

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CLEARCORRECT OPERATING LLC,

Petitioner

v.

ALIGN TECHNOLOGY INC.,
Patent Owner

IPR2025-00816
U.S. Patent No. 11,369,456

Declaration of Dr. Sumit Yadav
in Support of Petition for *Inter Partes* Review of U.S. Patent No. 11,369,456

TABLE OF CONTENTS

I.	Introduction.....	7
II.	Qualifications.....	7
III.	Materials Considered.....	12
IV.	Relevant Legal Standards	14
	A. Validity	15
	B. Level of Ordinary Skill	18
	C. Claim Construction.....	20
V.	The '456 Patent.....	24
	A. Overview	24
	B. Prosecution History	26
VI.	Overview of the Prior Art.....	28
	A. Chishti-511 (Ex-1004).....	28
	B. Chishti-876 (Ex-1005).....	34
	C. Sachdeva (Ex-1007)	35
	D. Becker (Ex-1006)	37
	E. General Overview of Indirect Teeth Movement in the Prior Art.....	40
VII.	Analogous Art.....	43
VIII.	Motivation to Combine.....	44
IX.	Ground of Unpatentability	53
X.	Claims 1-19 of the '456 Patent Are Unpatentable	54
	A. Chishti-511 in View of Chishti-876 and Sachdeva Renders Obvious Claims 1-9, 11, and 13-17	54

1.	Independent Claim 1	54
a.	[1(pre)] A computer-implemented method comprising:	54
b.	[1(a)] determining a schedule of movement for dental objects during treatment stages of an orthodontic treatment, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;	54
c.	[1(b)] calculating a respective treatment path for each of the dental objects between their respective initial position and respective final position;	59
d.	[1(c)] identifying a collision between a first of the dental objects and a second of the dental objects based at least on the schedule of movement of the dental objects and the respective treatment paths;	60
e.	[1(d)] performing a first modification of the schedule of movement in response to the identifying, ...	63
f.	[1(e)] the first modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages;	66
g.	[1(f)] determining that the first modification does not avoid a collision between the first of the dental objects and the second of the dental objects; and	67
h.	[1(g)] performing a second modification of the schedule of movement after the determining that the first modification does not avoid a collision, the second modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages.	71

2.	Dependent Claim 2: The method of claim 1, wherein the schedule of movement is determined by selection by a user.	74
3.	Dependent Claim 3: The method of claim 1, wherein the schedule of movement includes one of an all-equal pattern, an A-shaped pattern, a V-shaped pattern, a mid-line shift pattern, or a[n] M-shaped pattern.	75
4.	Dependent Claim 4: The method of claim 1, wherein the determining the schedule of movement comprises analyzing, by a computer processor, the dental objects in their respective initial positions and respective final positions.	79
5.	Dependent Claim 5: The method of claim 4, wherein the analyzing comprises determining a respective distance needed to move each of the dental objects from their respective initial positions to their respective final positions.	81
6.	Dependent Claim 6: The method of claim 1, further comprising producing a series of orthodontic appliances based at least on the modified schedule of movement, wherein each of the orthodontic appliances corresponds to a respective one of the treatment stages.	83
7.	Dependent Claim 7.....	85
a.	[7(a)] The method of claim 6, wherein the producing comprises: fabricating a respective positive mold of the dental objects for at least two of the treatment stages; and	85
b.	[7(b)] thermoforming a respective one of the orthodontic appliances over each of the respective positive molds.....	85
8.	Independent Claim 8	88

9.	Dependent Claim 9: The method of claim 8, wherein the second modification comprises slowing or stopping movement of the first of the dental objects during one or more of the treatment stages following a previous one of the treatment stages in which the first dental object moved.....	90
10.	Independent Claim 11	93
a.	[11(f)] performing a second modification of the schedule of movement after the determining that the first modification does not avoid a collision, wherein the second modification comprises one or more of: delaying initial movement of the first of the dental objects; and slowing or stopping movement of the first of the dental objects during one or more of the treatment stages following a previous one of the treatment stages during which the first of the dental objects moved.....	94
11.	Independent Claim 13	96
12.	Dependent Claim 14: The computer-implemented method of claim 13, wherein determining the schedule of movement comprises selecting a movement pattern from a plurality of predetermined movement patterns.	98
13.	Dependent Claim 15: The computer-implemented method of claim 13, further comprising manufacturing at least two orthodontic aligners, each of the orthodontic aligners corresponding to a respective one of the treatment stages.....	98
14.	Dependent Claim 16	100
15.	Independent Claim 17	101
a.	[17(f)] recalculating at least one of the respective routes based on the first or second modified schedule of movement.	103

B.	Chishti-511 in View of Chishti-876, Sachdeva, and Becker Renders Obvious Claims 10, 12, 18, and 19	103
1.	Dependent Claim 10	104
a.	[10(a)] The method of claim 9, further comprising: performing, after determining that the second modification does not avoid a collision, a modification of the schedule of movement of the dental objects, the modification comprising:	104
b.	[10(b)] moving the first of the dental objects away from the respective route of the second of the dental objects; and	105
c.	[10(c)] moving the first of the dental objects toward its respective final position after the second of the dental objects has sufficiently traversed its respective route to avoid the collision.	107
2.	Independent Claim 12	108
3.	Independent Claim 18	111
a.	[18(g)] stopping movement of the first of the dental objects; and	114
4.	Independent Claim 19	117
a.	[19(h)] moving the first dental object toward its previous position.....	119
XI.	Conclusion	121

I. Introduction

1. I, Dr. Sumit Yadav, submit this declaration to state my opinions on the matters described below.

2. I have been retained on behalf of Petitioner ClearCorrect Operating LLC as an independent expert for the above-identified *inter partes* review proceeding involving U.S. Patent No. 11,369,456 (“the ’456 patent”) (Ex-1001). Although I am being compensated for my time in connection with this IPR at my standard hourly consulting rate of \$500 per hour and reimbursed for reasonable out-of-pocket expenses, no part of my compensation depends on the outcome of this proceeding, and I have no other interest in this proceeding.

3. I have been asked to provide my technical review, analysis, insights, and opinions regarding the ’456 patent, the prior art references that form the basis for the invalidity ground set forth in the Petition for *Inter Partes* Review of the ’456 patent, and any other prior art publications cited in this declaration.

II. Qualifications

4. I believe that I am well qualified to serve as a technical expert in this matter based upon my educational and work experience summarized below. My *curriculum vitae* records my education, experience, and publications in greater detail. Ex-1029.

5. I received a Bachelor of Dental Surgery in 2002 and a Master of Dental Surgery in Orthodontics in 2006, both from India. I received a Ph.D. in Oral Biology from Indiana University – Purdue University, Indianapolis in 2010, and a Clinical Certificate in Orthodontics from University of Connecticut (“UCONN”) Health Center in 2013. I am also a Diplomat of the American Board of Orthodontics. In addition, I received my MBA from Northwestern University, Kellogg School of Management, in 2022. My qualifications and experience are also described in my *curriculum vitae* (Ex-1029).

6. I have authored or co-authored more than 140 articles in peer-reviewed journals. These publications span a range of topics, including: clear aligner treatment, orthodontic tooth movement, bone remodeling and modeling, orthodontic anchorage, mini-implant and bone integration, mechanical vibration and orthodontic tooth movement, mechanical vibration and root resorption, mechanical vibration and orthodontic retention, canine impaction, aligner orthodontics, and loading and unloading of the mandibular condylar cartilage of the temporomandibular joint (TMJ). I currently serve on the Editorial Board of Angle Orthodontist, and I am a reviewer for the American Journal of Orthodontics and Dentofacial Orthopedics, The Angle Orthodontist, the European Journal of Orthodontics, PLoS One, Progress in Orthodontics, the Journal of Dental Research, the Journal of Molecular Histology, Tissue Engineering, and the Journal of Applied Oral Science.

7. I have over 22 years of experience as a clinician and 17 years of experience as a research scientist. I am a Professor and Chairman at UNMC College of Dentistry. Since 2012, my research has been funded either through foundation grants (American Association of Orthodontic Foundation and National Institute of Health).

8. I have extensive expertise in orthodontic tooth movement both as a clinician and as a research scientist. I utilize basic biomechanics principles to maximize orthodontic tooth movement with minimal adverse effects in patients. Furthermore, I have worked extensively on optimizing orthodontic tooth movement with Clear Aligner Therapy (CAT) in patients. My research on clear aligners is focused on both the adolescent and adult patients. My research has focused on clear aligners and orthodontic tooth movement (M. Chaluparambil, S. Abu Arqub, C.-L. Kuo, L. Da Cunha Godoy, M. Upadhyay, S. Yadav, *Age-stratified assessment of orthodontic tooth movement outcomes with clear aligners*, Progress in Orthodontics 25:43 (Nov. 2024), <https://doi.org/10.1186/s40510-024-00542>). In this research, we compared the predicted versus achieved tooth movement between adults and adolescent patients. Our data has shown significant differences between adult and teenagers with CAT. Mandibular central and lateral incisors showed significantly greater over-correction in adults in the horizontal plane. The accuracy of rotations and vertical movements was comparable.

9. I also worked on comparing different aligner systems and their differential effect on orthodontic tooth movement. In this study, we compared treatment efficacy for specific tooth movement between two different clear aligner systems (M.T. Harandi, S. Abu Arqub, E. Warren, C.-L. Kuo, L. Da Cunha Godoy, S. Mehta, J. Feldman, M. Upadhyay, S. Yadav, *Assessment of clear aligner accuracy of 2 clear aligners systems*, American Journal of Orthodontics and Dentofacial Orthopedics, Vol. 164, No. 6, pp. 793-804 (Dec. 2023)). The achieved tooth movement was significantly different than predicted for both aligner systems. We concluded that the efficacy of clear aligner therapy systems in treating mild and moderate malocclusions was comparable. Deviation of the achieved movements from the predicted was greatest for rotational and vertical movements.

10. I have also worked on peripheral nerve regeneration using novel ionically conducting polymers. Nerve defects, particularly those larger than several millimeters, require use of allografts, autografts, or synthetic grafts for nerve regeneration. Allografts/autografts have the limitations of availability, morbidity, and disease transmission. Furthermore, current graft biomaterials are limited in part by slow deterioration of conductivity. We are working on developing a novel ionically conducting polymer that will be electronically stable and will stimulate nerve progenitor cells to heal the nerve defects. Our research has been funded by a UCONN convergence grant to the amount of \$50,000.

11. The objective of my National Institute of Health-funded projects is to understand TMJ degeneration and regeneration and to accelerate orthodontic tooth movement. The long-term goal of the applicant (PI) is to understand the mechanism regulating the growth and differentiation of mandibular condylar cartilage (MCC). Temporomandibular joint disorders (TMDs) affect over 15 million Americans, and it is estimated that the United States spends billions of dollars each year on TMDs. Bone Morphogenic Proteins (BMPs) signaling is crucial for the development and postnatal maintenance of MCC, while overexpression of BMP signaling has been associated with degenerative disorders of the cartilage. Despite a wealth of literature on BMPs signaling in the articular cartilage of the knee, little is known about BMPs role in the postnatal growth, adaptive remodeling, and pathogenesis of MCC. In our MCC loading model, we found increased cartilage thickness, increased matrix synthesis and mineralization, as well as increased hypertrophic differentiation of chondrocytes. Moreover, conditional deletion of BMP2 in MCC showed decreased synthesis and mineralization of extracellular matrix and decreased hypertrophic differentiation of chondrocytes. These data suggest that BMP2 regulates MCC growth and differentiation. However, the mechanisms underlying the regulatory effects of BMP2 in the matrix synthesis and hypertrophic differentiation of chondrocytes in MCC remain unknown. Our global hypothesis is that BMP2 is required for postnatal growth and adaptive remodeling of the MCC. Our

understanding is that BMP2 is the master regulator of extracellular matrix synthesis, matrix mineralization, and hypertrophic differentiation of chondrocytes.

III. Materials Considered

12. In forming my opinions, I have reviewed the following documents and any other documents cited in this declaration:

<u>Exhibit No.</u>	<u>Description</u>
Ex-1001	U.S. Patent No. 11,369,456 to Kitching et al. (“’456 patent”)
Ex-1002	Prosecution History of U.S. Patent No. 11,369,456
Ex-1004	U.S. Patent No. 6,471,511 to Chishti et al. (“Chishti-511”)
Ex-1005	U.S. Patent No. 6,729,876 to Chishti et al. (“Chishti-876”)
Ex-1006	Adrian Becker, <i>The Orthodontic Treatment of Impacted Teeth</i> (Martin Dunitz Ltd. 1998) (“Becker”)
Ex-1007	U.S. Patent No. 6,250,918 to Sachdeva et al. (“Sachdeva”)
Ex-1008	<i>ClearCorrect Operating LLC v. Align, Inc.</i> , IPR2017-01829, Decision Denying Institution, Paper 10 (PTAB Feb. 5, 2018)
Ex-1009	Speaker Profile of Rohit Sachdeva, retrieved from: https://www.emedevents.com/speaker-profile/rohit-sachdeva
Ex-1010	LinkedIn Profile of Ruedger Rubbert, retrieved from: https://www.linkedin.com/in/ruedger-rubbert-6136b119
Ex-1011	LinkedIn Profile of Ian Kitching, retrieved from: https://www.linkedin.com/in/ian-kitching-3961333
Ex-1012	LinkedIn Profile of Alexander Dmitriev, retrieved from: https://www.linkedin.com/in/alexander-dmitriev-5145991

<u>Exhibit No.</u>	<u>Description</u>
Ex-1013	<i>Align Technology, Inc. v. ClearCorrect Operating, LLC, et al.</i> , Case No. 6:24-cv-00187-ADA-DTG, Dkt. 142, Joint Claim Construction Statement (W.D. Tex. Jan. 3, 2025)
Ex-1014	Harold D. Kesling, <i>The Diagnostic Setup with Consideration of the Third Dimension</i> , Am. J. Orthodontics, Vol. 42, No. 10, pp. 740-48 (Oct. 1956)
Ex-1015	H.D. Kesling, <i>Coordinating the Predetermined Pattern and Tooth Positioner with Conventional Treatment</i> , presented at the meeting of the Southern Society of Orthodontists, pp. 285-93 (Jan. 28-29, 1946)
Ex-1016	Orhan C. Tuncay (ed.), <i>The Invisalign System</i> (Quintessence Publishing Co., Ltd. 2006)
Ex-1017	Declaration of Dr. Paul C. Clark
Ex-1018	U.S. Patent No. 6,702,575 to Hilliard
Ex-1019	U.S. Patent No. 6,309,215 to Phan et al.
Ex-1022	Stanley A. Alexander, <i>Levels of root resorption associated with continuous arch and sectional arch mechanics</i> , Am. J. Orthodontics and Dentofacial Orthopedics, Vol. 110, No. 3, pp. 321-24 (Sept. 1996)
Ex-1023	Vincent DeAngelis, <i>The Amalgamated Technique, a Mechanically and Biologically Efficient Method for Controlled Tooth Movement</i> , Angle Orthodontist, Vol. 50, No. 1, pp. 1-15 (Jan. 1980)
Ex-1024	Hyo-Sang Park et al., <i>Group Distal Movement of Teeth Using Microscrew Implant Anchorage</i> , Angle Orthodontist, Vol. 75, No. 4, pp. 602-09 (2005)
Ex-1028	<i>ClearCorrect Operating, LLC v. Align Technology, Inc.</i> , IPR2017-01829, Petition for <i>Inter Partes</i> Review of U.S. Patent No. 8,038,444, Paper 1 (PTAB July 20, 2017)

<u>Exhibit No.</u>	<u>Description</u>
Ex-1032	Email from Western District of Texas Law Clerk regarding Preliminary Claim Constructions dated January 21, 2025

IV. Relevant Legal Standards

13. In preparing this declaration and forming my opinions, I am relying on certain legal principles that counsel explained to me. My understanding of these concepts is summarized below.

14. I have been asked to provide my opinions regarding whether claims 1-19 (“the Challenged Claims”) of the ’456 patent would have been obvious to a person having ordinary skill in the art at the time of the alleged invention, in light of the prior art. I have been advised and understand that prior art includes all analogous art, and that two separate tests define the scope of analogous prior art: (1) whether the art is from the same field of endeavor, regardless of the problem addressed; and (2) if the reference is not within the field of the inventor’s endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved. It is my opinion that the Challenged Claims would have been obvious to a person having ordinary skill in the art at the time of the alleged invention.

15. In forming my opinions expressed below, in addition to my knowledge and experience based upon my work in the fields of computer architecture design,

including fault-tolerant computer architecture design, I have considered the documents listed in the Table in Section III above.

16. I have been advised and understand that a dependent claim is a patent claim that refers back to another patent claim. I have been informed and understand that a dependent claim includes all of the limitations of the claim to which it refers.

A. Validity

17. I have been advised and understand that there are two ways in which prior art may render a patent claim unpatentable. First, the prior art can “anticipate” the claim. Second, the prior art can make the claim “obvious” to a person of ordinary skill in the art. I understand that for an invention claimed in a patent to be patentable, it must not be anticipated and must not be obvious based on what was known before the invention was made.

18. I have been advised and understand that a patent claim is unpatentable as anticipated under 35 U.S.C. § 102 if each element of that claim is present either explicitly or inherently in a single prior art reference. I have also been advised and understand that, to be an inherent disclosure, the prior art reference must necessarily disclose the limitation. The fact that the reference might practice or contain a claimed limitation is insufficient to establish that the reference inherently teaches the limitation.

19. I have been advised and understand that a claimed invention is unpatentable under 35 U.S.C. § 103 if the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. I have also been advised and understand that the obviousness analysis takes into account factual inquiries, including the level of ordinary skill in the art, the scope and content of the prior art, and the differences between the prior art and the claimed subject matter.

20. I have further been advised and understand that the Supreme Court has recognized several rationales for combining references or modifying a reference to show obviousness of claimed subject matter. Some of these rationales include the following: (a) combining prior art elements according to known methods to yield predictable results; (b) simple substitution of one known element for another to obtain predictable results; (c) use of a known technique to improve a similar device (method, or product) in the same way; (d) applying a known technique to a known device (method, or product) ready for improvement to yield predictable results; (e) choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; and (f) some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art

reference or to combine prior art reference teachings to arrive at the claimed invention.

21. When considering the issue of obviousness, I have been advised and understand that I should consider (1) the scope and content of the prior art; (2) the differences between the prior art and the claims at issue; (3) the level of ordinary skill in the art; and (4) evidence of secondary indicia of nonobviousness. I have been informed that secondary indicia of nonobviousness include (i) “long-felt need” for the claimed invention, (ii) commercial success attributable to the claimed invention, (iii) unexpected results of the claimed invention, and (iv) “copying” of the claimed invention by others.

22. I have further been advised and understand that in connection with identifying a reason or motivation that would have led a person of ordinary skill in the art (POSITA) to combine or modify the relevant teachings in the prior art to obtain the claimed invention, a POSITA must have had a reasonable expectation of success in doing so. The reason to select and combine features, the predictability of the results of doing so, and a reasonable expectation of success may be found in the teachings of the prior art references themselves, in the nature of any need or problem in the field that was addressed by the patent, in the knowledge of a POSITA at the time, as well as in common sense or the level of creativity exhibited by a POSITA.

B. Level of Ordinary Skill

23. In rendering the opinions set forth in this declaration, I have been asked to consider the '456 patent's claims and the prior art through the eyes of a person of ordinary skill in the art. I understand that a person of ordinary skill in the art is determined by considering (1) the type of problems encountered in the art, (2) prior art solutions to those problems, (3) the rapidity with which innovations are made, (4) the sophistication of the technology, and (5) the educational level and years of experience level of those working in the pertinent field.

24. I understand that I must evaluate the '456 patent from the perspective of a person of ordinary skill in the art. That is, the '456 patent must be evaluated through the eyes of a person of ordinary skill in the art at the time of the alleged invention of this patent as of its earliest priority date—August 30, 2006. It is my opinion that such a person of ordinary skill in the art as related to the '456 patent would have been part of an interdisciplinary team. This team would have included members with an advanced degree related to dentistry (e.g., BDS, MDS, DDS, DMD) with experience in orthodontics, including 1-3 years of orthodontic training or equivalent experience. The team may have also included members with a degree in a technical area related to software, graphics, or computers, or a related discipline. This technical team member would have had 1-3 years of software development

experience, although more education could substitute for work experience and vice versa. Ex-1017, ¶24.

25. Based on my educational background and experience, such as my experience with orthodontics (*see* paragraphs 1-8), I am qualified as at least a person of ordinary skill in the art with respect to the '456 patent. In particular, by August 30, 2006, I had my Bachelors in Dental Sciences and Master's in Dental Sciences in Orthodontics. I was treating orthodontic patients since October 2003.

26. Thus, I am familiar with the knowledge of the person of ordinary skill in the art at the time of the alleged invention. I am able to opine on how a person of ordinary skill in the art would have understood the disclosure and claims of the '456 patent, the disclosures of the prior art, the motivation to combine the prior art, and what combinations would have been obvious and not have been obvious to one of ordinary skill in the art.

27. I understand that ClearCorrect previously filed a petition for *inter partes* review against U.S. Patent No. 8,038,444 (IPR2017-01829) (the "'444 IPR"), which is related to the '456 patent, where ClearCorrect proposed that a person having a doctorate in dental science and three to five years of training and practical experience in orthodontics would qualify as a POSITA. While I believe such a person would qualify as a POSITA, it is not my experience that this particular education and experience would be requirements. In my experience, a doctorate in

dental science is generally attained by a lower percentage of dentists, and so would be typical of a person with a greater than ordinary skill in the art. In 2006, there were many trained professionals with experience in orthodontics and treatment planning that did not have a doctorate in dental science.

28. As an example, Sachdeva is highly relevant prior art that names Rohit Sachdeva as an inventor. It appears that Mr. Sachdeva has a Master's in Dental Science. Ex-1009. And while Mr. Sachdeva does not appear to have a doctorate in dental science, his patent's disclosure still discloses techniques related to treatment planning. Thus, this is consistent with my experience that a doctorate in dental science was not necessary to have ordinary skill in the art in 2006.

29. I also note that both Sachdeva and the '456 patent support my opinion that a person of ordinary skill in the art related to the '456 patent would have been part of an interdisciplinary team. Mr. Rudger Rubbert, another inventor of the Sachdeva patent, appears to be an engineer with a background in mechanical engineering. Ex-1010. Similarly, at least two inventors of the '456 patent, Ian Kitching and Alexander Dmitriev, appear to have backgrounds in computer science, but no dental degrees. *See* Ex-1011; Ex-1012.

C. Claim Construction

30. I have been informed that in an *inter partes* review proceeding, claim terms should be construed under the same standard applied in federal district court

cases. Under this standard, I have been informed that claim terms are generally given their ordinary and customary meaning as understood by one of ordinary skill in the art in light of the specification and the prosecution history pertaining to the patent. I understand, however, that claim terms are generally not limited by the embodiments described in the specification.

31. I understand that in addition to the claims, specification, and prosecution history, other evidence may be considered to ascertain the meaning of claim terms, including textbooks, encyclopedias, articles, and dictionaries. I understand that the specification is highly relevant to the claim construction analysis and can be the single best guide to the meaning of a disputed term. I have been informed that the specification acts as a dictionary when it expressly defines terms used in the claims or when it defines terms by implication. I have been informed that this additional evidence is often less significant and less reliable than the claims, specification, and prosecution history.

32. I have been informed that claims should only be construed to the extent necessary to resolve any controversy. For all claim terms, I have considered and applied their plain and ordinary meaning as they would have been understood by one skilled in the art at the time of the alleged invention and consistent with the specification.

33. I have also been informed that in the related district court proceeding, the parties agreed to meaning below for the following terms:

Claim Term	Construction
slowing / slow claims 9, 11	[having / have] one or more teeth scheduled to move at a rate less than the rate of other teeth, or even [stopping / stop] using interim key frames, so that collisions and/or obstructions do not occur
“all-equal pattern” claim 3	A pattern where all of a patient’s teeth move in parallel with one another (i.e., all of the patient’s teeth that need to move begin moving at the same stage, and finish moving at the same stage)

Ex-1013, 8.

34. I have also been informed that in the related district court proceeding, Petitioner also proposed the following constructions for the following claim terms of the ’456 patent, and that Patent Owner contends that no construction is necessary. The district court issued preliminary constructions.

Term	Petitioner’s Proposed Construction	District Court’s Preliminary Construction
“V-shaped pattern” claim 3	“A pattern where teeth having the same and/or similar positions on the arch will be moved beginning at the same stage, and will move continuously until they reach their final position, and where the most posterior-positioned teeth move first (e.g., the molars, or teeth in position 7 and/or 8) then the next anterior-positioned teeth move	Plain and ordinary meaning

	sequentially until all of the teeth reach their final position, with the next anterior-positioned tooth not scheduled to begin moving until at least approximately the half-way stage of its respective posterior-positioned tooth”	
“A-shaped pattern” claim 3	“A pattern where teeth having the same and/or similar positions on the arch will be moved beginning at the same stage, and will move continuously until they reach their final position, with the most anterior-positioned teeth (e.g., the incisors, or teeth in positions 1 and/or 2) moving first and then the next posterior-positioned teeth sequentially moving until all of the teeth reach their final position”	Plain and ordinary meaning
“M-shaped pattern” claim 3	“ A pattern where teeth having the same and/or similar positions on the arch will be moved beginning at the same stage, and will move continuously until they reach their final position, with teeth between the anterior teeth and the posterior teeth (e.g., the bicuspid, or teeth in positions 4 and/or 5) and both the adjacent anterior and/or adjacent posterior teeth then sequentially moving until all of the teeth reach their final position”	Plain and ordinary meaning
“mid-line shift pattern” claim 3	“A pattern where tooth movement begins on one side of the patient’s arch to center the teeth with respective [sic] to the	Plain and ordinary meaning

	mid-line of the patient's mouth, with the next tooth/teeth to move not scheduled to begin moving until at least approximately the half way stage of its respective previously scheduled tooth/teeth"	
--	--	--

Ex-1013, 2-3, Ex-1032, 2-3.

35. Petitioner's proposed constructions mirror Applicant's definitions for the recited "pattern" terms from the '456 patent's specification and applied in grounds presented herein. *See* Ex-1001, 5:44-6:10, Figs. 3-7. As discussed below, the prior art renders the claims obvious under either Petitioner's proposed constructions (which are adopted and applied below) or Align's litigation position and the district court's preliminary constructions (plain and ordinary meaning).

V. The '456 Patent

A. Overview

36. The '456 patent claims priority to August 30, 2006. Ex-1001, p. 2, (60).

37. The '456 patent describes a computerized system for scheduling the movement of teeth in stages from an initial position to a final position, according to various movement patterns and orthodontic techniques. Ex-1001, Abstract, 2:16-27.

38. Using a scan of the patient's teeth in an initial state, the computer generates a digital model of the teeth. Ex-1001, 5:27-31. Based on this scan, the computer generates a digital model of the patient's teeth. Ex-1001, 5:47-55. A digital

model of the patient's teeth at a final position is then defined. Ex-1001, 3:61-4:1, 5:32-38. The computer determines a path of movement for each of the patient's teeth from initial to final positions. Ex-1001, 3:58-4:7, 5:34-43.

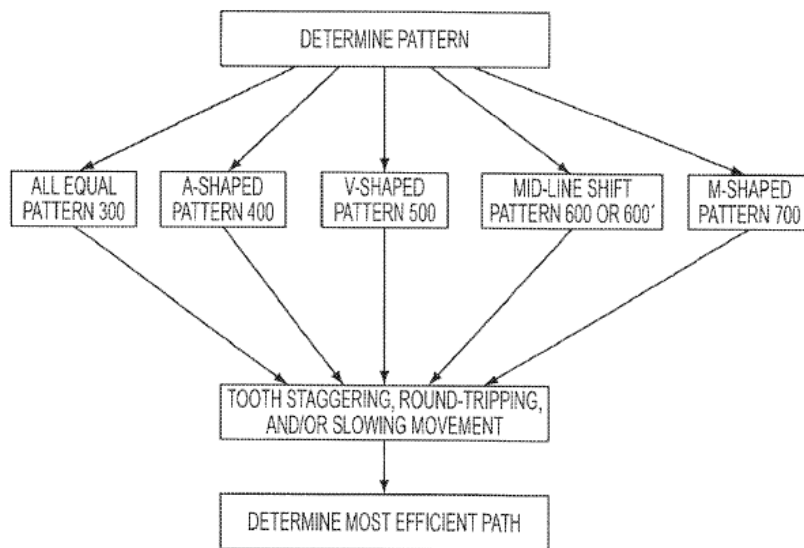


FIG. 2B

Ex-1001, Fig. 2B.

39. As shown above, one of various patterns of teeth movement is initially selected to be used by the system. Ex-1001, 5:57-6:16, Figs. 2B, 3-9.

40. The system then determines whether the specified teeth movement would result in collisions between teeth. Ex-1001, 6:43-47. The '456 patent admits that both pattern selection and collision detection are disclosed in Chishti-876. Ex-1001, 6:10-16, 6:47-54.

41. If a collision is detected, the system modifies the treatment plan using well-known techniques for avoiding the collision, such as "[s]taggering," "[s]lowing

down,” and “[r]ound-tripping.” Ex-1001, 12:67-13:12. “Round-tripping” is “the technique of moving a first tooth out of the path of a second tooth, and once the second tooth has moved sufficiently, moving the first tooth back to its previous position before proceeding to a desired final position of that first tooth.” Ex-1001, 13:8-12. The ’456 patent states that staggering, slowing down, and/or round-tripping can be applied “alone or in combination, and in any order.” Ex-1001, 13:12-14. But in the only exemplary embodiment incorporating all three techniques, the ’456 patent describes using staggering first, followed by “slowing-down,” and only then using “round-tripping *as a last resort*.” Ex-1001, 13:12-18 (emphasis added).

42. While the ’456 patent describes a specific manner of round-tripping, it does not purport to have invented this (or any) form of round-tripping. Nor does the ’456 patent identify any benefits of round-tripping. Instead, as noted above, round-tripping is described in the ’456 patent as “a last resort,” which indicates that despite the risks that a POSITA would have known to be associated with it, round-tripping may be a clinically necessary and acceptable technique in some circumstances. Ex-1001, 13:14-18.

B. Prosecution History

43. U.S. Application No. 16/723,706 (the “’706 application”) issued as the ’456 patent and stems from two provisional patent applications filed by Align on August 30, 2006. Ex-1001, p. 1, (21) & p. 2, (60). Align filed the first nonprovisional

parent in 2007, and it issued in 2011 as U.S. Patent No. 8,038,444 (the “’444 patent”).

44. During prosecution, the Office rejected certain claims of the ’456 patent as anticipated and/or obvious over two publications—Chishti-511 and U.S. Patent Publication No. 2004/0137400 to Chishti et al. (“Chishti-400”)—and one to Phan (U.S. Patent No. 6,309,215). Ex-1002, 3296-305.

45. In response to the prior art rejections, Applicant initiated an examiner interview, where it argued that “altering the tooth path” was different than “the schedule of movement.” Ex-1002, 3316. Applicant then amended the rejected claims to recite that the system would modify the schedule of movement to modify “*whether or not at least one of the dental objects move[s] during at least one of the treatment stages.*” See Ex-1002, 3320-28.

46. The Examiner also found that certain other claims contained allowable subject matter if rewritten in independent form. Ex-1002, 3305. The Applicant amended those claims, which, as amended, included modifications such as “delaying initial movement,” “slowing or stopping movement,” or “moving the first . . . dental object[] away from the respective route of the second . . . dental object[],” to be independent claims. Ex-1002, 3321-27.

47. Prior to filing the ’706 application, ClearCorrect filed IPR2017-01829 (“’444 IPR”), challenging the ’444 patent’s claims in view of Chishti-876 alone and

in combination with Chishti-511. Ex-1028. The Board declined to institute *inter partes* review based on, among other things, the definition of “round-tripping” appearing in the specification of the ’444 patent, which it determined was not explicitly disclosed in the Chishti references. *See generally* Ex-1008. But the ’456 patent’s claims do not recite “round-tripping.” Ex-1001, 16:7-20:32.

VI. Overview of the Prior Art

A. Chishti-511 (Ex-1004)

48. I understand that Chishti-511 is a U.S. patent that issued on October 29, 2002, more than one year before the earliest priority date of the ’456 patent. Ex-1004, p. 1, (45). Thus, Chishti-511 qualifies as prior art to the ’456 patent under at least 35 U.S.C. § 102(b).

49. Chishti-511 is titled “Defining Tooth-Moving Appliances Computationally” and discloses systems for segmenting an orthodontic treatment plan into a sequence of steps. Ex-1004, Abstract, Title. The system generates a digital model of the patient’s teeth and defines a series of treatment steps to be used with aligners, where the steps incrementally move the teeth from an initial position towards a final position. Ex-1004, 2:50-53, 3:32-5:6, Fig. 1. A high-level outline of this process is shown below:

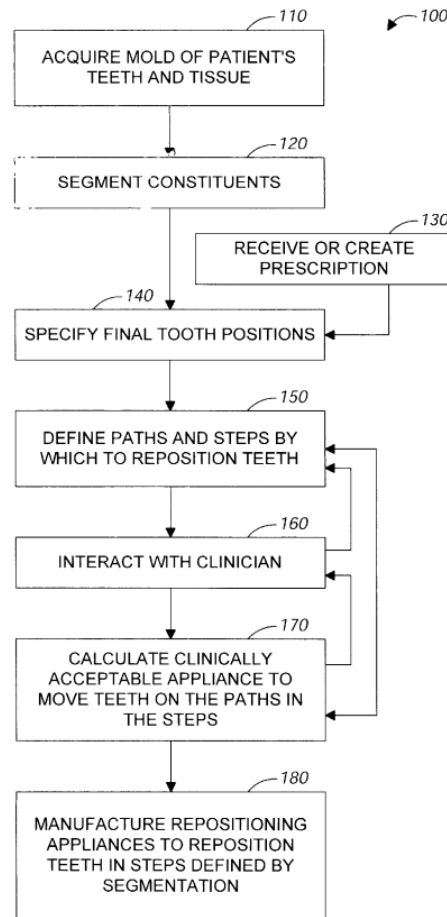


FIG. 1

Ex-1004, Fig. 1.

50. Chishti-511 also discloses that tooth path segments should be defined such that “moving from one point to the next in the sequence does not result in a collision of teeth.” Ex-1004, 4:7-22. Chishti-511 explains that while round-tripping first moves a tooth in a “direction other than directly toward the desired final position,” it “is sometimes necessary to allow teeth to move past each other.” Ex-1004, 4:13-16. Chishti-511 explains that after the initial and final positions for each tooth is determined, “the process next defines a tooth path for the motion of

each tooth,” and that “tooth paths are optimized in the aggregate so that the teeth are moved in the quickest fashion with the least amount of round-tripping to bring the teeth from their initial positions to their desired final positions.” Ex-1004, 4:7-12. After the tooth paths are defined, each path is segmented and the segmented tooth paths are “used to calculate clinically acceptable appliance configurations (or successive changes in appliance configuration) that will move the teeth on the defined treatment path in the steps specified by the path segments.” Ex-1004, 4:51-56. Chishti-511 further discloses that the proposed path for each tooth is compared against certain clinical constraints, and if there is a discrepancy that exceeds a certain threshold, the treatment plan can be modified. Ex-1004, 6:57-62, 7:9-22, 8:22-35. Clinical constraints include, for example, a maximum allowable force on the teeth and acceptable rates of displacement. Ex-1004, 1:59-67, 2:30-39, 6:51-7:8.

51. As shown below, Chishti-511 emphasizes that defining tooth paths and calculating aligner shapes is an iterative process, as shown below. Ex-1004, 4:27-50, 5:21-43, 8:42-66, Figs. 1, 2. If the proposed aligner shape does not satisfy the requisite criteria, or changes are made, the subprocess of defining the segmented paths is repeated (“After the treatment path has been redefined, the outer loop of the overall process is executed again (step 632)”). Ex-1004, 4:27-35, 8:42-66; Ex-1017, ¶¶ 35-39. This allows for repeated modifications “to redefine those parts of the treatment path having unacceptable aligners.” Ex-1004, 8:42-66.

53. In calculating the aligners (referring to Figure 2), Chishti-511 explains that the “analysis runs until an exit condition is reached, at which time the process evaluates whether the teeth have reached the desired end position for the current path segment, or a position sufficiently close to the desired end position (step 230),” and “[i]f an acceptable end position is not reached by the teeth, the process calculates a new candidate aligner shape (step 240).” Ex-1004, 5:21-27. Chishti-511 also discloses that a new aligner may be calculated even if an acceptable endpoint is reached, explaining that “[i]f an acceptable end position is reached, the motions of the teeth calculated by the finite elements analysis are evaluated to determine whether they are orthodontically acceptable (step 232). If they are not, the process also proceeds to calculate a new candidate aligner shape (step 240).” Ex-1004, 5:27-32.

54. Additionally, Chishti-511 explains that “[a]ligners may be unacceptable for a variety of reasons.” Ex-1004, 8:42-43. And in those circumstances, “the process transfers control to a path definition process (such as step 150, FIG. 1) to redefine those parts of the treatment path having unacceptable aligners (step 630)” if they did not require impossible movements. Ex-1004, 8:54-58. Chishti-511 further explains that “[t]his step can include both changing the increments of tooth motion, i.e., changing the segmentation, on the treatment path,

changing the path followed by one or more teeth in the treatment path, or both.”

Ex-1004, 8:58-61; Ex-1017, ¶¶ 35-39.

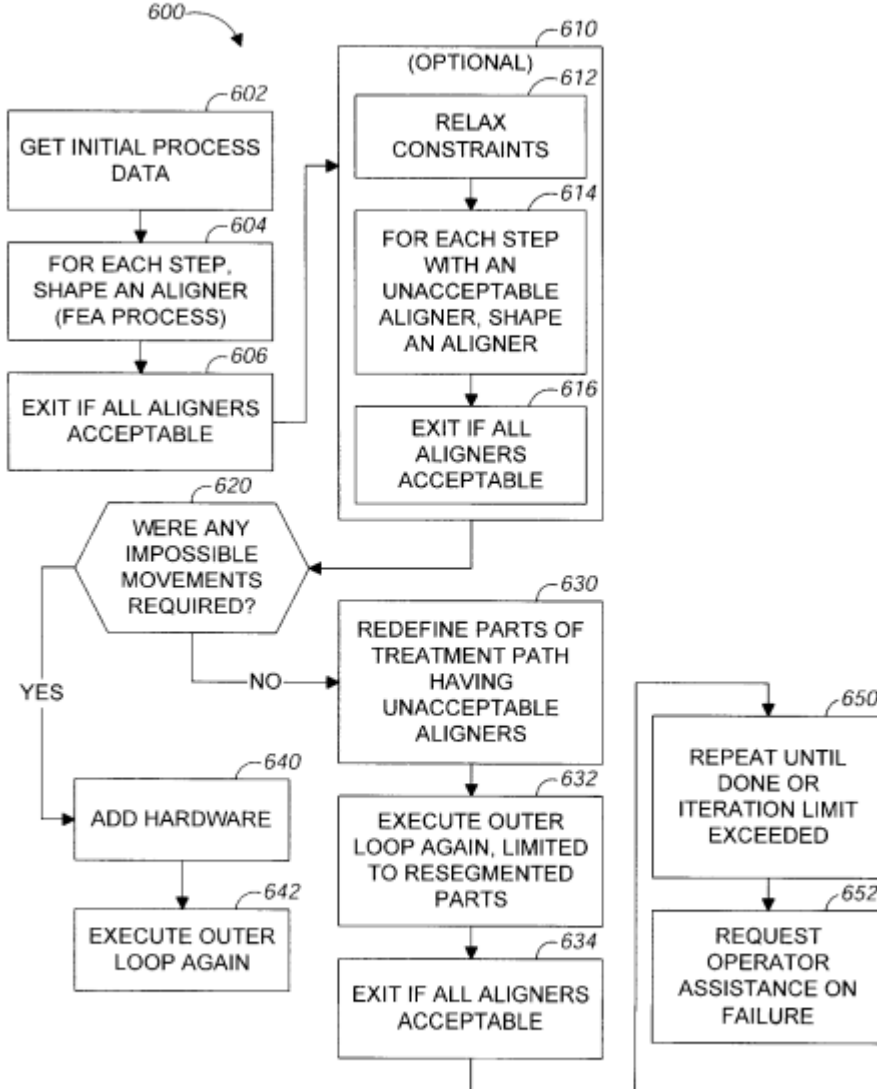


FIG. 6

Ex-1004, Fig. 6.

B. Chishti-876 (Ex-1005)

55. I understand that Chishti-876 is a U.S. patent that issued on May 4, 2004, more than one year before the earliest priority date of the '456 patent. Ex-1005, p. 1, (45). Thus, Chishti-876 qualifies as prior art to the '456 patent under at least 35 U.S.C. § 102(b).

56. Chishti-876 is titled “Tooth Path Treatment Plan” and discloses a system for preparing a treatment plan that involves selecting and using a treatment pattern. Ex-1005, Abstract, 2:15-19, Title. Chishti-876 discloses that its algorithm “draw[s] upon a database of preferred treatments,” which is based on prior successful treatments. Ex-1005, 14:63-15:1. The algorithm can “create several alternative paths and present each path graphically to the user.” Ex-1005, 15:1-3. Chishti-876 also discloses the well-known technique of slowing a tooth to avoid a collision as well as the known and routine method of manufacturing aligners by thermoforming over a positive mold. Ex-1005, 7:54-64, 12:22-32; Ex-1017, ¶¶ 40-46.

57. Chishti-876 further discloses the well-known and routine method of manufacturing aligners by thermoforming over a positive mold, where each aligner corresponds to a stage of the treatment plan. Ex-1005, 7:54-64. Chishti-876 also discloses variations in how a tooth may move.

58. Chishti-876 also discloses that “[a] set of rules can be applied to detect any collisions that will occur as the patient’s teeth move along the treatment paths,” and that “[i]f any collisions are detected, the program alters the path of at least one tooth in each colliding pair by selecting a new position for one of the intermediate steps The program then samples the new path (1604) and again applies the collision detection algorithm (1606). The program continues in this manner until no collisions are detected.” Ex-1005, 4:11-13, 13:35-45, Fig. 6.

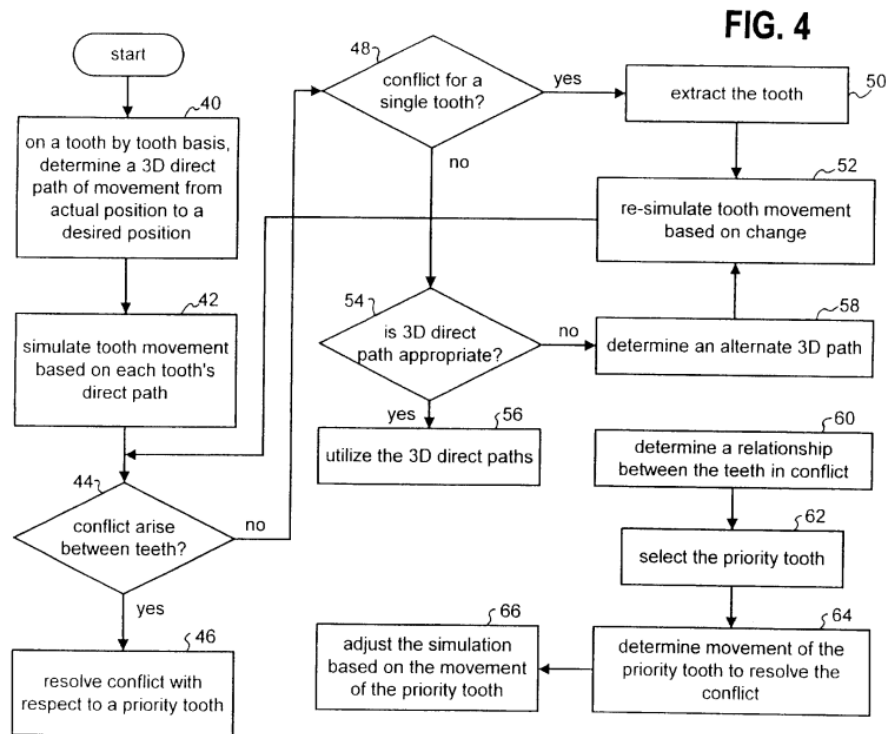
C. Sachdeva (Ex-1007)

59. I understand that Sachdeva is a U.S. patent that issued on June 26, 2001, more than one year before the earliest priority date of the ’456 patent. Ex-1007, p. 1, (45). Thus, Sachdeva qualifies as prior art to the ’456 patent under at least 35 U.S.C. § 102(b).

60. Sachdeva is titled “Method and Apparatus for Simulating Tooth Movement for an Orthodontic Patient” and discloses a system for orthodontic treatment planning that simulates tooth movement to determine whether a “conflict” arises between two teeth. Ex-1007, Abstract, 4:50-5:8, Title. Sachdeva explains that a “conflict” arises when “the movement of one tooth interferes with the direct path movement of another tooth[,] causing a particular tooth to not be able to obtain its desired position.” Ex-1007, 5:5-8. If a conflict is detected, it is resolved by modifying the scheduled tooth movement, for example, by delaying one tooth’s

movement while moving another tooth, and adjusting the simulation. Ex-1007, 3:43-48, 4:50-5:32.

61. For example, the system will identify a priority tooth between two teeth. Ex-1007, 5:9-26. In the case of an intra-arch conflict, “[i]f the lower tooth protrudes[,] preventing the upper tooth from moving back, the lower tooth must be moved before the upper tooth can be positioned. Conversely, if the upper tooth is interfering with the lower tooth from being moved out, the upper tooth must first be moved.” Ex-1007, 5:22-26, Fig. 4; Ex-1017, ¶¶ 47-51. Thus, whereas the teeth previously moved together, Sachdeva discloses modifying “whether or not” the teeth move to ensure that a collision is avoided. This is also known as “delaying,” as initial movement of the nonpriority tooth is delayed in favor of the priority tooth. As discussed, this is the feature that led to allowance of many of the ’456 patent’s claims (*see* paragraphs 45-46).



Ex-1007, Fig. 4.

D. Becker (Ex-1006)

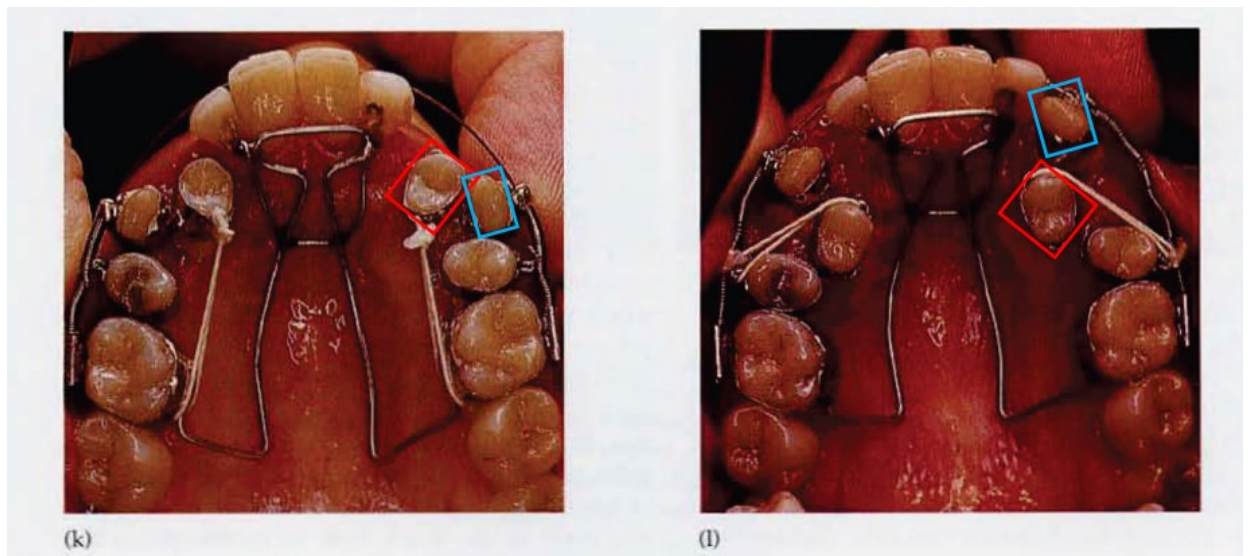
62. I understand that Becker is a textbook that was published in 1998, more than one year before the earliest priority date of the '456 patent. Ex-1006, 3. Thus, Becker qualifies as prior art to the '456 patent under at least 35 U.S.C. § 102(b).

63. Becker is titled *The Orthodontic Treatment of Impacted Teeth* and discloses repositioning a tooth using a round-tripping technique to avoid collisions between two teeth. Ex-1006, Title, 5. Becker explains that where a patient's teeth are "transposed," the "preferred line of treatment" may include "retranspos[ing] [the teeth] to their ideal positions" rather than "align[ing] the teeth in their transposed

positions.” Ex-1006, 5. In my opinion, a POSITA would have understood that tooth transposition refers to a dental anomaly where a tooth is located in the position normally occupied by a different tooth.

64. Becker discloses a method for treating this type of malocclusion. Below are images of a patient’s teeth, where a **more lingual tooth (i.e., a tooth closer to the tongue in red)** is initially transposed with a **more buccal tooth (i.e., a tooth closer to the cheek in blue)**.¹

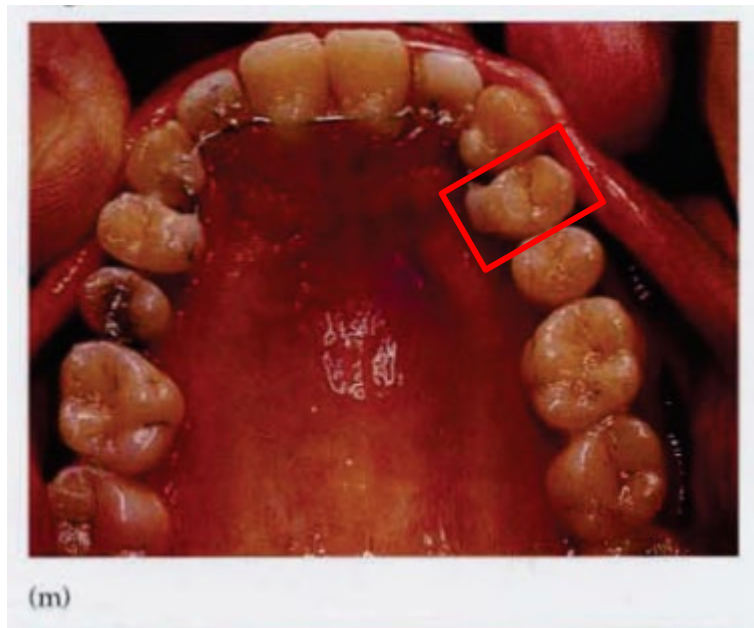
¹ Becker describes the tooth shown in the upper dental arch as a “lingual” tooth and describes movement of that tooth toward the center of the mouth as “lingual” movement (toward the tongue). Ex-1006, 5. But a POSITA would understand that when referencing teeth in the upper arch, movement to the center of the mouth is generally described as “palatal” movement, and that “lingual” movement is used when referencing teeth in the lower arch. Petitioner uses the “lingual” terminology from Becker, but a POSITA would recognize that Becker’s technique applies to teeth in either the upper or lower dental arch.



Ex-1006, 7 (Figs. 8.6(k), (l)). The **more buccal tooth** should be in the position shown on the right, but the **more lingual tooth** is blocking the direct path of the **more buccal tooth** from its position shown on the right to its position shown on the left.

65. Becker discloses using round-tripping, as described in the '456 patent, to correct the transposition of the teeth. Becker describes “slid[ing]” the **more buccal tooth** toward the midline (i.e., “in the mesio-distal plane”). Ex-1006, 5. To allow for this, the **more lingual tooth** “must be moved further lingually” “to allow its partner to pass by.” *Id.* Finally, the **more lingual tooth** “must be moved *in the opposite mesio-distal direction and back in the line of the arch.*” *Id.* (emphasis added).

66. Moving the **more lingual tooth** in the “opposite” direction and “back in the line of the arch” would return the tooth to its previous position, after which the tooth would proceed toward a desired final position. *Id.* Indeed, Figure 8.6(m) shows the **more lingual tooth** after it further moved to its final position.



Ex-1006, 8 (Fig. 8.6(m) (annotated)).

E. General Overview of Indirect Teeth Movement in the Prior Art

67. Indirect movement of teeth as described in Becker is often called round-tripping. Round-tripping—both as a general concept of moving a tooth in a direction other than directly towards its final position, and as the specific type of movement described in the '456 patent where a tooth moves in one direction and then back to its original position before moving to its final position—was a well-known technique at the time of the '456 patent for avoiding collisions between teeth. Through such indirect movements, clinicians create sufficient space for a second tooth to move towards its final position while avoiding collisions. Such indirect movement was understood to be sometimes necessary in cases involving crowding or impacted

teeth, like Becker, where direct movement of either the first tooth or second tooth is not otherwise possible without causing a collision.

68. A clinician presented with a patient where direct movement of a tooth towards its final position is not possible without causing a collision would consider various tooth movement techniques, including round-tripping, to avoid a collision. A clinician would consider both the risks of round-tripping movement (such as root resorption, loss of periodontal support, and prolonged treatment time caused by the round-tripping movement), as well as the benefit of achieving proper alignment while avoiding a collision.

69. Although round-tripping was understood to be avoided if possible, it was also understood to be a necessary option for some patients. For example, Chishti-511 explains that moving a tooth in a “direction other than directly toward the desired final position” “*is sometimes necessary* to allow teeth to move past each other.” Ex-1004, 4:9-16 (emphasis added). In some instances, the only alternative to round-tripping might be extraction, which could be even less desirable. This is consistent with the ’456 patent’s disclosure that round-tripping may be used “as a last resort” (Ex-1001, 13:12-18), and with a POSITA’s understanding that while it is preferable to avoid *unnecessary* indirect movement techniques, for some patients, some indirect movement may be necessary.

70. Other publications also confirm that round-tripping was well known. As discussed previously, Becker discloses that the “preferred line of treatment” may include the type of round-tripping specifically required in the ’456 patent. Ex-1006, 5. Becker discloses that a tooth is moved out of the way for another tooth to “pass by” before it is moved to its previous and then final positions. *Id.*; *supra* Section VI.D; *infra* Section X. Similarly, Park (Ex-1024) discloses a known movement technique whereby anterior teeth are moved to a forward position and then “retracted back after creating space with the distal movement of the molars and premolars.” Ex-1024, 5-6. DeAngelis (Ex-1023) also discloses a known movement technique where a tooth is tipped such that the root apex moves “from point *a* to point *b*,” and then is “brought back through point *a* to the desirable end-point *b*.” Ex-1023, Fig. 1B; *see also* Ex-1023, 2-3.

71. Finally, the prior art discloses that some of the reasons clinicians tended to avoid round-tripping may have been based on only anecdotal evidence and were not supported by more rigorous research. *See* Ex-1022, 3 (“‘[R]ound tripping’ ha[s] anecdotally been stated as a cause for resorption without any hard evidence.” (citation omitted)); Ex-1022, 1 (“Both treatment groups exhibited the same levels of resorption indicating that the side effect of treatment may be due to individual variation and not to the ‘round tripping’ of teeth so often assumed.”).

72. While the claims of the '456 patent do not recite the term round-tripping, the claims of Ground 2 include limitations related to that movement technique. But these types of movements were neither novel nor nonobvious, and the '456 patent's disclosure reflects a widespread consensus at the time of the patent that round-tripping was an option to be considered, with advantages and disadvantages, and that round-tripping would be used as necessary if it was the best (or potentially only) available treatment option.

VII. Analogous Art

73. In my opinion, each of the cited references is analogous art to the '456 patent and to each other. The '456 patent states that the “present invention is related generally to the field of orthodontics, and more particularly to staging a path of movement for correcting the position of one or more teeth.” Ex-1001, 1:25-27. Like the '456 patent, each of Chishti-511, Chishti-876, Sachdeva, and Becker is in the same field of endeavor, as each is directed to orthodontic treatment for repositioning misaligned teeth in patients. *See* Ex-1004, Abstract (discussing “orthodontic treatment path into clinically appropriate substeps for repositioning the teeth of a patient”); Ex-1005, Abstract (“prepar[ing] a malocclusion treatment plan”); Ex-1007, Abstract (discussing “simulating tooth movement for an orthodontic patient” and “determining, on a tooth by tooth basis, a three-dimensional direct path of movement”); Ex-1006, 5 (discussing teeth movement).

74. In my opinion, Chishti-511, Chishti-876, Sachdeva, and Becker are also analogous art because they are reasonably pertinent to the problem that the '456 patent purports to solve. In particular, the '456 patent alleges that it addresses the problem of potential collisions of teeth along a path for correcting tooth positions. Ex-1001, 1:25-27, 6:43-54 (the system “is configured to determine[] if the pattern should be modified to accommodate the teeth movement of the current patient to avoid collision”), 6:55-62 (discussing methods of avoiding collisions).

75. Chishti-511, Chishti-876, Sachdeva, and Becker are reasonably pertinent to this same problem. Chishti-511 discloses “defin[ing] a tooth path for the motion of each tooth” such that the movement “does not result in a collision of teeth.” Ex-1004, 4:7-9, 4:18-22. Chishti-876 similarly discloses that “determining a tooth path includes finding a collision[-]free shortest path.” Ex-1005, 2:28-30. Sachdeva similarly determines a “path of movement,” “determines whether a conflict arises between at least two teeth,” and resolves that conflict. Ex-1007, Abstract. Finally, Becker shows a known round-tripping technique used to avoid potential collision of teeth. Ex-1006, 5.

VIII. Motivation to Combine

76. In my opinion, a POSITA would have been motivated to combine the Ground 1-2 references with a reasonable expectation of success.

77. In my opinion, a POSITA would have been motivated to use Sachdeva's and Becker's collision identification and avoidance techniques to supplement Chishti-511's treatment-planning system. Chishti-511 discloses that its system generates "a clinically viable sequence of tooth positions, so that moving from one point to the next in the sequence does not result in a collision of teeth." Ex-1004, 4:15-22. Considering this express disclosure, in my opinion, a POSITA would have been motivated to look to teachings regarding techniques for identifying and avoiding collisions.

78. Sachdeva provides such a teaching. Like Chishti-511, Sachdeva recognizes that collisions are undesirable. *See* Ex-1007, 5:5-8 ("A conflict may arise in that the movement of one tooth interferes with the direct path movement of another tooth[,] causing a particular tooth to not be able to obtain its desired position."). Sachdeva further discloses automatically identifying collisions and resolving them. *See* Ex-1007, 5:3-26, Fig. 4. For example, Sachdeva discloses that a conflict can be resolved by giving one tooth priority to move it before another tooth (delaying one tooth), and it further explains how the changes will cause adjustments in the simulated treatment. Ex-1007, 5:3-32.

79. In my opinion, a POSITA would have recognized that integrating Sachdeva's automated collision identification, avoidance, and adjustment features into Chishti-511 would provide implementation details for the features disclosed in

Chishti-511 and would help achieve the “clinically viable sequence of tooth positions” sought by Chishti-511—that is, helping prevent the undesirable result of producing a set of aligners that might otherwise cause a collision. Ex-1004, 4:15-22. Indeed, in my opinion, a POSITA would have understood that the type of collision avoidance disclosed by Sachdeva (delaying an initial movement of a tooth) was a well-known treatment technique at the time of the invention. *See, e.g.*, Ex-1014, 6 (describing that a patient’s canine teeth are repositioned after “the central and lateral incisors are repositioned, and are in proper axial inclination”); Ex-1015, 5 (“[T]he mandibular teeth should advance toward the predetermined pattern and stationary anchorage somewhat ahead of the maxillary teeth.”); Ex-1016, 123-24 & Fig. 12-10a (describing a “[h]igh-anchorage pattern” where the anterior teeth are only moved after the posterior teeth have moved).² In my opinion, a POSITA would also have understood that such a system would improve patient results by avoiding unacceptable collisions and increase efficiency by reducing the need for a clinician to manually identify potential collisions.

80. I also understand that a POSITA would have had a reasonable expectation of success in combining Chishti-511 and Sachdeva. *See* Ex-1017, ¶¶ 56-61; Ex-1004, 4:7-22, 10:19-51; Ex-1007, 4:39-49, 5:3-32. A POSITA would

² I understand that Tuncay (Ex-1016) was publicly available at least by August 17, 2006. Ex-1021, ¶¶ 21-37.

understand that aligners producing collisions would not be acceptable, and that Sachdeva's collision-identification process may be used when determining the acceptability of aligners (e.g., triggering whether a new aligner should be calculated).

81. In my opinion, a POSITA similarly would have been motivated to combine Chishti-511 with Becker's teachings regarding avoiding collisions using round-tripping. Chishti-511 already discusses needing collision-free treatment paths (Ex-1004, 4:15-22), and a POSITA would have been motivated to look to techniques for avoiding collisions during treatment. In my opinion, a POSITA would have recognized that different patients may require different treatments and thus would have been motivated to include, in a system for treatment planning, multiple treatment methods to avoid potential collisions. Becker provides one such teaching, illustrating how round-tripping—as specifically discussed in the '456 patent—can be used to avoid collisions in the case of transposed teeth. Ex-1006, 5-7. For example, in transposition cases involving canines, a POSITA would have understood that a treatment plan might include repositioning the canine to its proper position, and that for some patients, round-tripping might be preferable over a different treatment (e.g., extracting the tooth) because canine teeth play a critical role in preventing collapse of the dental arch.

82. While the treatment shown for Becker's patient is one example, in my opinion, a POSITA would have understood that, depending on the specifics of a patient's initial malocclusion, there are different ways to implement the collision-avoidance technique disclosed in Becker. A POSITA would have also understood that if only minor tooth movement is required to avoid collision with a second tooth, aligners alone may be used to move the first tooth out of the path of a second tooth sufficiently to avoid a collision and then to move the first tooth back to its previous position before moving it towards its final position.

83. In my opinion, a POSITA would also recognize that in other cases, treatment where more significant tooth movement is needed to avoid a collision may utilize aligners with attachments, such as attachments shown in Becker, to achieve the desired movement. A POSITA would have understood that using such attachments was well known. For example, Chishti-511 describes that its process for computing the shape of an aligner will also take into account hardware attachments if necessary to create the tooth motion. *See* Ex-1004, 8:42-53 ("process 600 proceeds to execute a module that calculates the configuration of a hardware attachment to the subject tooth to which forces can be applied to effect the required motion"); *see also* Ex-1004, 10:1-6 (discussing that its aligners account for "the position and selection of attachments, and the addition or removal of material (e.g., adding wires or creating dimples)"), 6:21-24. State of the art similarly confirms that use of

attachments as shown in Becker was known. Ex-1016, 26, 30-38; Ex-1016, 34, 35 (Fig. 2-24c); Ex-1018, Abstract, 11:45-65; Ex-1019, Abstract, 3:21-48. Thus, in my opinion, a POSITA would have understood that, depending on the type of malocclusion, aligners may be used either alone or with attachments to achieve the type of round-tripping disclosed in Becker.

84. Although round-tripping can have disadvantages, in my opinion, a POSITA would have recognized that for some patients, there may be no other option other than to round-trip one or more teeth, particularly if the patient or clinician wishes to avoid extracting one or more teeth. Indeed, Chishti-511 expressly discloses that round-tripping is “sometimes necessary to allow teeth to move past each other.” Ex-1004, 4:13-15. Chishti-511, Becker and the ’456 patent are thus all consistent in understanding that round-tripping may be required to treat certain patients, even if it is, in the words of the ’456 patent, “a last resort.” Ex-1004, 4:9-16; Ex-1001, 13:12-18. Accordingly, a POSITA would have been motivated to include round-tripping as one feature in a system with robust software for generating treatment plans for a broad range of patients with different needs, and this would have been obvious, even if those features are only used in rare cases or as a last resort for patients that might otherwise not be able to be treated.

85. Moreover, I also understand that a POSITA would have had a reasonable expectation of success in combining Chishti-511 and Becker. Ex-1017 ¶ 62.

86. To the extent that it is argued that the prior art teaches away from the proposed combination, I disagree because the prior art discloses at least as much as what is described in the '456 patent itself for the round-tripping limitation. While Chishti-511 says teeth should be moved “with the least amount of round-tripping” (Ex-1004, 4:9-12), Chishti-511 describes round-tripping in the same manner as the '456 patent. Chishti-511 teaches that “[r]ound tripping is sometimes necessary to allow teeth to move past each other.” Ex-1004, 4:13-15. Chishti-511 recognizes there may be some disadvantages of round-tripping and recommends avoiding such movement when possible, but it also recognizes that round-tripping may be necessary in some circumstances. Ex-1004, 4:9-16. This is analogous to the '456 patent's disclosure, which refers to round-tripping as a matter of “last resort” when the collision cannot be resolved by other collision-avoidance techniques. Ex-1001, 13:12-18.

87. In my opinion, a POSITA also would have been motivated to combine Chishti-876's teachings regarding the use of movement patterns and the generation of schedules of movement with Chishti-511's treatment-planning system, as such a modification would improve efficiency by allowing a technician to generate a

treatment plan more quickly. Chishti-511 already discloses the importance of tailoring the generated treatment plan to a clinician's preferences and proposing treatment plans for a clinician's approval, and the use of predetermined movement patterns would facilitate interactions with a clinician by providing repeatable, known treatment techniques. *See, e.g.*, Ex-1004, 3:59-64 (discussing receiving prescription and constraints from clinicians and allowing clinician interaction through a client), 2:45-53, 4:36-50. A POSITA would have understood that such a modification would improve efficiency by allowing a technician to generate a treatment plan more quickly and with potentially fewer modifications, improve treatment quality by applying treatment techniques that had been used successfully for similar patients, implement clinician preferences, and improve patient flexibility by providing the type of multiple treatments appropriate for patients' needs.

88. I also understand a POSITA would have had a reasonable expectation of success in combining Chishti-876's pattern features with Chishti-511, as both disclose similar computer-implemented systems for patient treatment planning. Ex-1017, ¶¶ 63-64 (citing Ex-1004, 2:45-53; Ex-1005, 15:1-3).

89. In my opinion, a POSITA also would have been motivated to combine Chishti-876's teachings regarding a schedule of movement indicating whether or not each dental object moves during each of the treatment stages and determining the number of stages, as this modification would provide transparency and predictability

to the patient and clinician, as well as improve treatment efficiency. Chishti-511 already discloses calculating the movement of each dental object over the treatment plan to ensure that movement complies with orthodontically acceptable thresholds, and it further discloses calculating the steps of the treatment plan to accomplish the necessary repositioning in the quickest fashion. *See, e.g.*, Ex-1004, 4:15-22, 4:7-12. A POSITA would thus have been motivated to look to Chishti-876, which explains that the system determines whether or not teeth move during each discrete stage of the treatment plan. Ex-1005, 10:11-18. Such a change would be beneficial, as it would allow both patients and clinicians to understand whether/when teeth would move during treatment, as well as how many stages would be required for each tooth (determining the number of stages). Determining the number of stages would also benefit the system, as it would allow it to compare treatments to see which is “quickest.” Ex-1004, 4:7-12. A POSITA would understand that this would benefit the patient, as plans with fewer treatment stages may achieve patient’s goals more quickly, decrease patient discomfort, be more economical if fewer aligners or consultations are required, and increase the potential for successful outcomes.

90. I also understand that a POSITA would have had a reasonable expectation of success in combining these teachings of Chishti-876 with Chishti-511. Ex-1017, ¶¶ 74-76.

91. For the various features of Chishti-876, Sachdeva, and Becker discussed in this declaration, in my opinion, those various features would not have interfered with one another when combined with Chishti-511's system. *See also* Ex-1017, ¶ 79.

IX. Ground of Unpatentability

92. Based on my review of the materials set forth above, including my application of the knowledge of a POSITA, it is my opinion that the Challenged Claims of the '456 patent would have been obvious to one of ordinary skill in the art at the time of the purported invention (August 30, 2006).

93. In particular, it is my opinion that the Challenged Claims of the '456 patent would have been obvious to one of ordinary skill in the art based on the grounds shown below:

Ground	Claim(s) Challenged	35 U.S.C.	References
1	1-9, 11, 13-17	§ 103	Chishti-511, Chishti-876, and Sachdeva
2	10, 12, 18, 19	§ 103	Chishti-511, Chishti-876, Sachdeva, and Becker

X. Claims 1-19 of the '456 Patent Are Unpatentable

94. In my opinion, and for the reasons I have provided below in each asserted ground of unpatentability, claims 1-9, 11, and 13-17 of the '456 patent would have been obvious based on the teachings of Chishti-511 in view of Chishti-876, and Sachdeva, and claims 10, 12, 18, and 19 would have been obvious based on the teachings of Chishti-511 in view of Chishti-876, Sachdeva, and Becker.

A. Chishti-511 in View of Chishti-876 and Sachdeva Renders Obvious Claims 1-9, 11, and 13-17

95. In my opinion, Chishti-511 in view of Chishti-876 and Sachdeva renders obvious claims 1-9, 11, and 13-17.

1. Independent Claim 1

a. [1(pre)] A computer-implemented method comprising:

96. In my opinion, to the extent the preamble is limiting, Chishti-511 discloses a “computer-implemented method” for orthodontic treatment planning. Ex-1004, Abstract (providing for “[m]ethods and corresponding apparatus for segmenting an orthodontic treatment path into clinically appropriate substeps for repositioning the teeth of patient”); *see also* Ex-1004, 1:33-39, 2:34-39, 10:19-51. Chishti-876 and Sachdeva similarly disclose that their relevant steps are computer implemented. *See* Ex-1005, 13:23-48, 23:7-32; Ex-1007, 4:39-49.

b. [1(a)] determining a schedule of movement for dental objects during treatment stages of an orthodontic

treatment, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;

97. In my opinion, Chishti-511 alone or in view of Chishti-876 renders this feature obvious.

98. Chishti-511 discloses that, after establishing beginning and final positions for each tooth (dental object) undergoing orthodontic treatment, the process “defines a tooth path for the motion of each tooth.” Ex-1004, 4:7-22. “The tooth paths are segmented,” such that the “end points of each path segment” represent a “clinically viable repositioning,” and “the aggregate of segment end points constitute[s] a clinically viable sequence of tooth positions.” *Id.* The segmented tooth paths are then “used to calculate clinically acceptable appliance configurations.” Ex-1004, 4:51-67. Each step of the schedule “indicates whether or not each of the dental objects moves during each of the treatment stages.”

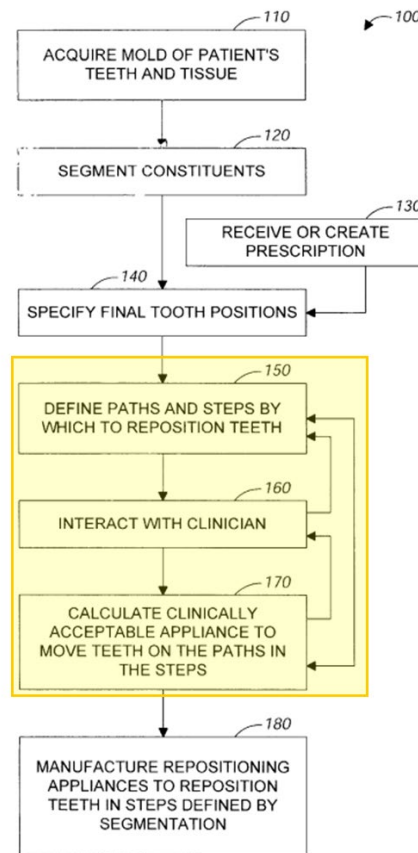


FIG. 1

Ex-1004, Fig. 1 (annotated).

99. The segmented tooth paths are “used to calculate clinically acceptable appliance configurations . . . that will move the teeth on the defined treatment path in the steps specified by the path segments.” Ex-1004, 4:51-67. In my opinion, a POSITA would have understood that the sequence of tooth positions and corresponding appliance configurations is a schedule of movement that indicates whether or not a dental object moves during each of the treatment stages. *See*

Ex-1004, 6:63-66 (noting that some teeth may be identified as immobile, further indicating that the schedule reflects whether or not a tooth moves).

100. In my opinion, to the extent it is argued that this feature is not rendered obvious by Chishti-511, Chishti-876 likewise discloses and renders obvious this feature. For the reasons explained in Section VIII., in my opinion, a POSITA would have been motivated to modify Chishti-511 to include Chishti-876's teachings regarding generating a schedule of movement indicating whether each dental object moves during each of the treatment stages. Chishti-876 discloses that its system will "define or map the movement of selected individual teeth from the initial position to the final position over a series of successive steps." Ex-1005, 9:13-19; *see also* Ex-1005, 7:13-19, Fig. 3. Chishti-876's system "takes into consideration" "[m]ovement: a detailed, sequential description of how the patient's teeth should be moved in order to accomplish the desired goals for final placement," which is a section of the treatment plan that "specifies an order [of] moving the patient's teeth." Ex-1005, 9:33-45, 10:12-14. Using these teachings, "a plan is generated for moving teeth" (a "schedule of movement"). Ex-1005, 10:29-34. Chishti-876 further explains that its system "considers a set of movement constraints which affect the tooth path movement plan," and that such considerations include, for example: "[s]pace," "[t]eeth moving past each other," "[w]hich teeth are moving when?" and "[w]hich teeth need to be moved before others are moved?" Ex-1005, 11:32-65.

101. As shown in the annotated diagram below, Chishti-876's schedule of movement shows for each treatment stage whether each tooth is moving (annotated green for the leftmost tooth) or not moving (annotated red for the leftmost tooth).

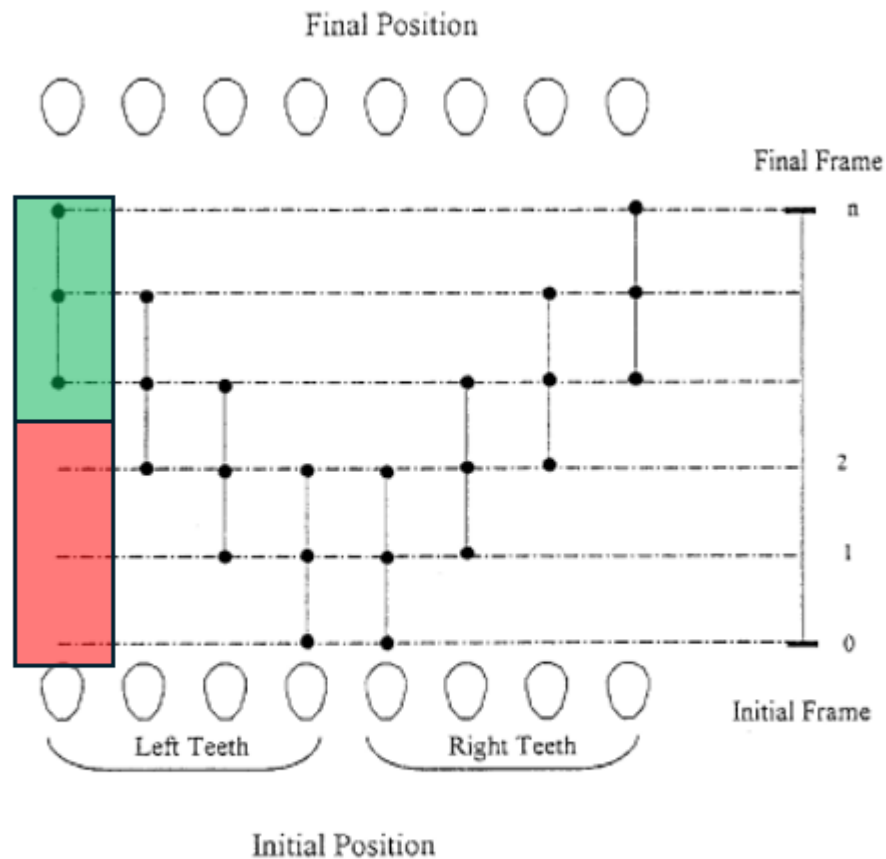


FIG. 11

Ex-1005, Fig. 11 (annotated), 17:1-7.

102. Chishti-876 also describes “a two-dimensional array” that is “used to track specific movements for each tooth at a specific period of time.” Ex-1005,

11:38-40. “One dimension of this array relates to teeth identification, while the second dimension relates to the time periods or stages.” Ex-1005, 11:41-43. Chishti-876 further provides examples of its schedule of movement. For example, it provides a “diagram of the A type movement.” Ex-1005, 17:1-7, Fig. 11. With that movement type, “the next tooth starts to move when the current tooth reaches midway to the current tooth’s goal position.” *Id.*

103. Thus, in my opinion, Chishti-876’s schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages. And for the reasons discussed in Section VIII, in my opinion, a POSITA would have been motivated to combine the teachings of Chishti-511 and Chishti-876.

c. [1(b)] calculating a respective treatment path for each of the dental objects between their respective initial position and respective final position;

104. In my opinion, Chishti-511 discloses this feature, teaching that its system “defines a tooth path” (calculating a respective treatment path) “for the motion of each tooth,” which includes “bring[ing] the teeth from their *initial positions* to their desired *final positions*.” Ex-1004, 4:7-22 (emphases added); *see also* Ex-1004, 4:51-67 (explaining that the segmented tooth paths “are used to calculate clinically acceptable appliance configurations” that “will move the teeth on the defined treatment path in the steps specified by the path segments”), 11:4-8 (claiming a “computer-implemented method for segmenting an orthodontic

treatment path,” which includes moving each “tooth from an initial position to a final position”). Chishti-511 further explains that the segmented tooth paths “are used to calculate clinically acceptable appliance configurations” that “will move the teeth on the defined treatment path in the steps specified by the path segments” (during the treatment stages). Ex-1004, 4:51-67.

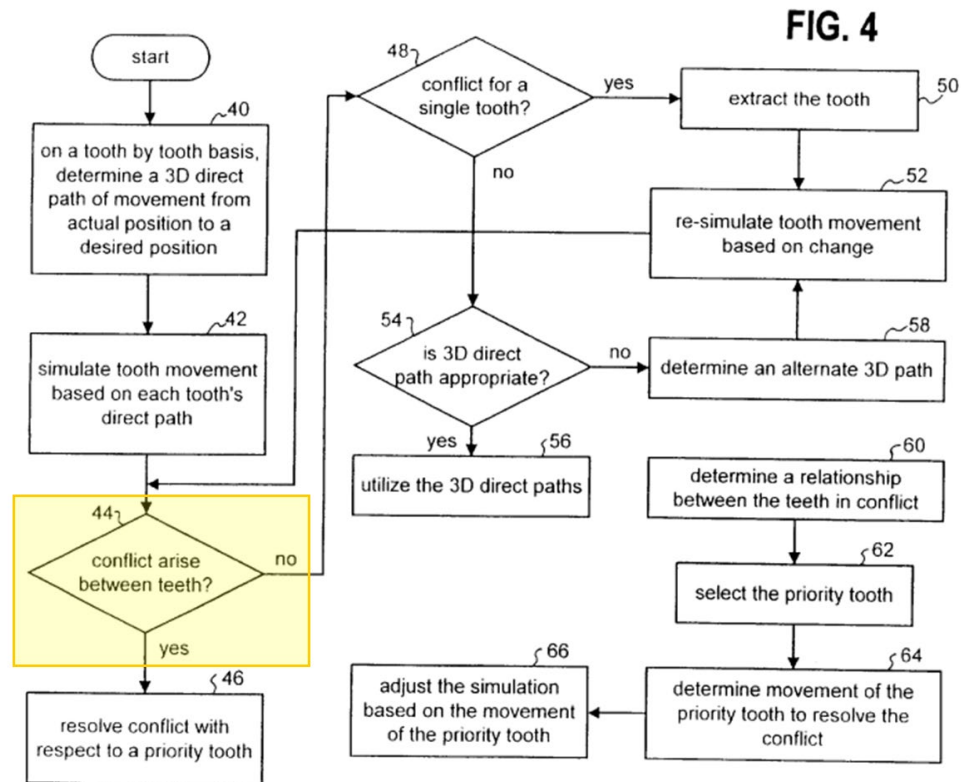
d. [1(c)] identifying a collision between a first of the dental objects and a second of the dental objects based at least on the schedule of movement of the dental objects and the respective treatment paths;

105. In my opinion, Chishti-511 alone or in view of Sachdeva renders this limitation obvious.

106. Chishti-511’s solution seeks a “clinically viable sequence of tooth positions” that “do[] not result in a collision of teeth.” Ex-1004, 4:7-22. Chishti-511 further states that new proposed aligners will be calculated if the system determines that teeth motion is not “orthodontically acceptable” or if “an acceptable end position is not reached by the teeth.” Ex-1004, 5:25-32. In my opinion, a POSITA would have understood that a schedule of movement resulting in a collision would be orthodontically unacceptable and unlikely to reach an acceptable end position. Chishti-511 further teaches that, when aligners are unacceptable, “the process transfers control to a path definition process . . . to redefine those parts of the treatment path having unacceptable aligners.” Ex-1004, 8:42-61. Chishti-511 further

discusses resolving this unacceptability by “changing the segmentation” or “changing the path followed by one or more teeth.” Ex-1004, 8:54-61. Thus, during Chishti-511’s treatment-planning process, the system identifies unacceptable movements, including those resulting in a collision based on respective teeth paths, so that the schedule of movement can be redefined.

107. In my opinion, for the reasons discussed in Section VIII, a POSITA would have been motivated to modify Chishti-511 to include Sachdeva’s collision identification teachings. During Sachdeva’s treatment-planning process, the computer “simulate[s] tooth movement based on each tooth’s direct path” and determines if “a conflict in movement arose between at least two teeth.” Ex-1007, 5:3-8, Fig. 4.



Ex-1007, Fig. 4 (annotated). Sachdeva explains that a conflict may arise if the “movement of one tooth interferes with the direct path movement of another tooth” (i.e., a collision), “causing a particular tooth to not be able to obtain its desired position.” Ex-1007, 5:3-8. Moreover, Sachdeva recognizes that a conflict may arise by teeth scheduled to move together and may be resolved by the system changing the schedule of movement (as discussed below for limitations 1(d) and 1(e)). Ex-1007, 5:9-26; Sections X.A.1.e-.f. Thus, Sachdeva discloses a system identifying a collision between a first of the dental objects and a second of the dental objects based at least on their respective treatment paths.

e. [1(d)] performing a first modification of the schedule of movement in response to the identifying,

108. In my opinion, Chishti-511 alone or in view of Sachdeva renders this limitation obvious.

109. Chishti-511 discloses that, when aligners are unacceptable, “the process transfers control to a path definition process . . . to redefine those parts of the treatment path having unacceptable aligners.” Ex-1004, 8:42-61; *see also* Ex-1004, 4:7-50, 5:7-32, Figs. 1, 2, 4, 6; *see also* Ex-1004, 6:57-7:8 (describing determining whether the “previously evaluated aligner was found to violate one or more constraints,” and if “the end position and dynamics of motion of the currently selected tooth by the previously selected aligner” are not acceptable, “a change in the aligner is calculated in the region of the currently selected tooth (step 450)”), 8:29-9:2 (describing that after “an aligner configuration has been found for each step or segment of the treatment path (step 604), the overall process 600 determines whether all of the aligners are acceptable (step 606)”), Figs. 4, 6. In my opinion, a POSITA would have understood this is performed in response to identifying a collision, as Chishti-511 discloses seeking a “clinically viable sequence of tooth positions” that “does not result in a collision of teeth.” Ex-1004, 4:7-22; *see also* Ex-1004, 8:42-9:14 (disclosing “[a]ligners may be unacceptable for a variety of reasons”), 5:7-32; *supra* Section X.A.1.d (limitation 1(c)).

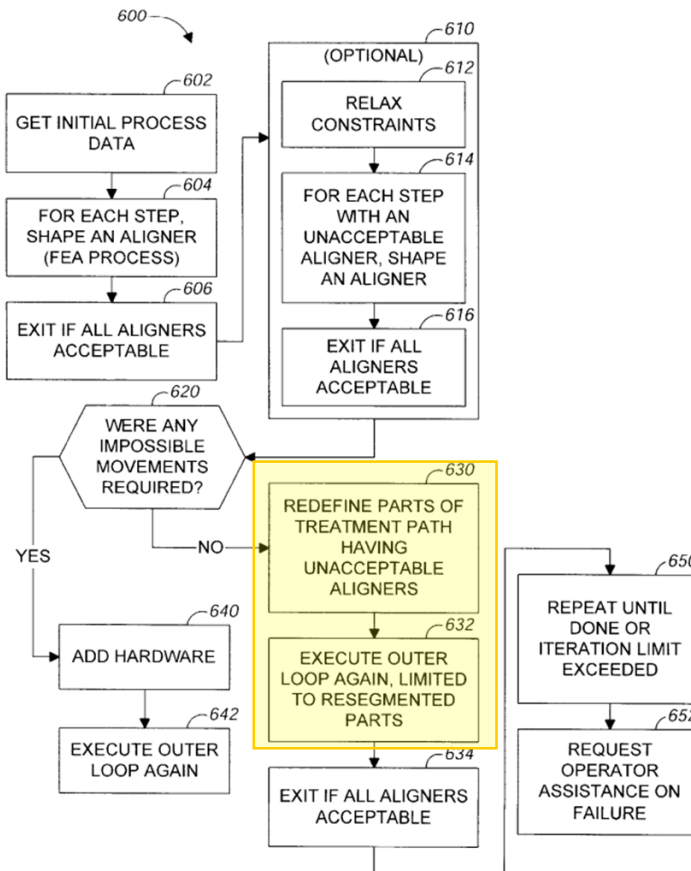
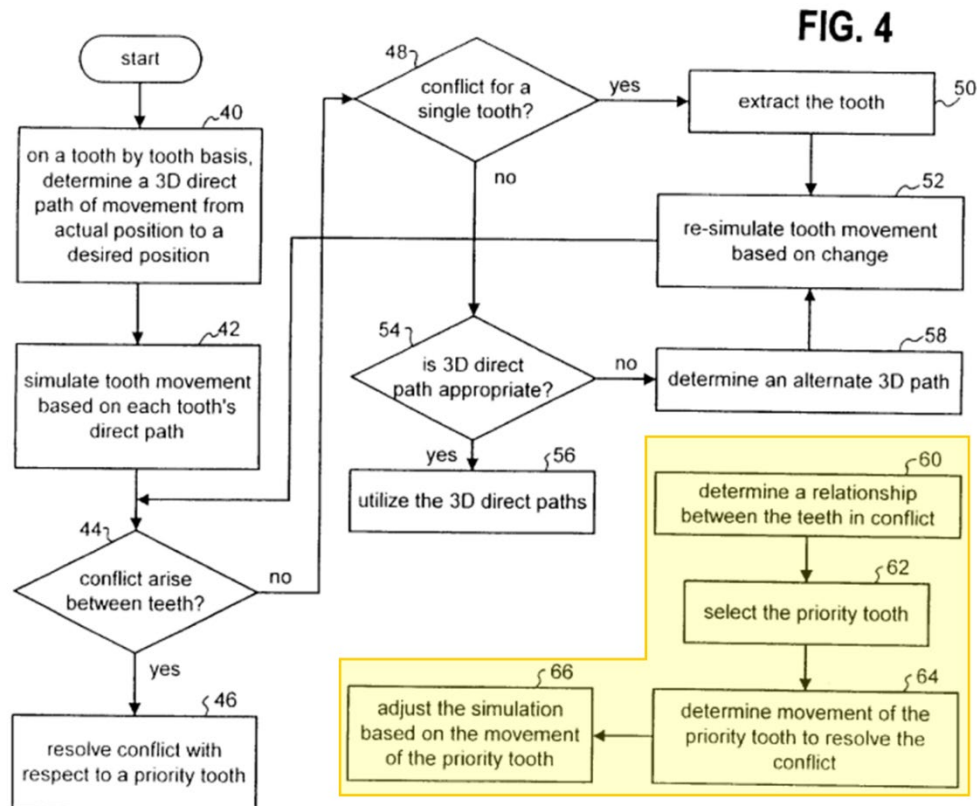


FIG. 6

Ex-1004, Fig. 6 (annotated). Thus, this path redefinition will be performed “in response to the identifying” of a collision.

110. If the processor identifies a collision, the path redefinition process will perform “a first modification of the schedule of movement” to avoid the collision, as Chishti-511 explains that its modifications include “changing the increments of tooth motion, i.e., changing the segmentation, on the treatment path, changing the path followed by one or more teeth in the treatment path, or both.” Ex-1004, 8:54-61; *see also* Ex-1004, Figs. 4, 6.

111. If it is argued that Chishti-511 does not expressly disclose modifying the schedule of movement in response to “identifying a collision,” Sachdeva does. *Supra* Section VIII. As discussed for limitation 1(c), Sachdeva identifies a collision. *Supra* Section X.A.1.d. Sachdeva further explains that, “[i]f a conflict arose” (i.e., in response to the identifying), the system will change the “movement of the priority tooth . . . to resolve the conflict” (performing a first modification of the schedule of movement). Ex-1007, Fig. 4; *see also* Ex-1007, 5:9-36 (discussing delaying a tooth in response to identifying a collision); *infra* Section X.A.1.f (limitation 1(e), discussing Sachdeva’s delaying modification).



Ex-1007, Fig. 4 (annotated). By delaying the nonpriority tooth that resulted in a collision (as discussed for limitation 1(e)), Sachdeva performs a first modification of the schedule of movement in response to the identifying (to avoid the collision). As discussed in Section VIII, a POSITA would have been motivated to implement Sachdeva's modification of a schedule of movement in response to identifying a collision in Chishti-511's system.

f. [1(e)] the first modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages;

112. In my opinion, Sachdeva discloses this feature.

113. As explained above for limitations 1(c) and 1(d), Sachdeva describes a process for identifying collisions and modifying the schedule of movement to resolve them. *Supra* Sections X.A.1.d-e. Sachdeva discloses that its collision-avoidance process selects a “priority tooth” between the colliding teeth. Ex-1007, 5:9-26. It explains that “the actual position of the tooth will dictate” which tooth has “priority.” *Id.* “If the lower tooth protrudes[,] preventing the upper tooth from moving back, the lower tooth must be moved before the upper tooth can be positioned. Conversely, if the upper tooth is interfering with the lower tooth from being moved out, the upper tooth must first be moved.” *Id.*

114. In my opinion, a POSITA would have understood that, often, teeth will move at the same time if possible. In the examples provided by Sachdeva, however, two teeth are prevented from initially moving together due to interfering with each other. Sachdeva's system modifies the schedule of movement for the nonpriority tooth so that instead of moving with the priority tooth, the nonpriority tooth's initial movement is instead delayed and moved after the priority tooth in a later treatment stage. Thus, Sachdeva's modification modifies "whether or not at least one of the dental objects move[s] during at least one of the treatment stages."

115. For the reasons explained in Section VIII, a POSITA would have been motivated to modify Chishti-511 to include Sachdeva's collision-avoidance techniques.

g. [1(f)] determining that the first modification does not avoid a collision between the first of the dental objects and the second of the dental objects; and

116. In my opinion, Chishti-511 alone or in view of Sachdeva discloses and renders this feature obvious.

117. Chishti-511 discloses that "[a]fter the treatment path has been redefined" to account for the unacceptable aligners, the process is re-executed to ensure all aligners are now acceptable (i.e., the collisions have been resolved and there are no further collisions). Ex-1004, 8:54-9:14. If the system determines that unacceptable aligners still remain, the process repeats, performing additional

modifications “until an acceptable set of aligners is found or an iteration limit is exceeded.” *Id.* Thus, Chishti-511 discloses an iterative process that continues to evaluate its planned treatment until it attains an acceptable treatment path without collisions.

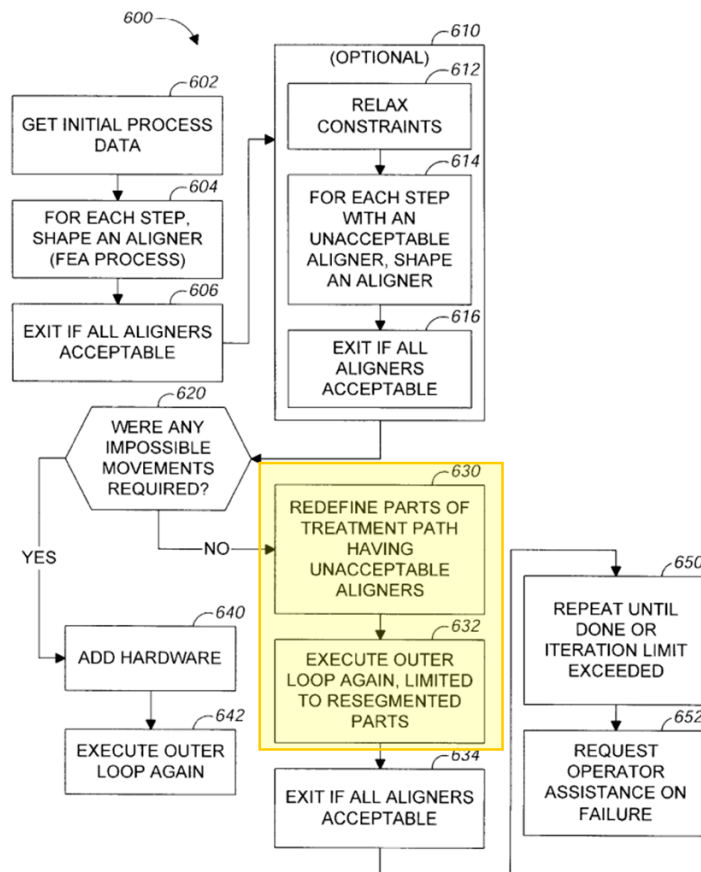


FIG. 6

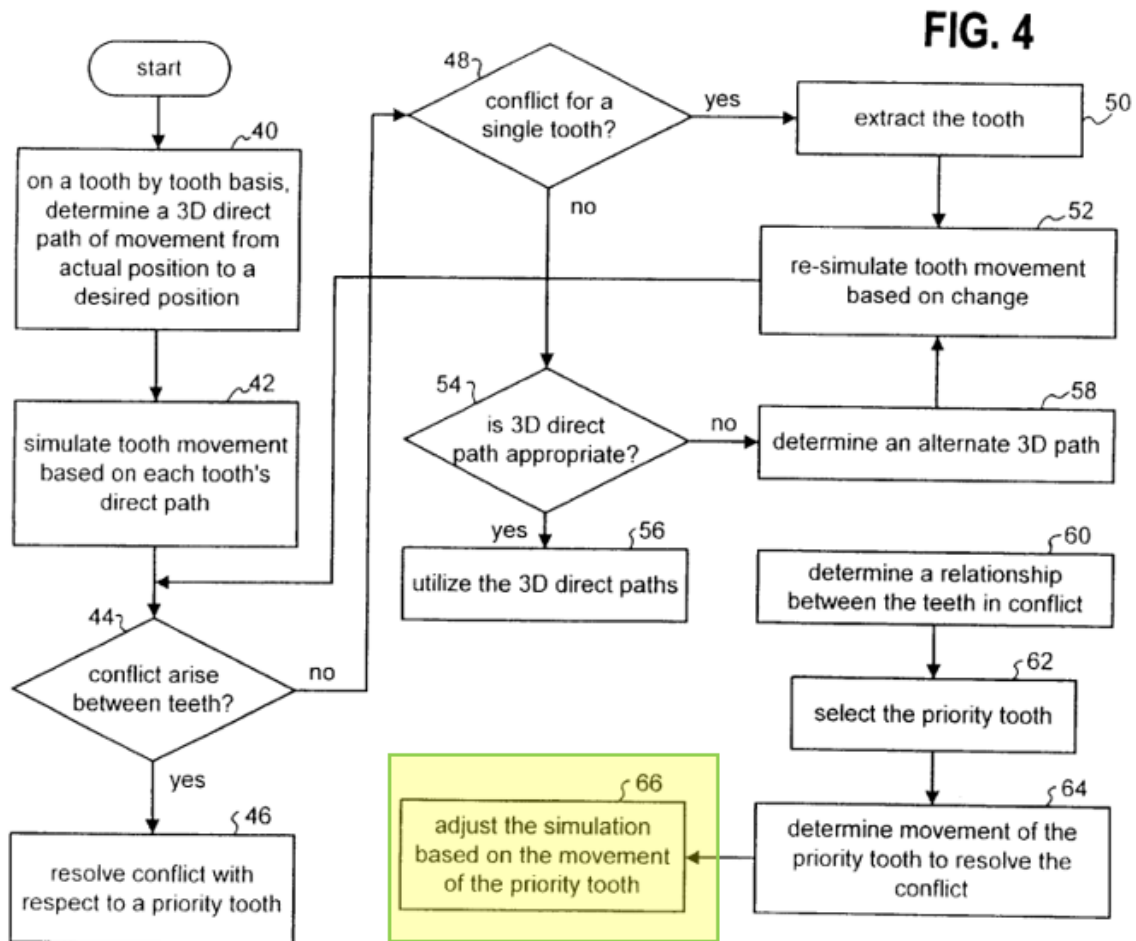
Ex-1004, Fig. 6 (annotated).

118. Thus, the same steps of the combined system discussed in limitations 1(c)-1(d) will be iteratively performed to determine whether the treatment plan is acceptable. *Supra* Sections X.A.1.d-.e. In my opinion, because Chishti-511 (alone

or in view of Sachdeva) continues to check if the aligners are acceptable as the process loops, a POSITA would have understood that its process determines whether the first modification successfully avoided the collision between the first and second dental objects, including determining if the modification did not avoid a collision.

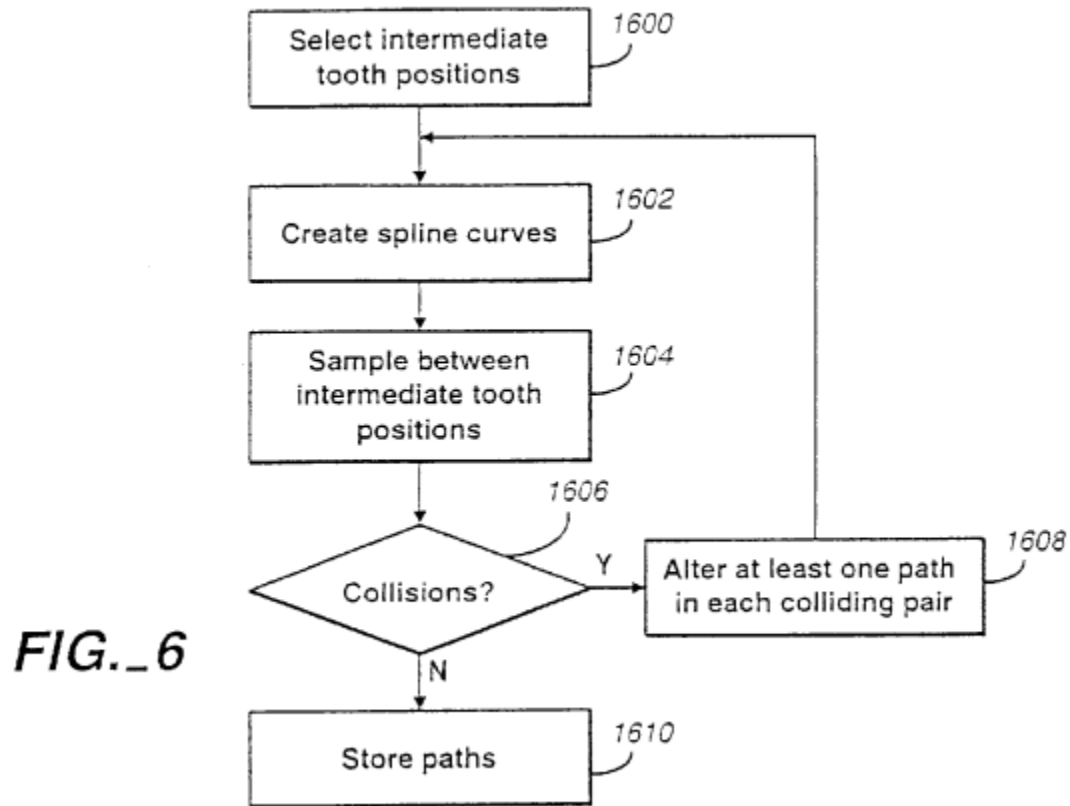
Ex-1004, 4:18-22, 4:51-56, 5:25-43, 8:29-35, Figs. 1, 2, 4, 6.

119. This understanding of the combined system is also consistent with Sachdeva, which discloses that “the simulation is adjusted based on the movement” previously performed to avoid a collision. Ex-1007, 5:29-32; *see also* Ex-1007, Fig. 4 (annotated below):



Thus, like Chishti-511, Sachdeva's system will continue simulating results to detect additional potential collisions.

120. Chishti-876 likewise discloses that its system “alters the path” when detecting a collision and the “program then samples the new path (1604) and again applies the collision detection algorithm (1606).” Ex-1005, 13:38-48, Fig. 6. Chishti-876 explains that “[t]he program continues in this manner until no collisions are detected.” Ex-1005, 13:38-48.



Ex-1005, Fig. 6. Thus, in my opinion, this feature was well known and would have been obvious in view of the combined system, and a POSITA would have been motivated to make the combination for the reasons discussed in Section VIII.

- h. [1(g)] performing a second modification of the schedule of movement after the determining that the first modification does not avoid a collision, the second modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages.**

121. In my opinion, Chishti-511 in view of Sachdeva renders this limitation obvious.

122. As explained above, Chishti-511 details an iterative process. *Supra* Section X.A.1.g (limitation 1(f)). Therefore, similar to the combination's teaching of limitation 1(d), the combination likewise teaches performing a second modification "to redefine those parts of the treatment path [still] having unacceptable aligners." Ex-1004, 8:54-9:14; *supra* Section X.A.1.e. Indeed, as discussed, the system "repeat[s] until an acceptable set of aligners is found or an iteration limit is exceeded." *Id.* Thus, Chishti-511's path definition process will repeat and those unacceptable portions of the treatment path will be redefined if the first modification did not avoid a collision and the system will perform a second modification on subsequent iterations. *Id.*

123. For example, Chishti-511 explains that after "an aligner configuration has been found for each step or segment of the treatment path (step 604), the overall process 600 determines whether all of the aligners are acceptable (step 606)." Ex-1004, 8:29-32. "If they are, the process exits and is complete. Otherwise, the process optionally undertakes a set of steps 610 in an attempt to calculate a set of acceptable aligners." Ex-1004, 8:32-35. "[R]edefin[ing] those parts of the treatment path having unacceptable aligners (step 630)" includes "changing the increments of tooth motion, i.e., changing the segmentation, on the treatment path, changing the path followed by one or more teeth in the treatment path, or both." Ex-1004, 8:54-61, Fig. 6. And "[a]fter the treatment path has been redefined, the outer loop of the

overall process is executed again (step 632).” Ex-1004, 8:61-63, Fig. 6. “[T]he overall process can be repeated until an acceptable set of aligners is found or an iteration limit is exceeded (step 650).” Ex-1004, 8:66-9:2, Fig. 6.

124. It would have been obvious to a POSITA to combine Chishti-511 with Sachdeva to likewise leverage Sachdeva’s that “[i]f a conflict arose” (i.e., in response to the identifying), the system will change the “movement of the priority tooth . . . to resolve the conflict” to perform a second modification of the schedule of movement. Ex-1007, 5:9-36. A POSITA would recognize that different parameters for Sachdeva’s modification technique would be available depending on the needs of the patient. For example, if it was found that the nonpriority tooth was not delayed long enough to avoid the collision, the length of the delay of the nonpriority tooth may be extended to additional treatment stages (thus further modifying whether or not the dental object moved during a treatment stage). Similarly, the system may seek to adjust which tooth is the priority tooth, thus delaying what was previously set as the priority tooth and moving what was previously the nonpriority tooth. Similarly, the second modification may include stopping a tooth that was previously scheduled to move to avoid a collision. These modifications would adjust “whether or not at least one of the dental objects move[s] during . . . [a] treatment stage[.]” *Id.* In my opinion, a POSITA also would have understood that modifying a schedule to include Sachdeva’s delaying technique is

one of a finite number of identified, predictable solutions, and they would have been motivated to do so for the reasons discussed in Section VIII. It also would have involved no more than combining prior art elements according to known methods to yield predictable results.

2. Dependent Claim 2: The method of claim 1, wherein the schedule of movement is determined by selection by a user.

125. In my opinion, Chishti-876 renders this limitation obvious. Chishti-876 discloses that its process “allows a user to select one move pattern from a plurality of move patterns” to complete the desired dental repositioning. Ex-1005, 17:17-19, 17:65-67 (“In summary, the process 2100 directs the procedure to an appropriate process depending on the move pattern that is *specified by the user*.” (emphasis added)).

126. Chishti-876 also discloses that its schedule of movement can be determined by the user-selected pattern. Chishti-876 explains that each treatment pattern presents a “transformation curve” applied to each tooth in order “to move th[at] tooth from its initial position to its final position.” Ex-1005, 12:38-43. Chishti-876 further explains that its system “generat[es] the malocclusion treatment plan in accordance with the selected treatment pattern.” Ex-1005, 2:63-3:5, 2:20-25. Using these patterns, Chishti-876 explains that it will “define or map the movement of selected individual teeth from the initial position to the final position over a series

of successive steps.” Ex-1005, 9:13-19; *see also* Ex-1005, Abstract, 2:63-3:5, 3:24-33 (explaining that its algorithm draws upon a library of predetermined tooth-treatment movement patterns).

127. For the reasons discussed in Section VIII, in my opinion, a POSITA would have been motivated to modify Chishti-511 to include the teachings generating a schedule of movement using selected movement patterns, as in Chishti-876.

3. Dependent Claim 3: The method of claim 1, wherein the schedule of movement includes one of an all-equal pattern, an A-shaped pattern, a V-shaped pattern, a mid-line shift pattern, or a[n] M-shaped pattern.

128. In my opinion, Chishti-876 discloses and renders obvious this limitation.

129. As discussed for claim 2, Chishti-876’s system uses teeth treatment patterns to generate a schedule of movement. *Supra* Section X.A.2; *see also* Ex-1005, Abstract, 2:63-3:5, 3:24-33. Chishti-876 discloses various “patterns” of teeth movements, including an “[a]ll [e]qual” pattern, an A-type pattern, and a V-type pattern. Ex-1005, 16:53-17:13.

130. With the “[a]ll [e]qual [m]ovement” pattern, “all teeth in a given group are moving at the same time.” Ex-1005, 16:57-67. Figure 10, shown below, illustrates a schedule of movement using an all-equal pattern:

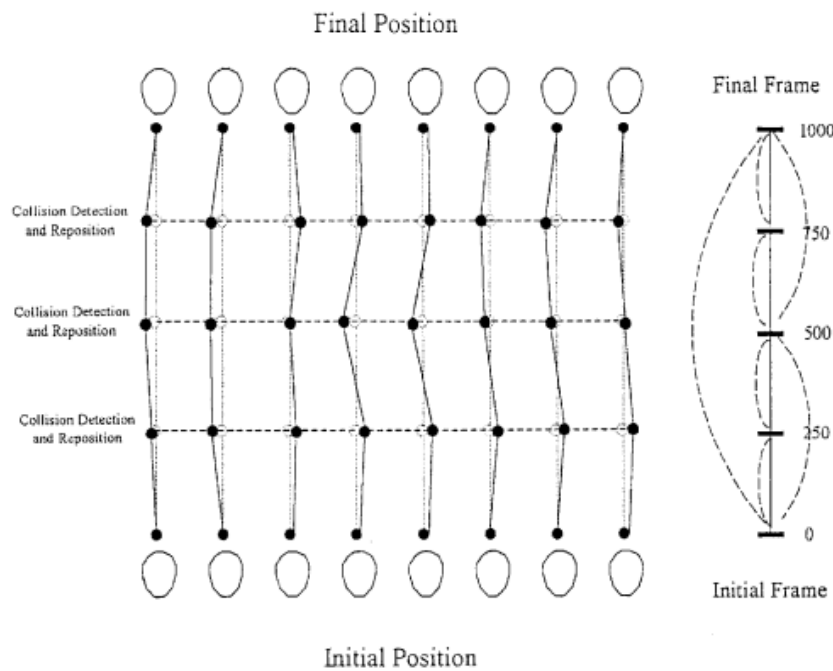


FIG. 10

Ex-1005, Fig. 10. As shown above, all of the patient's teeth move in parallel with one another, as all of the patient's teeth that need to move begin moving at the same stage and finish moving at the same stage. Thus, this satisfies the parties' agreed construction of an "all-equal pattern." Ex-1013, 8. Notably, this is the same general pattern as shown in the '456 patent. *See* Ex-1001, 2:50-52, Fig. 3.

131. Chishti-876 also discloses an A-shaped pattern, which it calls an "A-type movement," explaining that with "this type of movement, the anterior tooth moves first, followed by the posterior teeth." Ex-1005, 17:1-7. This pattern is shown below:

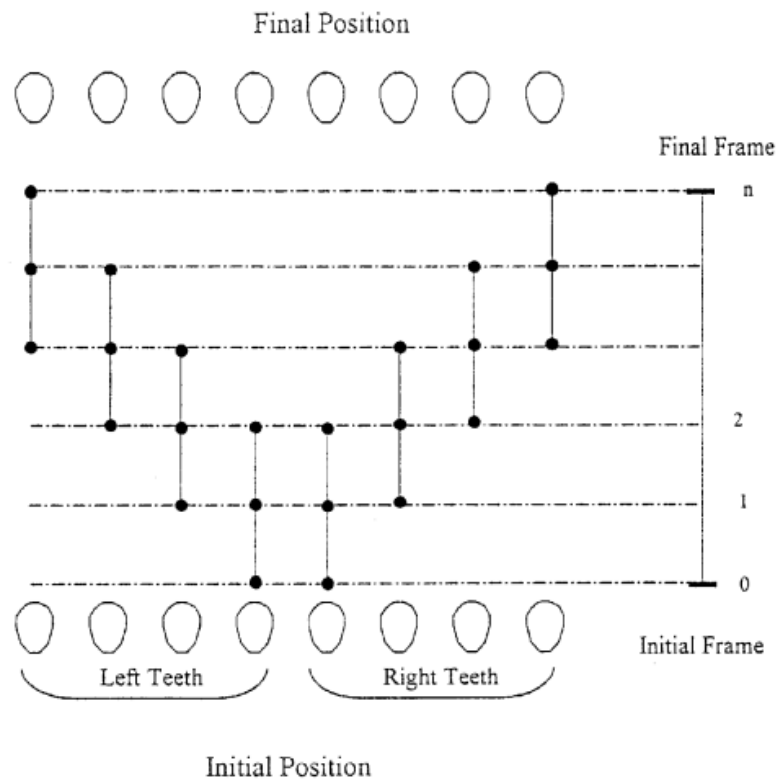
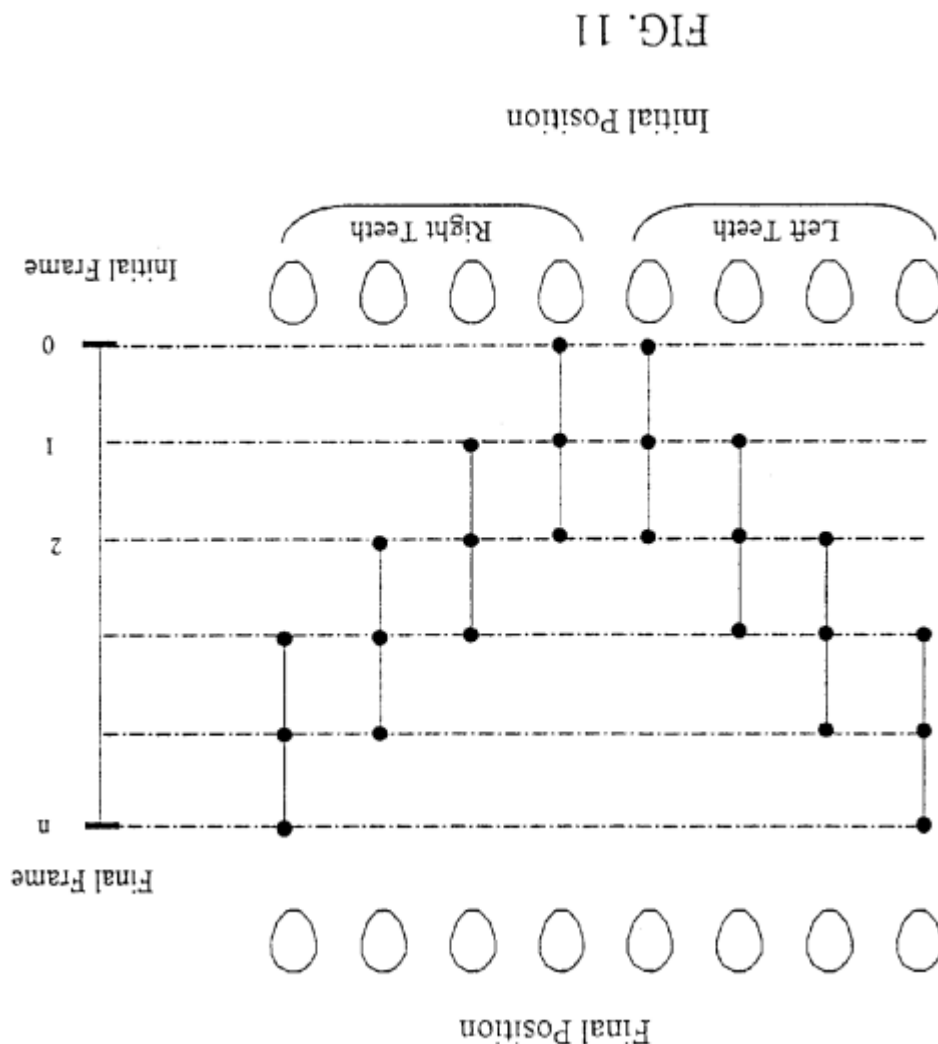


FIG. 11

Ex-1005, Fig. 11.

132. This satisfies the construction for A-shaped pattern, which is “A pattern where teeth having the same and/or similar positions on the arch will be moved beginning at the same stage, and will move continuously until they reach their final position, with the most anterior-positioned teeth (e.g., the incisors, or teeth in positions 1 and/or 2) moving first and then the next posterior-positioned teeth sequentially moving until all of the teeth reach their final position.” As shown above, the most anterior-positioned teeth begin moving first, with next posterior-positioned teeth sequentially moving until all of the teeth reach their final position. Also, teeth

with similar positions are moved together beginning at the same stage and are moved continuously until they reach their final position. Thus, Chishti-876 discloses this pattern under ClearCorrect's construction or plain and ordinary meaning. *See* Ex-1013, 2-3. While Chishti-876 shows its pattern with the first stages depicted on the bottom, a reorientation of the image with the first stages depicted on top shows why Chishti-876 explains that the "movement looks like an A character." Ex-1005, 17:3-4.



Ex-1005, Fig. 11 (reoriented). The '456 patent depicts its A-shaped pattern with the same shape. *See* Ex-1001, 2:53-54, Fig. 4. Thus, regardless of the construction of “A-shaped pattern,” the prior art shows at least as much as is disclosed in the '456 patent itself. Chishti-876 similarly discloses a V-shaped pattern. *See* Ex-1005, 17:8-13, Fig. 12.

133. For the reasons explained in Section VIII, it would have been obvious to modify Chishti-511 to include Chishti-876’s teachings regarding the use of the various disclosed movement patterns.

4. Dependent Claim 4: The method of claim 1, wherein the determining the schedule of movement comprises analyzing, by a computer processor, the dental objects in their respective initial positions and respective final positions.

134. In my opinion, Chishti-511 alone or in view of Chishti-876 renders this limitation obvious.

135. Chishti-511 explains that, after “[h]aving both a beginning position and a final position for each tooth, the process next defines a tooth path for the motion of each tooth.” Ex-1004, 4:7-22. These initial and final tooth positions are analyzed by the system to “optimize[]” the tooth paths “so that the teeth are moved in the quickest fashion . . . to bring the teeth from their initial positions to their desired final positions.” *Id.* Chishti-511 also explains that the steps of its method may be performed on a computer by a computer processor. Ex-1004, 2:34-39, 3:31-39,

10:19-51. A POSITA would have understood that, while creating the acceptable tooth paths, Chishti-511's processor analyzes the dental objects in their respective initial positions and respective final positions.

136. In my opinion, if it is argued that Chishti-511 does not disclose this limitation, it would have been obvious in view of Chishti-876. Chishti-876 teaches that when selecting a movement pattern, its system "takes into consideration the following: 1. ***Initial Position***: a detailed description of the initial malocclusion [sic]," and "2. ***Final Position***: a detailed description of treatment goals for the patient." Ex-1005, 9:34-67 (emphases added). Indeed, Chishti-876 explains that its "program receives as input the ***initial and final positions*** of the patient's teeth and uses this information to select intermediate positions for each tooth to be moved." Ex-1005, 13:27-30 (emphasis added). Thus, Chishti-876's determination of the schedule of movement includes analyzing the dental objects in their respective initial and final positions. Chishti-876 also discloses a computer processor for executing instructions to perform its steps. *See* Ex-1005, 13:23-48, 23:7-32.

137. In my opinion, a POSITA would have been motivated to analyze the dental objects in their initial and final positions because this data would assist in analyzing whether the dental objects started and ended in their correct locations and to identify whether the generated paths had been "optimized" as taught by Chishti-511. Ex-1004, 4:7-12. I understand that a POSITA also would have had a reasonable

expectation of success in combining Chishti-511 and Chishti-876 because it would involve a mere software modification. And because Chishti-511 already has access to the initial and final positions, as used in Chishti-876, the modification would merely involve analyzing those positions when determining tooth paths to ensure that the teeth travel from the initial to final positions. Ex-1017, ¶¶ 77-78.

5. Dependent Claim 5: The method of claim 4, wherein the analyzing comprises determining a respective distance needed to move each of the dental objects from their respective initial positions to their respective final positions.

138. In my opinion, Chishti-876 discloses this feature. The '456 patent admits that “the computer program can suitably calculate distances between a first tooth and a second tooth and then apply geometrical techniques, such as those disclosed in [Chishti-876].” Ex-1001, 6:47-54.

139. Chishti-876 discloses that “determining a tooth path comprises finding a collision[-]free shortest path between an initial position and a final position for one or more teeth.” Ex-1005, 23:65-67; *see also* Ex-1005, 2:28-30, 13:33-35, 14:25-40, Fig. 7. In my opinion, a POSITA would have understood that determining a “shortest” path would include determining a distance between an initial position and final position to determine which collision-free path is shortest. Chishti-876 also discloses that with its X-type or “all equal” movement pattern, the system determines the schedule of movement by first analyzing, for each tooth, a beginning frame and

ending frame, determining if the “moving distance” from the beginning frame to the mid frame (i.e., the first half of the distance) “meets a given criterion,” and determining whether the “moving distance” from the mid frame to the end frame (i.e., the second half of the distance) “meets a given criterion.” Ex-1005, 16:57-67, 18:1-42, Figs. 15-16. In my opinion, a POSITA would recognize that, together, these values constitute the “respective distance needed to move each of the dental objects from [its] respective initial position[] to [its] respective final position[]” which is determined and analyzed by Chishti-876’s system.

140. In my opinion, if it is argued that Chishti-876’s system does not determine the claimed distance, it would have been obvious to do so to ensure that the shortest path is found, as Chishti-876 discloses. Ex-1005, 23:65-67, 2:28-30, 13:33-35; *see also* Ex-1005, 14:25-40, Fig. 7. A POSITA would have been motivated to implement such a calculation with Chishti-511’s system to improve patient results by allowing the system to determine which paths have shorter distances and to avoid the use of paths that may violate safe movement limits, especially because Chishti-511 expresses a desire to move teeth “in the quickest fashion.” Ex-1005, 4:9-12. I also understand that a POSITA would have had a reasonable expectation of success in such a combination because Chishti-511’s system already includes the necessary information (e.g., initial and final positions,

tooth paths, and segments) (Ex-1004, 4:7-22), and such a change would involve a mere software modification. Ex-1017, ¶¶ 66-69.

6. Dependent Claim 6: The method of claim 1, further comprising producing a series of orthodontic appliances based at least on the modified schedule of movement, wherein each of the orthodontic appliances corresponds to a respective one of the treatment stages.

141. In my opinion, Chishti-511 discloses this feature.

142. As Chishti-511 explains, its system uses a “series” of adjustments “using appliances,” where “[e]ach appliance configuration represents a step along the treatment path.” Ex-1004, 4:51-67, 1:33-58. Thus, Chishti-511 discloses a series of orthodontic appliances, each corresponding to a respective treatment stage. Chishti-511 discloses that the appliances are manufactured (produced) after the schedule of movement is redefined and acceptable. Ex-1004, 4:51-5:6.

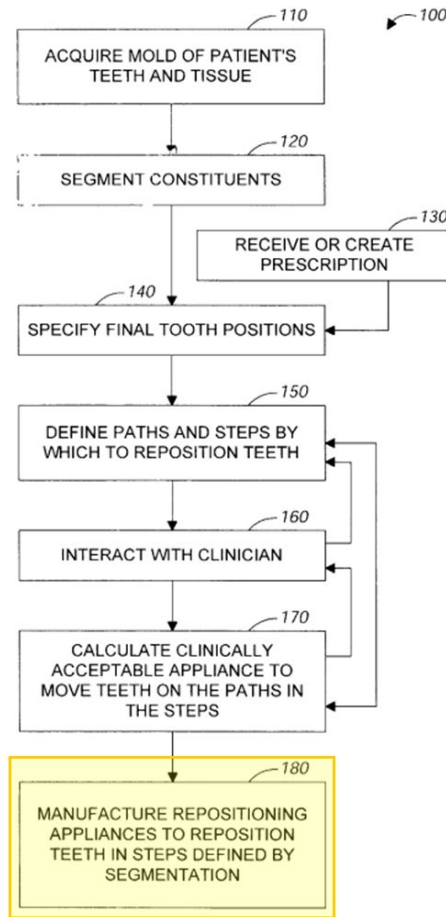


FIG. 1

Ex-1004, Fig. 1 (annotated). Thus, the series of orthodontic appliances that is produced “reposition[s] teeth in steps” based at least on the modified schedule of movement, and thus each of the orthodontic appliances corresponds to a respective one of the treatment stages. *Id.*

7. Dependent Claim 7

- a. [7(a)] The method of claim 6, wherein the producing comprises: fabricating a respective positive mold of the dental objects for at least two of the treatment stages; and**

143. In my opinion, Chishti-511 discloses this feature, explaining that it fabricates “positive models to produce the repositioning appliance[s],” and that “adding a wax patch to the digital model will generate a positive mold that has the same added wax patch geometry.” Ex-1004, 9:43-56. Each appliance configuration represents one stage (of multiple) along the treatment path. Ex-1004, 4:51-67. In my opinion, a POSITA would have understood that because this manufacturing of “positive models” is used to produce aligners for each stage of the movement pattern, “positive models” would be fabricated for at least two of the treatment stages, as claimed.

- b. [7(b)] thermoforming a respective one of the orthodontic appliances over each of the respective positive molds.**

144. In my opinion, Chishti-511 alone or in view of Chishti-876 renders this feature obvious.

145. Chishti-511 discloses that its aligners are “manufactured by pressure fitting polymeric material over a positive physical model of the digital teeth.” Ex-1004, 9:43-56. The claimed “thermoforming” fabrication is disclosed by Chishti-511’s pressure-fitting manufacturing process. A POSITA would have understood

that thermoforming is a well-known manufacturing process whereby a plastic sheet is heated to a pliable temperature, shaped into a specific form using a mold, and then cooled to maintain its new shape. Pressure-fitting a polymeric material over a positive physical model of teeth—as disclosed in Chishti-511—would be understood by a POSITA to be a type of thermoforming, as pressure-fitting uses air pressure in conjunction with the heated plastic sheet to help shape the appliance in the form of the mold. Indeed, the '456 patent admits this was known—the specification's only mention of a manufacturing technique describes “using a *conventional pressure molding* technique to form the appliance around the positive mold.” Ex-1001, 3:42-46 (emphasis added)). Thus, the '456 patent admits that the required fabrication process was merely “conventional,” and a POSITA would have understood that the '456 patent's conventional manufacturing process, which is consistent and matches Chishti-511's disclosure of pressure-fitting, makes this limitation both disclosed and rendered obvious by Chishti-511.

146. In my opinion, if it is argued that Chishti-511 does not disclose this feature, this limitation is rendered obvious by Chishti-876, which discloses that dental appliances may be a “polymeric shell” manufactured “from a thin sheet of a suitable elastomeric polymer, such as Tru-Tain 0.03 in, *thermal forming* dental material.” Ex-1005, 7:54-64 (emphasis added), 7:1-19. A POSITA would have understood that Chishti-876's disclosed thermal forming dental material would be

used to form Chishti-876's polymeric shells through the process of thermoforming the dental material over a respective positive mold (as described in Chishti-511).

147. Because Chishti-511 discloses manufacturing dental aligners using a conventional technique (Ex-1004, 9:43-56), a POSITA would have been motivated to look to known ways to manufacture the generated aligners, and Chishti-876 discloses known methods for manufacturing these dental appliances. Ex-1005, 7:54-64.

148. In my opinion, using thermoforming for dental-appliance manufacturing would have had a reasonable expectation of success, as thermoforming is just one of a finite number of identified, predictable solutions, and was a well-known and routine technique for dental-aligner manufacturing at the relevant time. The '456 patent's specification does not purport to have invented the technique. *See, e.g.*, Ex-1001, 3:38-48 ("One technique for producing an orthodontic appliance involves creating a positive mold of the patient's dentition at one of the treatment stages and using a conventional pressure molding technique to form the appliance around the positive mold."). The state of the art also confirms this technique was known. Ex-1016, 198 ("A thermoforming process is used for aligner fabrication."); Ex-1016, 18-23 (describing thermoforming to fabricate dental appliances in 1959). Accordingly, it would have been obvious to combine Chishti-

876's disclosure of thermoforming with Chishti-511's disclosure of manufacturing dental aligners.

8. Independent Claim 8

149. Claim 8 is obvious based on Chishti-511 in view of Chishti-876 and Sachdeva. Claim 8 repeats or recites features that are substantively identical to features recited in claim 1. *Compare* Ex-1001, 16:7-33, *with* Ex-1001, 16:59-17:14.

The table below shows the correspondence between the claims.

Claim 1	Claim 8
[1(pre)] A computer-implemented method comprising:	[8(pre)] A computer-implemented method comprising:
[1(a)] determining a schedule of movement for dental objects during treatment stages of an orthodontic treatment, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;	[8(a)] determining a schedule of movement for dental objects during treatment stages of an orthodontic treatment, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;
[1(b)] calculating a respective treatment path for each of the dental objects between their respective initial position and respective final position;	[8(b)] calculating a respective treatment path for each of the dental objects between their respective initial position and respective final position;
[1(c)] identifying a collision between a first of the dental objects and a second of the dental objects based at least on the schedule of movement of the dental objects and the respective treatment paths;	[8(c)] identifying a collision between a first of the dental objects and a second of the dental objects based at least on the schedule of movement of the dental objects and the respective treatment paths;
[1(d)] performing a first modification of the schedule of movement in response to the identifying,	[8(d)] performing a first modification of the schedule of movement in response to the identifying,

[1(e)] the first modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages;	[8(e)] wherein the first modification comprises delaying initial movement of the first of the dental objects;
[1(f)] determining that the first modification does not avoid a collision between the first of the dental objects and the second of the dental objects; and	[8(f)] determining that the first modification does not avoid a collision between the first of the dental objects and the second of the dental objects; and
[1(g)] performing a second modification of the schedule of movement after the determining that the first modification does not avoid a collision, the second modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages.	[8(g)] performing a second modification of the schedule of movement after the determining that the first modification does not avoid a collision.

150. One minor variation is that claim limitation 8(e) recites that the first modification “comprises delaying initial movement of the first of the dental objects.” But as discussed with respect to limitation 1(e), Sachdeva discloses “delaying initial movement of the first of the dental objects.” *Supra* Section X.A.1.f. Similarly, limitation 1(g) contains more limitations than limitation 8(g), but the overlapping limitations are identical. Ex-1003, ¶150. Accordingly, claim limitations 8(pre)-8(g) are taught or suggested for the reasons discussed here and in Sections X.A.1.a-h, which discuss the corresponding portions of claim 1.

9. Dependent Claim 9: The method of claim 8, wherein the second modification comprises slowing or stopping movement of the first of the dental objects during one or more of the treatment stages following a previous one of the treatment stages in which the first dental object moved.

151. In my opinion, Chishti-511 in view of Chishti-876 renders this limitation obvious.

152. As explained above, Chishti-511 teaches performing a second modification “to redefine those parts of the treatment path [still] having unacceptable aligners.” Ex-1004, 8:54-9:14; *supra* Sections X.A.1.g-.h (limitations 1(f)-1(g)). And while Chishti-511 explains a desire to move a patient’s teeth from one point to the next without causing a collision, it leaves open to a POSITA the methods for how to alter tooth movement to avoid a collision.

153. Chishti-876 details a flexible system “allow[ing] a great deal of freedom in planning a patient’s treatment,” including the slowing or stopping of dental objects. Ex-1005, 12:22-32. In particular, Chishti-876 discloses how movement plans may accelerate and decelerate teeth movement as necessary, and how therefore it would have been obvious, when developing a treatment plan, to make modifications that slow a tooth’s movement after a previous stage in which the tooth moved. Ex-1005, 12:25-32 (“One component may accelerate along a curve between one pair of stages (e.g., stages 3 and 8 in a treatment plan having that many stages), while another moves linearly between another pair of stages (e.g., stages 1

to 5), and then changes direction suddenly and slows down along a linear path to a later stage (e.g., stage 10).”). Thus, in Chishti-876, the one tooth (first tooth) slows—it is “scheduled to move at a rate less than the rate of other teeth” (Ex-1001, 13:4-8)—as the other tooth accelerates (whereas the first tooth moves linearly), and thereafter, the first tooth “slows down” even further relative to the other described tooth, consistent with the parties’ agreed-upon construction for slowing. Ex-1005, 12:25-31; Ex-1013, 8. Moreover, the disclosed slowing also takes place “following a previous one of the treatment stages in which the first dental object moved,” as the first tooth only further slows in a later stage. *Id.*

154. In my opinion, a POSITA would have been motivated to combine Chishti-876’s slowing technique with Chishti-511 and would have understood that this slowing movement during subsequent treatment stages may be used to avoid a collision as it would alter the rate on which one of the soon-to-collide dental objects is moved. Indeed, Chishti-876’s slowing technique is one tool in a POSITA’s toolbox to avoid a collision if a collision between a first and second tooth remains after the initial modification. Because Chishti-511 and Chishti-876 describe iterative processes, a POSITA would have understood that the subsequent modification may be required to resolve the collisions one at a time until no issues remain. For example, after the first tooth is delayed in a first modification, a collision may potentially be detected in a later stage after the first tooth began its initial movement.

To account for this, the first tooth may initially be set to move after delaying; however, at a later stage, the first tooth may be slowed relative to other teeth to ensure that it avoided colliding with other teeth. In my opinion, a POSITA would have found this to be beneficial because, if the rate of movement of the tooth was slowed, it may help avoid a collision while still progressing toward its final position, potentially leading to faster overall treatment. A POSITA would have been motivated to make this combination given Chishti-511's express desire to move teeth to final positions in the quickest fashion. Ex-1004, 4:7-12. Thus, in my opinion, it would have been obvious for the computer process to use Chishti-876's slowing feature as a "second modification" following a previous one of the treatment stages in which the first dental object moved.

155. A POSITA would have understood that performing a second modification to a treatment plan by slowing or stopping the movement of a tooth that moved in a prior stage would mean simply choosing from a finite number of identified, predictable solutions, and would involve no more than combining prior art elements according to known methods to yield predictable results. I also understand that a POSITA would have had a reasonable expectation of success in modifying Chishti-511 to include Chishti-876's teachings regarding changes in tooth speed, including slowing. Ex-1017, ¶¶ 70-71 (citing Ex-1004, 4:15-22).

10. Independent Claim 11

156. Claim 11 is obvious based on Chishti-511 in view of Chishti-876 and Sachdeva. Most of claim 11—including limitations 11(pre)-11(e)—repeats or recites features that are substantively identical to features recited in claim 1. *Compare* Ex-1001, 16:7-21, 16:25-27, *with* Ex-1001, 17:31-48. The tables below show the correspondence between the claims.

Limitations 1(pre)-1(f)	Limitations 11(pre)-11(e)
[1(pre)] A computer-implemented method comprising:	[11(pre)] A computer-implemented method comprising:
[1(a)] determining a schedule of movement for dental objects during treatment stages of an orthodontic treatment, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;	[11(a)] determining a schedule of movement for dental objects during treatment stages of an orthodontic treatment, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;
[1(b)] calculating a respective treatment path for each of the dental objects between their respective initial position and respective final position;	[11(b)] calculating a respective treatment path for each of the dental objects between their respective initial position and respective final position;
[1(c)] identifying a collision between a first of the dental objects and a second of the dental objects based at least on the schedule of movement of the dental objects and the respective treatment paths;	[11(c)] identifying a collision between a first of the dental objects and a second of the dental objects based at least on the schedule of movement of the dental objects and the respective treatment paths;
[1(d)] performing a first modification of the schedule of movement in response to the identifying,	[11(d)] performing a first modification of the schedule of movement in response to the identifying;
[1(e)] the first modification of the schedule of movement modifying whether or not at least one of the dental	[Claim 11 does not include the corresponding requirement found in claim 1]

objects move[s] during at least one of the treatment stages;	
[1(f)] determining that the first modification does not avoid a collision between the first of the dental objects and the second of the dental objects; and	[11(e)] determining that the first modification does not avoid a collision between the first of the dental objects and the second of the dental objects; and

157. Accordingly, claim limitations 11(pre) through 11(e) are taught or suggested for the reasons discussed in Sections X.A.1.a-e and X.A.1.g, which discuss the corresponding portions of claim 1. As discussed below, the prior art also discloses or suggests the remaining feature 11(f).

- a. **[11(f)] performing a second modification of the schedule of movement after the determining that the first modification does not avoid a collision, wherein the second modification comprises one or more of: delaying initial movement of the first of the dental objects; and slowing or stopping movement of the first of the dental objects during one or more of the treatment stages following a previous one of the treatment stages during which the first of the dental objects moved.**

158. In my opinion, Chishti-511 in view of Chishti-876 and Sachdeva renders this limitation obvious for the same reasons provided for 1(e) and 1(g). *Supra* Sections X.A.1.f, X.A.1.h. For the reasons discussed with respect to limitation 1(g), Chishti-511 in view of Sachdeva renders obvious “performing a second modification of the schedule of movement after the determining that the first modification does not avoid a collision.” Moreover, for the reasons discussed with respect to limitations

1(e) and 1(g), Chishti-511 in view of Sachdeva renders obvious that the second modification comprises “delaying initial movement of the first of the dental objects.”

Supra Sections X.A.1.f, X.A.1.h.

159. Whereas limitation 1(g) recites “the second modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages,” limitation 11(f) recites that the second modification comprises “one or more of[] delaying . . . and slowing or stopping.” I understand that when addressing similar language in the ’444 patent, the PTAB interpreted that language to require one “and/or” the other listed steps. *See* Ex-1008, 8-9. If a similar interpretation is applied here, requiring only one of either (i) delaying *and/or* (ii) slowing or stopping, Sachdeva discloses the portion requiring delaying initial movement of the first of the dental objects, and thus satisfies this limitation. *Supra* Sections X.A.1.e-f. As discussed there, Sachdeva discloses the portion requiring delaying initial movement of the first of the dental objects, and thus satisfies this limitation. Ex-1007, 5:22-26; *supra* Section X.A.1.e-f.

160. In my opinion, to the extent it is argued that both (1) delaying and (2) slowing or stopping are required, slowing is taught by Chishti-876 as discussed with respect to claim 9, and a POSITA would have understood that both techniques can be used to avoid collision and provide effective treatment. *Supra* Section X.A.9; *see also* Section VIII. Thus, this claim is rendered obvious under any

interpretation—that is, regardless of whether one or both of delaying and slowing are required. *See supra* Sections X.A.1.f, .h, X.A.9.

161. Indeed, a POSITA would have understood that modifying a schedule of teeth movement to include techniques such as delaying the initial movement of a tooth and/or slowing or stopping the movement of a tooth would mean simply choosing from a finite number of identified, predictable solutions, and would involve no more than combining prior art elements according to known methods to yield predictable results.

11. Independent Claim 13

162. Claim 13 is obvious based on Chishti-511 in view of Chishti-876 and Sachdeva. Claim 13 repeats or recites features that are substantively identical to features recited in claim 1. *Compare* Ex-1001, 16:7-33, *with* Ex-1001, 18:22-45. The tables below show the correspondence between the claims.

Claim 1	Claim 13
[1(pre)] A computer-implemented method comprising:	[13(pre)] A computer-implemented method comprising:
[1(a)] determining a schedule of movement for dental objects during treatment stages of an orthodontic treatment, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;	[13(a)] determining a schedule of movement for dental objects during treatment stages, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;
[1(b)] calculating a respective treatment path for each of the dental objects	[13(b)] calculating a respective route from an initial position toward a final

between their respective initial position and respective final position;	position for each of the dental objects during the treatment stages;
[1(c)] identifying a collision between a first of the dental objects and a second of the dental objects based at least on the schedule of movement of the dental objects and the respective treatment paths;	[13(c)] performing a first modification to the schedule of movement to avoid a collision or obstruction between a first dental object and a second dental object of the dental objects on their respective routes,
[1(d)] performing a first modification of the schedule of movement in response to the identifying,	
[1(e)] the first modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages;	[13(d)] the first modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages;
[1(f)] determining that the first modification does not avoid a collision between the first of the dental objects and the second of the dental objects; and	[13(e)] determining that the first modification does not avoid the collision or obstruction between the first dental object and second dental object; and
[1(g)] performing a second modification of the schedule of movement after the determining that the first modification does not avoid a collision, the second modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages.	[13(f)] performing a second modification of the schedule of movement after determining that the first modification does not avoid the collision or obstruction, the second modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages.

163. Limitations 13(pre)-13(b) are substantively identical to 1(pre)-1(b) and 13(d)-13(f) are substantively identical to 1(e)-1(g). Finally, 13(c) is substantively identical to 1(c) and 1(d) together. 13(c) recites that a modification is made “to avoid

a collision” and 1(c) and 1(d) together recite identifying a collision and performing a modification “in response to identifying” the collision (and limitation 1(d)’s discussion shows that a modification is made to avoid a collision). Accordingly, claim features 13(pre) through 13(f) are taught or suggested for the reasons discussed in Sections X.A.1.a-h, which discuss the corresponding portions of claim 1.

12. Dependent Claim 14: The computer-implemented method of claim 13, wherein determining the schedule of movement comprises selecting a movement pattern from a plurality of predetermined movement patterns.

164. In my opinion, Chishti-511 in view of Chishti-876 renders this limitation obvious.

165. As explained for claim 2, Chishti-876 explains that its algorithm allows for the selection of a movement pattern from a plurality of movement patterns from a predetermined library, which determine a schedule of movement. Ex-1005, Abstract, 2:63-3:10, 3:24-33, 3:38-40, 3:49-51, 14:63-15:4. Chishti-876 provides several exemplary movement patterns, including how the schedule of movement will be generated based on the selected pattern. Ex-1005, 2:44-62, 3:6-10, 3:24-27, 3:38-40, 3:49-51, 16:48-17:17, Figs. 10-14; 14:63-15:4. Thus, claim 14 would have been obvious for the reasons provided here and for claim 2. *Supra* Sections VIII, X.A.2 (claim 2).

13. Dependent Claim 15: The computer-implemented method of claim 13, further comprising manufacturing at least two

**orthodontic aligners, each of the orthodontic aligners
corresponding to a respective one of the treatment stages.**

166. In my opinion, Chishti-511 discloses this feature. As Chishti-511 explains, each appliance (aligner) has a specific geometry selected to reposition a tooth from its initial arrangement to a first intermediate arrangement. Ex-1004, 1:47-58, 5:7-12. Once that intermediate arrangement is approached or achieved, then one or more additional intermediate appliances are produced and successively placed on the teeth, moving the teeth in stages, until a final appliance is placed on the teeth resulting in the desired final tooth arrangement. Ex.1004, 1:33-58; *see also* Ex-1004, 4:51-67 (explaining that “each appliance configuration represents a step along the treatment path” and segmented tooth paths are then “used to calculate clinically acceptable appliance configurations”). Thus, in my opinion, each of the orthodontic aligners in Chishti-511 corresponds to a respective one of the treatment stages. Chishti-511 also discloses using a “series” of aligners (at least two). Ex-1004, 1:39-47, 8:22-28.

167. Finally, Chishti-511 also discloses that the aligners are manufactured: in “manufacturing step (step 180) in which appliances defined by the process are manufactured.” Ex-1004, 3:32-39, 5:1-6; *see also* Ex-1004, 10:19-51.

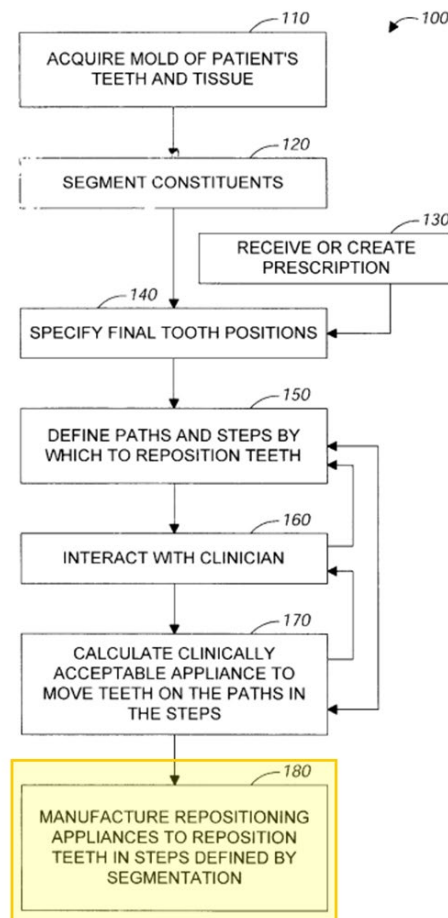


FIG. 1

Ex-1004, Fig. 1 (annotated). Claim 6 also demonstrates the features of this claim.

see X.A.6.

14. Dependent Claim 16

168. Claim 16 is obvious based on Chishti-511 in view of Chishti-876 and Sachdeva. Claim 16 repeats or recites features that are substantively identical to features recited in claim 7, except for the preamble and minor changes to their wording relative to earlier claims. *Compare* Ex-1001, 16:53-58, *with* Ex-1001, 18:54-59. The table below shows the correspondence between the claims.

Claim 7	Claim 16
[7(a)] The method of claim 6, wherein the producing comprises: fabricating a respective positive mold of the dental objects for at least two of the treatment stages; and	[16(a)] The computer-implemented method of claim 15, wherein the manufacturing comprises: fabricating a respective positive mold of the dental objects for at least two of the treatment stages; and
[7(b)] thermoforming a respective one of the orthodontic appliances over each of the respective positive molds.	[16(b)] thermoforming an orthodontic aligner over each respective positive mold.

169. Accordingly, claim 16 is taught or suggested for the reasons discussed in Section X.A.7 (claim 7).

15. Independent Claim 17

170. Claim 17 is obvious based on Chishti-511 in view of Chishti-876 and Sachdeva. Most of claim 17 repeats or recites features that are substantively identical to features recited in claim 13. *Compare* Ex-1001, 18:22-45, *with* Ex-1001, 18:60-19:10. The table below shows the correspondence between the claims.

Claim 13	Limitations 17(pre)-17(e)
[13(pre)] A computer-implemented method comprising:	[17(pre)] A computer-implemented method comprising:
[13(a)] determining a schedule of movement for dental objects during treatment stages, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;	[17(a)] determining a schedule of movement for dental objects during treatment stages, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;
[13(b)] calculating a respective route from an initial position toward a final	[17(b)] calculating a respective route from an initial position toward a final

position for each of the dental objects during the treatment stages;	position for each of the dental objects during the treatment stages;
[13 (c)] performing a first modification to the schedule of movement to avoid a collision or obstruction between a first dental object and a second dental object of the dental objects on their respective routes, the first modification of the schedule of movement modifying whether or not at least one of the dental objects move during at least one of the treatment stages;	[17(c)] performing a first modification to the schedule of movement to avoid a collision or obstruction between a first dental object and a second dental object of the dental objects on their respective routes;
[13(d)] determining that the first modification does not avoid the collision or obstruction between the first dental object and second dental object; and	[17(d)] determining that the first modification does not avoid the collision or obstruction between the first dental object and second dental object; and
[13(e)] performing a second modification of the schedule of movement after determining that the first modification does not avoid the collision or obstruction, the second modification of the schedule of movement modifying whether or not at least one of the dental objects move during at least one of the treatment stages.	[17(e)] performing a second modification of the schedule of movement after determining that the first modification does not avoid the collision or obstruction; and

171. Limitations 13(c) and 13(e) contain more limitations than limitations 17(c) and 17(e), respectively, but the overlapping limitations are identical. Accordingly, claim features 17(pre) through 17(e) are taught or suggested for the reasons discussed for claim 13 (which refers to claim 1). *See* Sections X.A.11,

X.A.1.a-e, X.A.1.g-h. As discussed below, the prior art also discloses or suggests the remaining feature 17(f).

a. [17(f)] recalculating at least one of the respective routes based on the first or second modified schedule of movement.

172. In my opinion, Chishti-511 discloses this limitation.

173. As explained above, Chishti-511's system will modify the schedule of movement if aligners are unacceptable. In that case, the system "transfers control to a path definition process . . . to redefine those parts of the treatment path having unacceptable aligners." Ex-1004, 8:54-65. Chishti-511 explains that this step includes "changing the increments of tooth motion, i.e., changing the segmentation, on the *treatment path*, *changing the path* followed by one or more teeth in the treatment path, or both." *Id.* (emphasis added). Chishti-511 further explains that "th[is] *recalculation*" is performed for "those aligners on the *redefined* portions of the *treatment path*." *Id.* (emphases added). Thus, Chishti-511 discloses recalculating at least one respective route based on the modified schedule of movement.

B. Chishti-511 in View of Chishti-876, Sachdeva, and Becker Renders Obvious Claims 10, 12, 18, and 19

174. In my opinion, Chishti-511 in view of Chishti-876, Sachdeva, and Becker renders obvious claims 10, 12, 18, and 19.

1. Dependent Claim 10

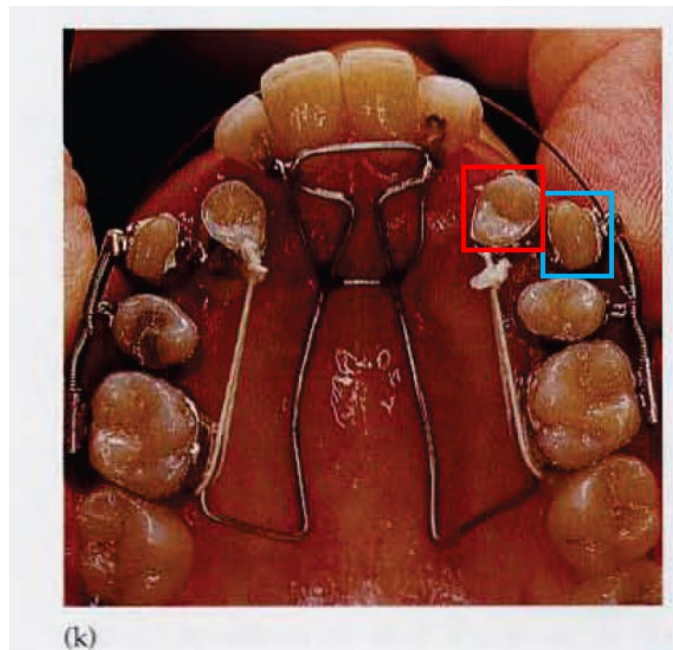
- a. [10(a)] The method of claim 9, further comprising:
performing, after determining that the second
modification does not avoid a collision, a modification
of the schedule of movement of the dental objects, the
modification comprising:**

175. In my opinion, Chishti-511 in view of Sachdeva renders this limitation obvious for the same reasons provided for limitations 1(f) and 1(g). *Supra* Sections X.A.1.g-h. Indeed, Chishti-511 discloses that “[a]fter the treatment path has been redefined” to account for the unacceptable aligners, the process is re-executed to ensure all aligners are now acceptable (i.e., the collision has been resolved and there are no further collisions). Ex-1004, 8:54-9:14. If the system determines that unacceptable aligners still remain, the process repeats, performing additional modifications “until an acceptable set of aligners is found or an iteration limit is exceeded.” *Id.* Thus, for the same reasons that the system will determine that the first modification did not avoid a collision and perform a second modification, the system will likewise determine that the second modification does not avoid a collision and perform another modification of the schedule of movement of the dental objects. *Supra* Sections X.A.1.g-h.

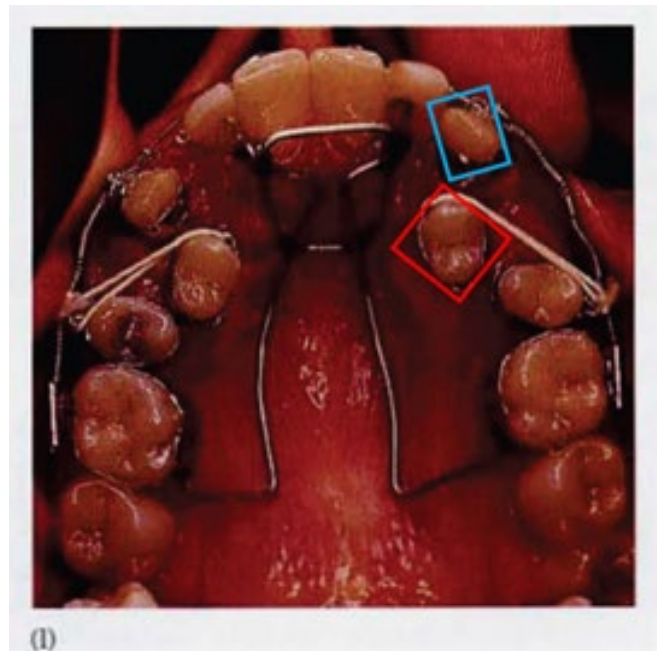
- b. [10(b)] moving the first of the dental objects away from the respective route of the second of the dental objects; and

176. In my opinion, Chishti-511 in view of Becker renders this limitation obvious.

177. While Chishti-511 explains that the treatment path would be modified in light of an unresolved collision, in my opinion, it leaves open to a POSITA the methods for how to alter tooth movement to avoid the collision. One such avoidance method is disclosed in Becker. Indeed, Becker presents a malocclusion in which a more lingual tooth (“first tooth,” red) is transposed in position with a more buccal tooth (“second tooth,” blue)—such that the more buccal tooth needs to be moved toward the incisors and the midline of the mouth. Ex-1006, 5.



Ex-1006, 7 (Fig. 8.6(k) (annotated)). As can be seen in Figure 8.6(k) above, moving the more buccal tooth to its proper position would cause a collision between the two teeth. To resolve the transposition, Becker discloses “slid[ing] the more buccal of the transposed teeth” (i.e., the tooth closer to the cheek) “in the mesio-distal plane” (i.e., toward the midline or center of the dental arch). Ex-1006, 5. To allow this movement, Becker discloses that the more lingual tooth “must be moved further lingually to allow its partner to pass by.” *Id.* Figure 8.6(l) below depicts the more lingual tooth after it has moved lingually and allowed the more buccal tooth to pass by. *Id.*



Ex-1006, 7 (Fig. 8.6(l) (annotated)).

178. In my opinion, a POSITA would understand moving the more lingual tooth further lingually to be “moving the first of the dental objects away from the

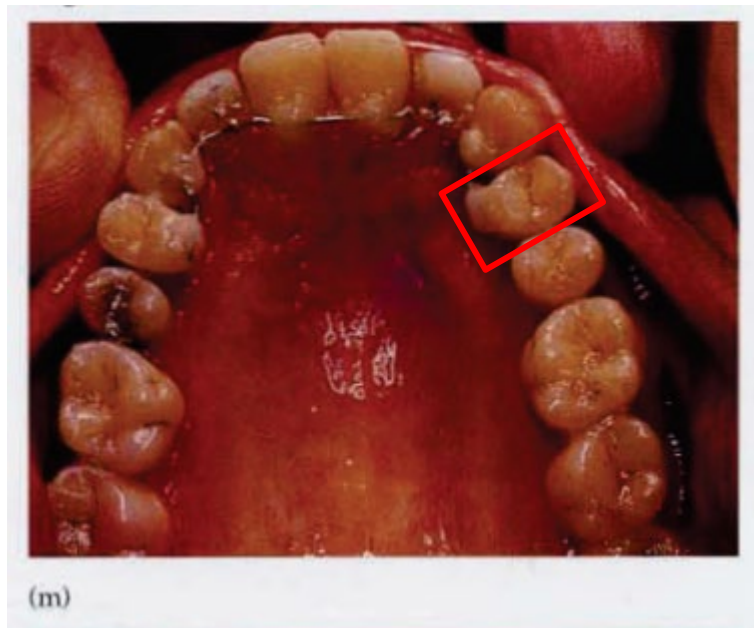
respective route of the second of the dental objects.” A POSITA would have been motivated to modify the combined system to implement Becker’s collision-avoidance technique for the same reasons discussed in Section VIII.

- c. **[10(c)] moving the first of the dental objects toward its respective final position after the second of the dental objects has sufficiently traversed its respective route to avoid the collision.**

179. In my opinion, Chishti-511 in view of Becker renders this limitation obvious.

180. As explained above, Becker discloses a patient with transposed teeth posing a risk of collision. Becker explains that after **the more lingual tooth** has “allow[ed] its partner to pass by” (“after the second of the dental objects has sufficiently traversed its respective route to avoid the collision”), **the more lingual tooth** moves back to its previous position before moving toward a desired final position of that first tooth. Ex-1006, 5

181. Becker shows that after the more buccal tooth has sufficiently traversed its route to avoid collision, the **more lingual tooth** continues to move towards its respective final position. *Id.* Indeed, Figure 8.6(m) below shows **the more lingual in** its desired final position.



Ex-1006, 8 (Fig. 8.6(m) (annotated)).

182. In my opinion, a POSITA would have been motivated to modify the combined system to implement Becker's round-tripping collision avoidance for the same reasons discussed in Section VIII.

2. Independent Claim 12

183. Claim 12 is obvious based on Chishti-511 in view of Chishti-876, Sachdeva, and Becker. Most of claim 12 repeats or recites features that are substantively identical to features recited in claim 1 or claim 10. *Compare* Ex-1001, 16:7-33 and 17:20-30, *with* Ex-1001, 17:59-18:21. The tables below show the correspondence between the claims.

Claim 1	Limitations 12(pre)-12(f)
[1(pre)] A computer-implemented method comprising:	[12(pre)] A computer-implemented method comprising:

[1(a)] determining a schedule of movement for dental objects during treatment stages of an orthodontic treatment, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;	[12(a)] determining a schedule of movement for dental objects during treatment stages of an orthodontic treatment, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;
[1(b)] calculating a respective treatment path for each of the dental objects between their respective initial position and respective final position;	[12(b)] calculating a respective treatment path for each of the dental objects between their respective initial position and respective final position;
[1(c)] identifying a collision between a first of the dental objects and a second of the dental objects based at least on the schedule of movement of the dental objects and the respective treatment paths;	[12(c)] identifying a collision between a first of the dental objects and a second of the dental objects based at least on the schedule of movement of the dental objects and the respective treatment paths;
[1(d)] performing a first modification of the schedule of movement in response to the identifying,	[12(d)] performing a first modification of the schedule of movement in response to the identifying;
[1(e)] the first modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages;	[Claim 12 does not include the corresponding requirement found in claim 1]
[1(f)] determining that the first modification does not avoid a collision between the first of the dental objects and the second of the dental objects; and	[12(e)] determining that the first modification does not avoid a collision between the first of the dental objects and the second of the dental objects; and
[1(g)] performing a second modification of the schedule of movement after the determining that the first modification does not avoid a collision, the second modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages.	[12(f)] performing a second modification of the schedule of movement after the determining that the first modification does not avoid a collision, wherein the second modification comprises:

Claim 10	Limitations 12(g)-12(h)
[10(a)] The method of claim 9, further comprising: performing, after determining that the second modification does not avoid a collision, a modification of the schedule of movement of the dental objects, the modification comprising:	[Claim 12 does not include the corresponding requirement found in claim 10]
[10(b)] moving the first of the dental objects away from the respective route of the second of the dental objects; and	[12(g)] moving the first of the dental objects away from the respective route of the second of the dental objects; and
[10(c)] moving the first of the dental objects toward its respective final position after the second of the dental objects has sufficiently traversed its respective route to avoid the collision.	[12(h)] moving the first of the dental objects toward its respective final position after the second of the dental objects has sufficiently traversed its respective route to avoid the collision.

184. Accordingly, claim limitations 12(pre)-12(f) are taught or suggested for the reasons discussed in Sections X.A.1.a-e and X.A.1.g-h, which discuss the corresponding portions of claim 1, and limitations 12(g)-12(h) are taught or suggested for the reasons discussed in Sections X.B.1.b-c, which discuss the corresponding portions of claim 10.

185. A difference between claims 10 and 12 is that claim 12 recites certain steps (limitations 12(g)-12(h)) as part of performing a second modification of the schedule of movement, whereas claim 10 recites a modification “after determining that the second modification does not avoid a collision” (e.g., a third modification). But as discussed with respect to limitation 10(a), Chishti-511’s iterative process will

continue to re-execute until there are no further collisions. *Supra* Section X.B.1.a. Thus, the modifications described in limitations 10(a)-10(c) may be performed as a second modification or a third modification depending on the needs of the patient, and both are disclosed and rendered obvious for the reasons discussed with respect to limitations 1(g) and 10(a)-10(c). *Supra* Sections X.A.1.h, X.B.1.a-c.

3. Independent Claim 18

186. Claim 18 is obvious based on Chishti-511 in view of Chishti-876, Sachdeva, and Becker. Most of claim 18—including elements 18(pre)-18(f) and 18(h)—repeats or recites features that are substantively identical to features recited in claim 1 or claim 10. *Compare* Ex-1001, 16:7-33 and 17:20-30, *with* Ex-1001, 19:13-20:6. The tables below show the correspondence between the claims.

Claim 1	Limitations 18(pre)-18(e)
[1(pre)] A computer-implemented method comprising:	[18(pre)] A computer-implemented method comprising:
[1(a)] determining a schedule of movement for dental objects during treatment stages of an orthodontic treatment, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;	[18(a)] determining a schedule of movement for dental objects during treatment stages, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;
[1(b)] calculating a respective treatment path for each of the dental objects between their respective initial position and respective final position;	[18(b)] calculating a respective route from an initial position toward a final position for each of the dental objects during the treatment stages;
[1(c)] identifying a collision between a first of the dental objects and a second	[18(c)] performing a first modification to the schedule of movement to avoid a

of the dental objects based at least on the schedule of movement of the dental objects and the respective treatment paths;	collision or obstruction between a first dental object and a second dental object of the dental objects on their respective routes;
[1(d)] performing a first modification of the schedule of movement in response to the identifying,	
[1(e)] the first modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages;	[Claim 18 does not include the corresponding requirement found in claim 1]
[1(f)] determining that the first modification does not avoid a collision between the first of the dental objects and the second of the dental objects; and	[18(d)] determining that the first modification does not avoid the collision or obstruction between the first dental object and second dental object; and
[1(g)] performing a second modification of the schedule of movement after the determining that the first modification does not avoid a collision, the second modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages.	[18(e)] performing a second modification of the schedule of movement after determining that the first modification does not avoid the collision or obstruction, wherein the first modification or second modification comprises:

Claim 10	Limitations 18(e)-18(h)
[10(a)] The method of claim 9, further comprising: performing, after determining that the second modification does not avoid a collision, a modification of the schedule of movement of the dental objects, the modification comprising:	[18(e)] performing a second modification of the schedule of movement after determining that the first modification does not avoid the collision or obstruction, wherein the first modification or second modification comprises:

[10(b)] moving the first of the dental objects away from the respective route of the second of the dental objects; and	[18(f)] moving the first dental object away from the respective route of the second dental object;
	[18(g)] stopping movement of the first of the dental objects; and
[10(c)] moving the first of the dental objects toward its respective final position after the second of the dental objects has sufficiently traversed its respective route to avoid the collision.	[18(h)] moving the first dental object toward its respective final position after the second dental object has sufficiently traversed its respective route to avoid the collision.

187. Similar to claim 12, a difference between claims 10 and 18 is that claim 18 recites certain steps (limitations 18(g)-18(h)) as part of performing a first or second modification of the schedule of movement, whereas claim 10 recites a modification “after determining that the second modification does not avoid a collision” (e.g., a third modification). But as discussed with respect to limitation 10(a), Chishti-511’s iterative process will continue to re-execute until there are no further collisions. *Supra* Section X.B.1.a. Thus, the modifications described in limitations 10(a)-10(c) may be performed as a first or second modification (as in claim 18) or a later modification (as in claim 10) depending on the needs of the patient, and each is disclosed and rendered obvious for the reasons discussed with respect to limitations 1(g), 10(a)-10(c). *Supra* Sections X.A.1.h, X.B.1.a-c. Additionally, similar to the discussion for claim 13, 18(c) recites that a modification is made “to avoid a collision” and 1(c) and 1(d) together recite identifying a collision

and performing a modification “in response to identifying” a collision (and limitation 1(d)’s discussion shows that a modification is made to avoid a collision).

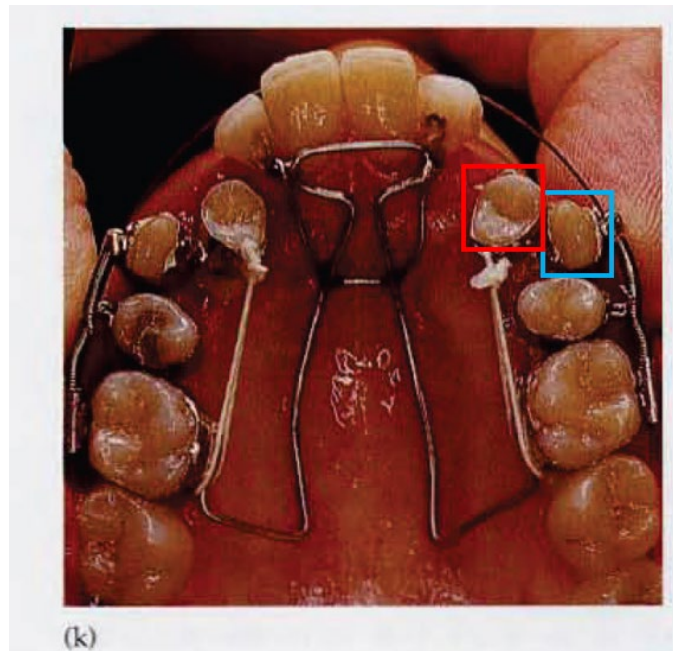
188. Accordingly, claim limitations 18(pre) through 18(f) and 18(h) are taught or suggested for the reasons discussed in Sections IX.A.1.a-e, IX.A.1.g, IX.A.1.h, and X.B.1.a-c, which discuss the corresponding portions of claims 1 and 10.

189. As discussed below, the prior art also discloses or suggests the remaining feature 18(g).

a. [18(g)] stopping movement of the first of the dental objects; and

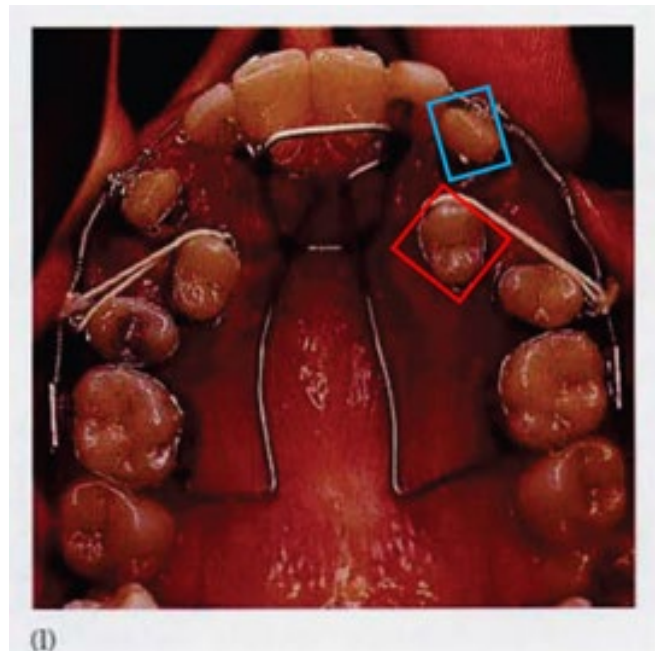
190. In my opinion, Chishti-511 in view of Becker renders this limitation obvious.

191. As explained above, Becker discloses **the more lingual of the transposed teeth** “must be moved further lingually to allow its partner to pass by.” Ex-1006, 5.



Ex-1006, 7 (Fig. 8.6(k) (annotated)).

192. Becker also discloses “slid[ing] the more buccal of the transposed teeth” (i.e., the tooth closer to the cheek) “in the mesio-distal plane” (i.e., toward the midline or center of the dental arch). Ex-1006, 5. A POSITA would understand that Becker’s more lingual tooth is stopped while it awaits “its partner to pass by” (stopping movement of the first of the dental objects). *Id.* Indeed, as shown below, Becker’s more lingual tooth is only moved to its previous position after the more buccal tooth has “pass[ed] by” and corrected the transposition. *Id.*



Ex-1006, 7 (Fig. 8.6(i) (annotated)).

193. In my opinion, a POSITA would have understood that Becker's express disclosure of "allow[ing] its partner to pass by" before "mov[ing] in the opposite mesio-distal direction" would mean that the second tooth is clear from the path of the first tooth before movement of the first tooth is continued to ensure that subsequent movement of first tooth would not result in a collision. Ex-1006, 5. Thus, the first tooth would be stopped during the period in which the "partner" tooth is "pass[ing] by." *Id.* A POSITA would understand that stopping movement of the tooth while the second tooth moves is preferable to continuing movement of the tooth away from its initial position because this would avoid movement that would cause more root resorption than is necessary to allow movement of the second tooth, which is consistent with Chishti-511's goal of using the "least amount of round-

tripping.” Ex-1004, 4:9-12. A POSITA would have been motivated to modify the combined system to implement Becker’s round-tripping collision avoidance for the same reasons discussed in Section VIII.

4. Independent Claim 19

194. Most of claim 19—including elements 19(pre)-19(g)—repeats or recites features that are substantively identical to features recited in claims 1 or 18. *Compare* Ex-1001, 16:7-27 and 19:28-20:2, *with* Ex-1001, 20:7-32. The tables below show the correspondence between the claims.

Limitations 1(pre)-1(f)	Limitations 19(pre)-19(d)
[1(pre)] A computer-implemented method comprising:	[19(pre)] A computer-implemented method comprising:
[1(a)] determining a schedule of movement for dental objects during treatment stages of an orthodontic treatment, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;	[19(a)] determining a schedule of movement for dental objects during treatment stages, wherein the schedule of movement indicates whether or not each of the dental objects moves during each of the treatment stages;
[1(b)] calculating a respective treatment path for each of the dental objects between their respective initial position and respective final position;	[19(b)] calculating a respective route from an initial position toward a final position for each of the dental objects during the treatment stages;
[1(c)] identifying a collision between a first of the dental objects and a second of the dental objects based at least on the schedule of movement of the dental objects and the respective treatment paths;	[19(c)] performing a first modification to the schedule of movement to avoid a collision or obstruction between a first dental object and a second dental object of the dental objects on their respective routes;

[1(d)] performing a first modification of the schedule of movement in response to the identifying,	
[1(e)] the first modification of the schedule of movement modifying whether or not at least one of the dental objects move[s] during at least one of the treatment stages;	[Claim 19 does not include the corresponding requirement found in claim 1]
[1(f)] determining that the first modification does not avoid a collision between the first of the dental objects and the second of the dental objects; and	[19(d)] determining that the first modification does not avoid the collision or obstruction between the first dental object and second dental object; and

Limitations 18(e)-(g)	Limitations 19(e)-19(g)
[18(e)] performing a second modification of the schedule of movement after determining that the first modification does not avoid the collision or obstruction, wherein the first modification or second modification comprises:	[19(e)] performing a second modification of the schedule of movement after determining that the first modification does not avoid the collision or obstruction, wherein the first modification or second modification comprises:
[18(f)] moving the first dental object away from the respective route of the second dental object;	[19(f)] moving the first dental object away from the respective route of the second dental object;
[18(g)] stopping movement of the first of the dental objects; and	[19(g)] stopping movement of the first of the dental objects; and

195. Like the discussion for claim 13, 19(c) recites that a modification is made “to avoid a collision” and 1(c) and 1(d) together discuss identifying a collision and performing a modification “in response to identifying” the collision (and

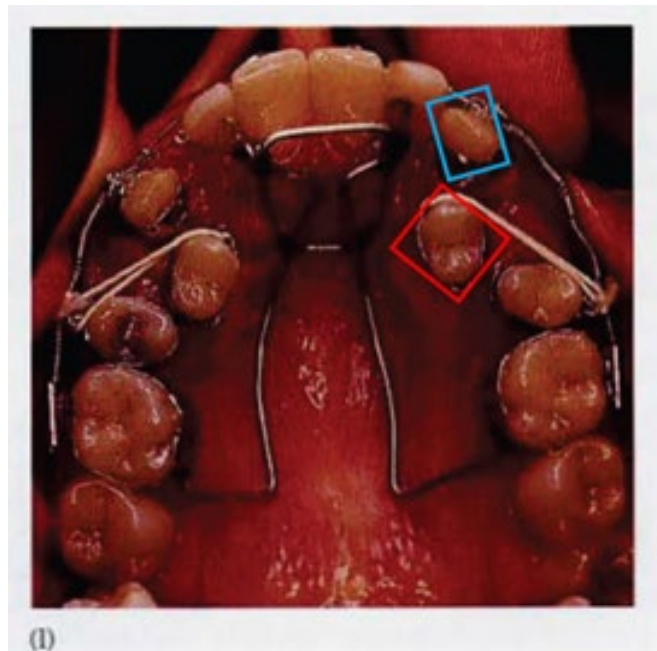
limitation 1(d)'s discussion shows that a modification is made to avoid a collision). Accordingly, claim limitations 19(pre)-19(g) are taught or suggested for the reasons discussed in Sections X.A.1.a-e, X.A.1.g and X.B.3, which discuss the corresponding portions of claims 1 and 18. *Supra* Sections X.B.1.a-c.

196. As discussed below, the prior art also discloses or suggests the remaining feature 19(h).

a. [19(h)] moving the first dental object toward its previous position.

197. In my opinion, Chishti-511 in view of Becker renders this limitation obvious.

198. As explained previously, Becker discloses a situation with transposed teeth posing a risk of collision. Becker discloses that **the more lingual tooth** “must be moved further lingually to allow its partner to pass by.” Ex-1006, 5. Figure 8.6(1) below depicts the **more lingual tooth** after it has moved lingually and allowed the **more buccal tooth** to pass by. *Id.*



Ex-1006, 7 (Fig. 8.6(l) (annotated)).

199. Becker further explains that, after the more lingual tooth has “allow[ed] its partner to pass by,” the more lingual tooth moves back to its previous position before moving toward a desired final position. Ex-1006, 5. In particular, Becker explains that once the more buccal tooth has moved sufficiently, the more lingual tooth “must be moved in the opposite mesio-distal direction and back in the line of the arch.” *Id.* A POSITA would understand that moving the more lingual tooth in the “opposite” direction that it previously moved and “back” to where it was before (“in line of the arch”) would involve moving the more lingual tooth back to its previous position (Ex-1001, 13:8-12). The more lingual tooth then moves toward its respective final position as explained with respect to limitation 10(c). *Supra* Section

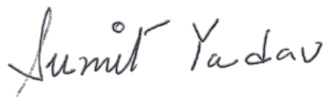
X.B.1.c. A POSITA would have been motivated to modify the combined system to implement Becker's round-tripping collision avoidance for the same reasons discussed in Section VIII.

XI. Conclusion

200. For the reasons set forth above, in my opinion, a POSITA would have considered claims 1-19 of the '456 patent to be obvious over the prior art discussed above.

201. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: April 11, 2025

By: 

Dr. Sumit Yadav