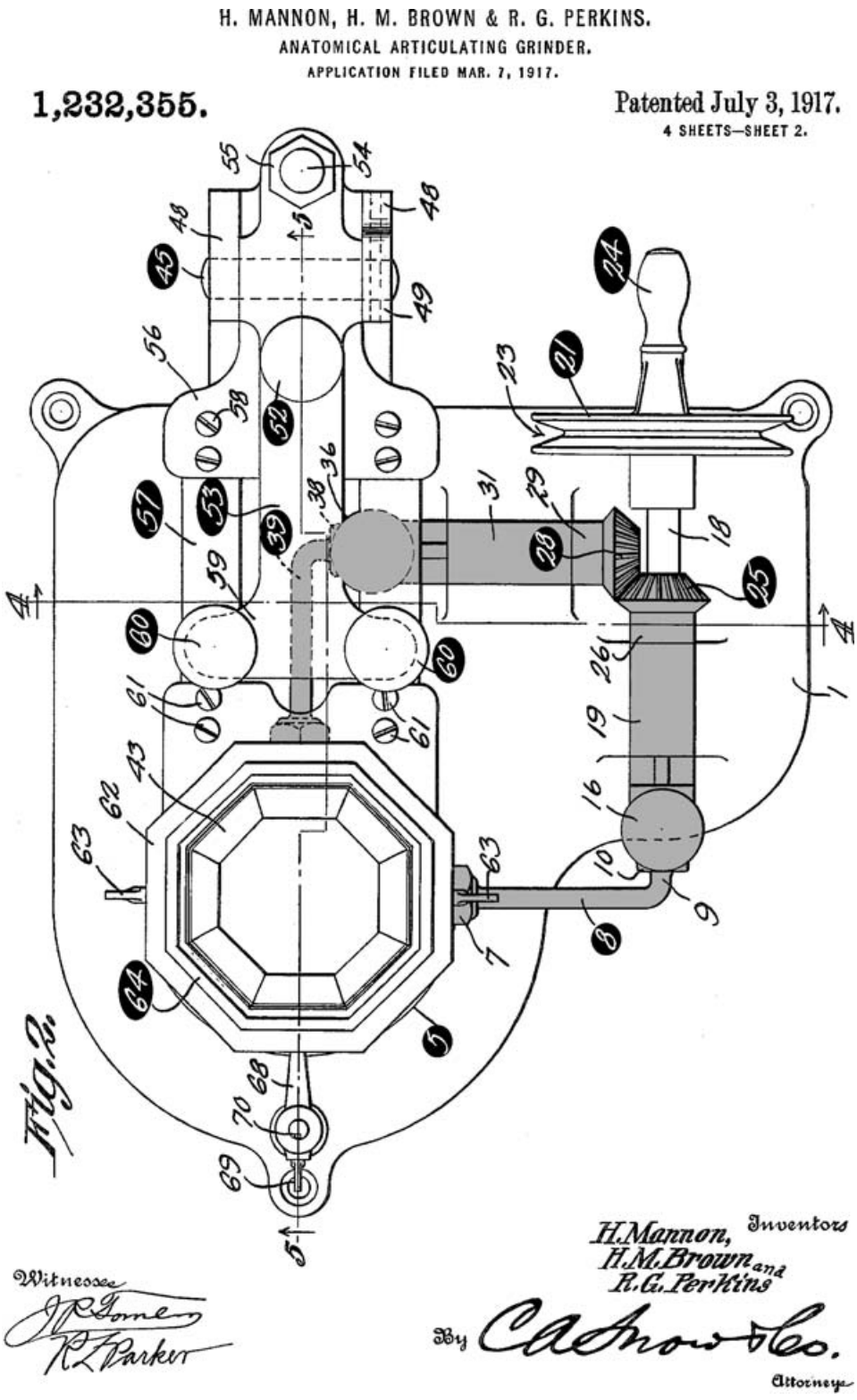

Figure 6b. The Mannon et al "Anatomical Articulating-Grinder." By turning hand crank (24), lateral and protrusive movements of the lower denture table (5) could by produced by the action of gears (25 and 28) that turned shafts (8) and (39) through a series of universal joints. (Reprinted from the 1917 US Patent.)[8]

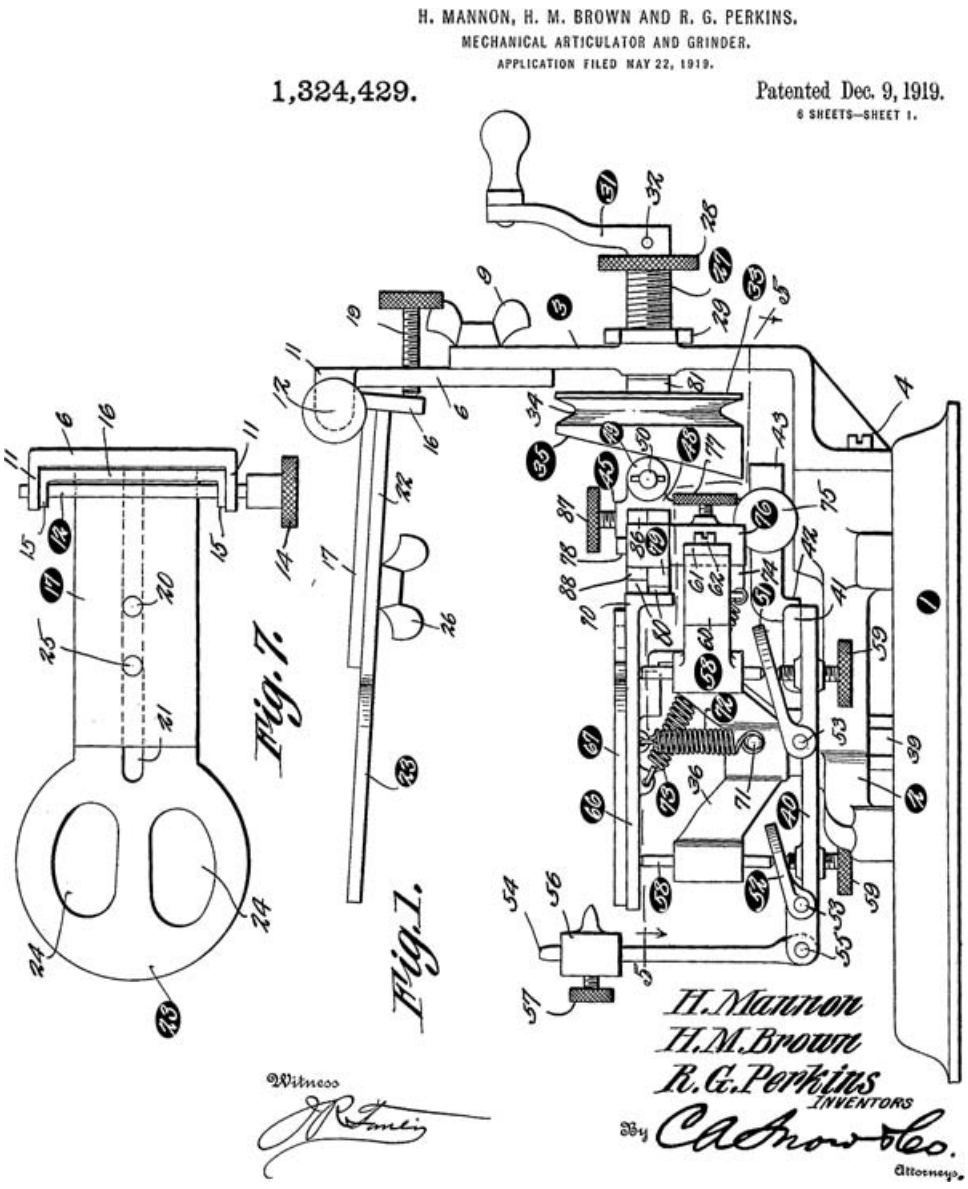

Figure 7a. The Mannon et al "Mechanical Articulator and Grinder." Patent Figure 1 shows the highly complex nature of this device. Retractile springs (72) and (73) resist the action of shaft (48) to rotate in the horizontal plane and shaft (45) to rotate in the vertical plane allowing plate (66) carrying the lower denture to follow preset articulator controls; that is, incisal guide (52), condylar guide (51), and the locking members (76) of the articulator. Patent Figure 7 is a top view of the upper member illustrating the relationship of the cast holder (23) with the slide support (17) and hinge (12). (Reprinted from the 1919 US Patent.)[18]

posts (2) that had ball and socket joints (3) on either end to allow universal lateral movement.[8] A hand crank (24) was supplied in the back and to the side of the instrument to activate the grinding mechanism. By the action of the gears (25 and 28) causing the flexible shafts (8 and 39) to rotate, lateral and anterior-posterior movements could be produced. An optional pulley (21) was provided.[8]

The second instrument, the "Mechanical Articulator and Grinder" was patented in 1919.[18] The patent letter stated that, "*The device is . . . to be used for articulating and grinding artificial teeth, and . . . it being possible to locate the rotating points, to regulate the incisal angle, to regulate the outward and downward path of the mandible, and to reproduce the lateral movements of the mandible. . .In general, the device has for its object,*

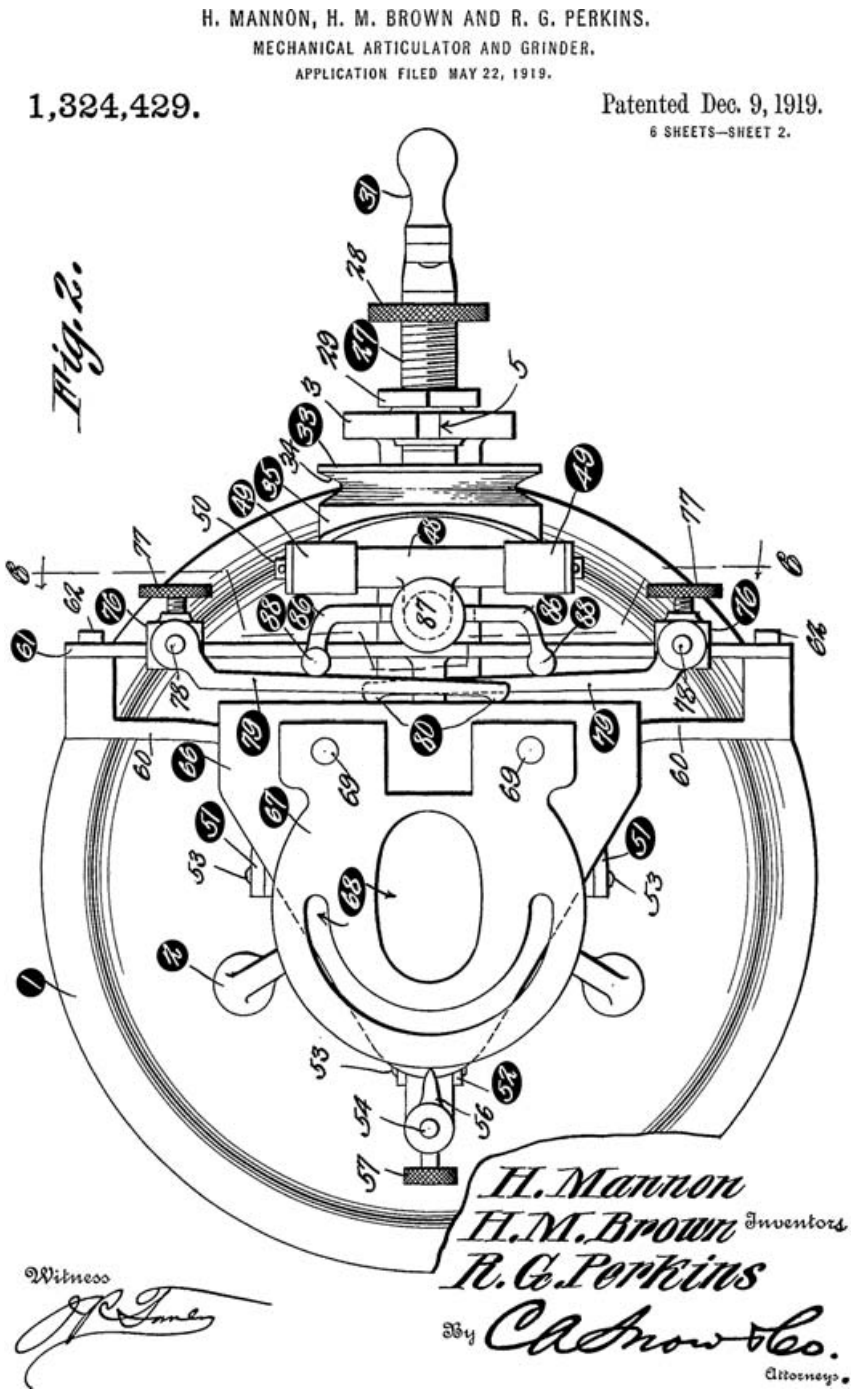

Figure 7b. The Mannon et al "Mechanical Articulator and Grinder." In part, patent Figure 2 illustrates the connections between turning of the hand crank (31) and the oscillatory and protrusive movements of plate (66) that carries lower cast holder (67). The rotation of cam flange (35) in contact with rollers (49) effects reciprocal movements of arms (86), the end knobs (88) of which engage radius rods (79). The radius rods are carried by locking members (76) that can be moved toward and away from each other on guide strip (61), thereby altering the relationship of lugs (80) that engage plate (66). Since lugs (80) cross each other in the midline, the closer that locking members are located to each other, the wider the "swing" of plate (66). The locking members can be moved laterally until the lugs are aligned in the midline, in which case plate (66) will move forward. (Reprinted from the 1919 US Patent.)[18]

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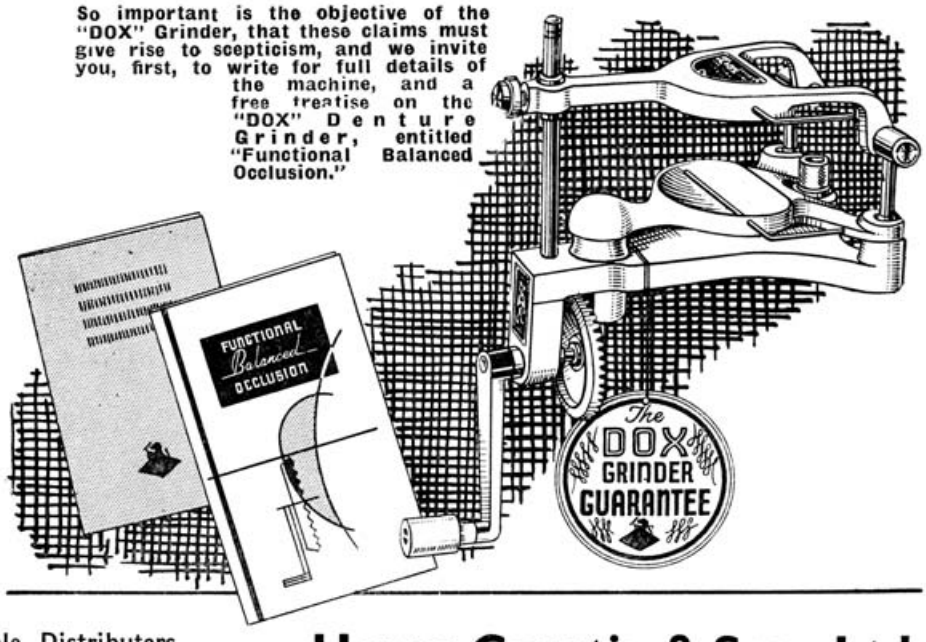

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Figure 8. The new "DOX" Grinder, distributed by Henry Courtin & Sons Ltd., London, England. This device required that it be secured at the edge of a bench. It likely produced an elliptical grinding pattern.[19]

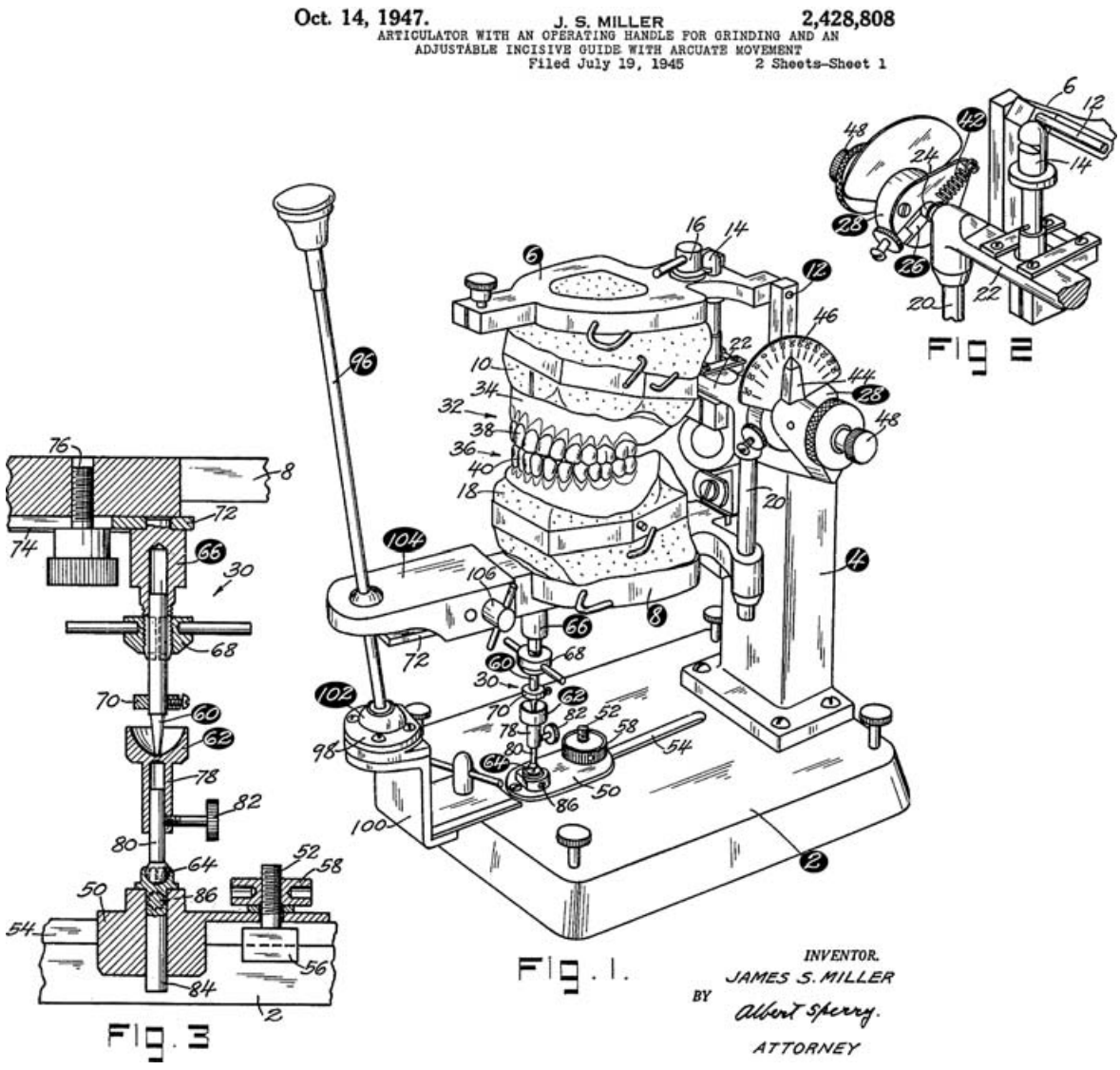

Figure 9a. The J.S. Miller Articulator and Grinder. The "incisive guide" was actually an anterior undercarriage (Patent Fig 3) that supported and allowed the free movement of the lower member of the articulator. The freedom of movement was permitted by two universal joints: pin (60) and guide (62) and ball (64) and socket at its lower aspect. The operator could move the lower member in any direction with handle (96). Patent Fig 2 illustrates the (arcon) feature of the adjustable condylar controls. (Reprinted from the 1947 US Patent.)[20]

the provision of means for simulating the highly complex movements of the mandible in the act of mastication."[18] The "Articulator and Grinder" was designed with all the controls on the lower member (Fig 7a, b). The main lower assembly was mounted on a circular base (1) with tripod feet (2) and carried the controls for the movement of the adjustable lower cast holder (67) attached to plate (66) as well as standard (3) that included the hand crank (31), shaft (27) and adjustable upper cast holder (23) that vertically hinged at (12). When wheel (33) was rotated by hand crank (31), cam flange (35) functioned against rollers (49), causing shaft (48) to rotate in a horizontal plane and shaft (45) to rotate in a vertical plane. The resulting action was "horizontal rocking" and "vertical swinging" movements of connecting members (40), (76), and (79) that permitted plate (66) carrying mandibular cast holder (67) to follow the previously set controls of the instrument. These controls

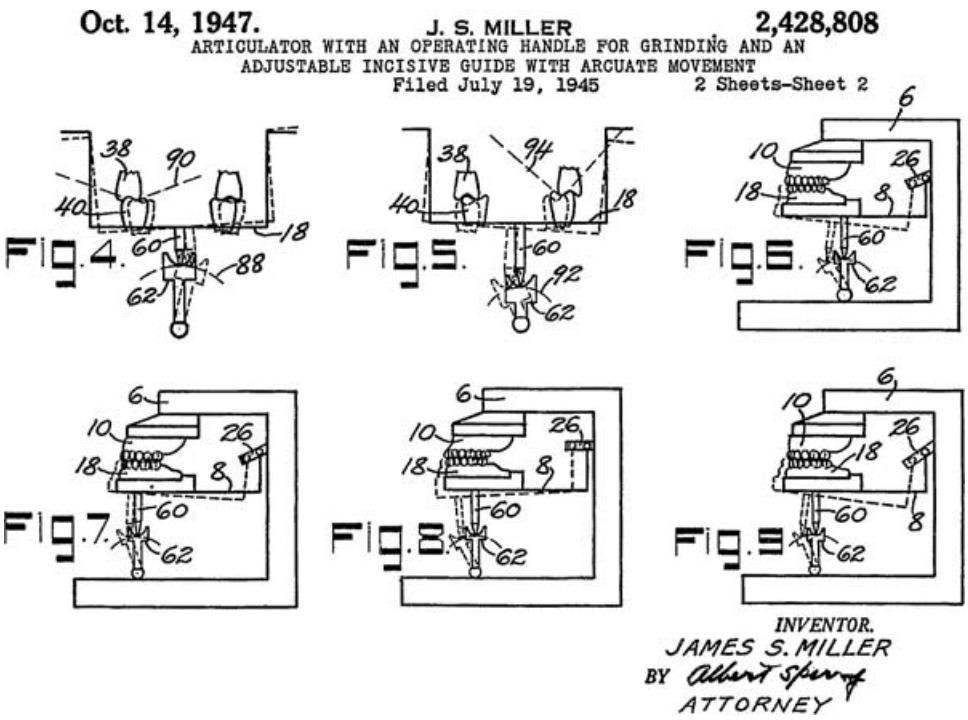

Figure 9b. The J.S. Miller Articulator and Grinder. Patent Figures 4 through 9 schematically represent how the "incisive guide" grinding process, by using previously established condylar controls, can produce many of the possible movements of the lower member and thereby create various cusp forms. (Reprinted from the 1947 US Patent.)[20]

included the incisal pin (58) and guide (52) and the condylar guides (51) and pins (58), both mounted on an oscillating member (40). The pins were maintained in centric position by the tension of "retractile" springs (72) and (73). The distance between the "vertical rotation centers" could be adjusted by moving locking members (76) with attached radius rods (79) along with guide strip (61).[18] As in the 1917 patent, an optional pulley (33) was also provided. James House classified this articulator as a "milling machine" that produced a "vertical bumping action."[10] Undoubtedly, it did.

A 1934 advertisement proclaimed of the new "DOX" Grinder: (Fig 8) "PERFECT OCCLUSION IS NOW WITHIN THE REACH OF EVERY PRACTITIONER. Faultless occlusion in full denture work is now removed from the realm of the specialist only...a few seconds only is all that is required to produce, infallibly, accurate occlusion..."[19] The "DOX" Grinder was introduced by H.T.J. Edwards at the 8th Australian Dental Congress in 1933.[20] Edwards believed that the absolute necessity for grinding in dentures on completion was a well-established fact; however, he did not follow the principles of balanced occlusion but held that only a "functional central occlusion" would ensure efficient dentures. In designing the "DOX" Grinder, Edwards ignored those movements that are not concerned with the final trituratory action of mastication. Therefore, the movement "produced by the eccentricity of the cam, is confined to the lower denture, as in nature, and its range is small enough to be wholly within the cusp outlines of the posterior teeth. A range of uninterrupted movement is provided to and from the position of central occlusion in every physiologically possible direction, including the slight retrusive movement of which the mandible is capable." The hand crank of this tripod-type device was on the lower front requiring that the instrument be secured at the edge of the work surface.

On October 14, 1947, James S. Miller, of Trenton, NJ, received a patent[21] for an arcon-type articulator and grinder that had some very unusual features (Fig 9a). It had a moveable lower member (8) with the upper member (6) pivotally mounted

at hinge (12). The entire functioning mechanism was suspended on a base (2) and a posterior column (4) (Patent Fig 1). The adjustable condylar controls (28) consisted of a pin (24) and a slot (26) with retracting springs (42) to maintain a centric position (Patent Fig 2). The condylar inclination was recorded on scale (46).[21]

Miller believed that "it is necessary to grind in the [denture] teeth so that they will be capable of moving freely and in a natural manner . . . and be comfortable to the patient when in use." "It is also important," he said, "for the teeth to have cusps of such height and inclination as to insure proper mastication of food."[21] To accomplish this, Miller devised a "novel" type of "incisive guide" that consisted of an anterior support undercarriage (66) and a controlling handle (96) "for guiding the anterior portion of the lower member of the articulator and the lower denture as it is moved to reproduce the movement of the patient's lower jaw."[21] The undercarriage (66) was capable of support as well as allowing free movement by virtue of the pin and cusp (60), (62), and universal joint (64). The controlling handle (96) with universal joint (102) was linked to the undercarriage (66) by adjustable bar (104) "so that upon movement of the controlling handle in any direction, the lower member (8) would correspondingly move."[21] *Patent* Figures 4–8 (Fig 9b) are intended to schematically illustrate that by a combination of movements and various condylar paths "it is possible to produce many and varied forms of cusps and to insure accurate reproduction of the movements of the patient's lower jaw while providing the necessary cusp height and inclination to afford proper mastication."[21]

There will be more on the history of "grinders" in a future issue of the *Journal of Prosthodontics*.

Acknowledgment

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