UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CLEARCORRECT OPERATING LLC,

Petitioner

v.

ALIGN TECHNOLOGY INC.,
Patent Owner.

IPR2025-000817
U.S. Patent No. 10,791,936

Declaration of Lina J. Karam, Ph.D.

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I. Introduction

1. I, Lina J. Karam, 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. 10,791,936 ("the '936 patent") (Ex-1001). Although I am being compensated for my time in connection with this IPR at my standard hourly consulting rate 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 '936 patent, the prior art references that form the basis for the invalidity grounds set forth in the Petition for *Inter Partes* Review of the '936 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.

5. I am currently an Emerita Professor in the School of Electrical, Computer and Energy Engineering at Arizona State University (ASU), and the Director of the R&D Image, Video, and Usability (IVU) Laboratory at ASU. Prior to becoming Emerita Professor, I was a tenured Full Professor, Computer Engineering Program Chair and Computer Engineering Director for Industry Engagement at ASU. From 2020 to 2022, I served as Dean of the School of Engineering at the Lebanese American University. From 2019 to 2021, I served as the Editor-in-Chief of the high-impact *IEEE Journal of Special Topics in Signal Processing*. I am also the President of PICARIS, LLC, a consulting company that provides expertise on media processing, compression, computer vision, and machine learning. I am also Chief Technical Advisor at AIAEC, LLC.

6. My research includes topics such as Signal, Image, and Video Processing, Compression, and Transmission; Computer Vision (2D and 3D); Biomedical Signal Processing; Artificial Intelligence; Machine Learning; Perceptual-based Processing; Visual Attention Models; Automated Quality Assessment and Monitoring; Multidimensional Signal Processing; and Digital Filtering. I have various awards in recognition of my work, including the U.S. National Science Foundation CAREER Award, Intel Outstanding Researcher Award, U.S. National Aeronautics and Space Administration (NASA) Technical Innovation Award, the IEEE Signal Processing Society (SPS) Best Journal Paper

Award, IEEE Phoenix Section Outstanding Faculty Award, and IEEE Region 6 Award. I am featured in the 8th, 9th, and 10th editions of Research.com (2022-2024) among World Top Computer Science Scientists.

7. I am an Institute of Electrical and Electronics Engineers (IEEE) Fellow, the highest grade level in IEEE conferred each year to no more than one-tenth of 1% of all IEEE voting members, for my contributions in the image and video processing, visual media compression and transmission, and digital filtering areas. In addition to serving as Editor-in-Chief of a prestigious IEEE journal, I have also served on several IEEE Boards and chaired multiple IEEE committees. For example, I served on the IEEE Signal Processing Society (SPS) Board of Governors (2016-2018), IEEE SPS Publications Board (2019-2021), IEEE SPS Award Board (2019-2020), IEEE SPS Conference Board (2003-2005 & 2017-2018), IEEE Publication Services and Products Board (PSPB) Strategic Planning Committee (2014-2016), IEEE Technical Activities Board (TAB)/PSPB Product and Services Committee, IEEE Educational Activities Board (EAB) Faculty Resources Committee, and IEEE TechRxiv Advisory and Editorial Boards. I am also an expert delegate of the ISO/IEC JTC1/SC29 Committee (Coding of audio, picture, multimedia, and hypermedia information) and participating in JPEG/MPEG standardization activities.

8. As part of my various roles at ASU, PICARIS, AIAEC, ISO, and IEEE, I am actively involved in industry. For example, I contributed to the development of image and video processing and compression at AT&T Bell Labs (Murray Hill), and multi-dimensional data processing and visualization at Schlumberger. Later in my career, I collaborated in the research and development of computer vision, 3D imaging, machine learning, image/video processing, compression, and transmission projects with various industry leaders, including Intel, Qualcomm, Google, NTT, Motorola, Freescale, NXP, General Dynamics, and NASA. More recently, I took on the role of Chief Technical Advisor at AIAEC, LLC, supervising work and product development in the field of AI and machine learning.

9. In addition, I directed the development of image/video processing, compression, computer vision, 3D imaging, and machine learning technologies. The developed imaging processing technologies were adopted at medical institutions including the Barrow Neurological Institute (BNI). More details can be found in B. Kanberoglu, J.P. Debbins, and L.J. Karam, "Accurate Brain Tumor Biopsy Using 3D ^{1}H-MRS Neuronavigation," *18th Annual ISMRM meeting*, April 2010; B. Kanberoglu, L.J. Karam, J.P. Debbins, "Context-Based GRAPPA Reconstruction using a Small Kernel," *18th Annual ISMRM meeting*, April 2010; B. Kanberoglu, T. Trouard, L. Karam, and J.P. Debbins, "Scanner Calibration For Multisite Geometric Accuracy: How To Do It," *17th Annual ISMRM meeting*, April 2009; B. Kanberoglu,

N. Zobenica, R. Ryan, M. C. Preul, L.J. Karam, and J.P. Debbins, "Accurate Brain Tumor Biopsy Using 3D ^{1}H-MRS Neuronavigation," *17th Annual ISMRM meeting*, April 2009; C-Y Lee, L.J. Karam, and J.P. Debbins, "High-Order Diffusion Imaging Used to Differentiate Cytotoxic and Vasogenic Edema in Humans," *17th Annual ISMRM meeting*, April 2009; B. Lenoski, L.C. Baxter, L.J. Karam, J. Maisog, and J.P. Debbins, "On the Performance of Autocorrelation Estimation Algorithms for fMRI Analysis," *IEEE Journal on Special Topics in Signal Processing, Special Issue on Functional Magnetic Resonance Imaging*, vol. 2, no. 6, pp. 828-38, Dec. 2008; B. Lenoski, L. Karam, J. Debbins, and. L. Baxter, "Autocorrelation Correction Methods in Clinical fMRI: Fixed Versus Variable P-Value Thresholding of 3T fMRI Datasets," *13th Annual Meeting Human Brian Mapping*, Jun. 2007; and in B. Lenoski, L. Karam, L. Baxter, and J. Debbins, "Clinical Significance of Global versus Local fMRI Autocorrelation Estimation," *Joint Annual Meeting ISMRM-ESMRMB*, Berlin, Germany, May 2007.

10. In addition, I directed the development of automated biomedical image processing and computer vision technologies that enable high-throughput cancer diagnostics and drug discovery. The developed automated image analysis technologies were licensed for cancer research at different industries and institutions, including the Translational Genomics Institute (TGEN) and the New York School of Medicine. More details can be found in L.J. Karam and A. Said,

"Automatic Cell Migration and Proliferation Analysis," U.S. Patent No. 9,082,164 B2, issued July 14, 2015; A.F. Said, L.J. Karam, and S.R. Gehler, "Use of Muscale CMA_{cfz} Automated Image Analysis Software to Accurately Quantitate Cell Migration," *16th Annual Society for Biomolecular Sciences Conference (SBS)*, Apr. 2010; A. Said and L.J. Karam, "Cell Migration Analysis using a Statistical Level-Set Segmentation on a Wavelet-Based Structure Tensor Feature Space," *7th International Symposium on Signal Processing and Information Technology (ISSPIT)*, pp. 473-78, Dec. 2007; and in A. Said, L.J. Karam, M.E. Berens, Z. Lacroix, and R.A. Renaut, "Migration and Proliferation Analysis for Bladder Cancer Cells," *IEEE International Symposium on Biomedical Imaging*, pp. 320-23, Apr. 2007.

11. Details about other developed image/video processing technologies can be found in S. Varadarajan, L. J. Karam, and D. Florencio, "Background Subtraction using Spatio-Temporal Continuities," *2nd European Workshop on Visual Information Processing (EUVIP)*, pp. 144-48, July 2010; M. M. Subedar and L. J. Karam, "Increased Depth Perception with Sharpness Enhancement for Stereo Video," *SPIE Electronic Imaging, Stereoscopic Displays and Applications XXI*, vol. 7524, Jan. 2010; S. Varadarajan, L. J. Karam, and D. Florencio, "Background Recovery from Video Sequences using Motion Parameters," *IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, pp. 989-92, Apr.

2009; A. F. Said and L. J. Karam, "Multi-Region Texture Image Segmentation based on Constrained Level-Set Evolution Functions," *IEEE Digital Signal Processing Workshop*, pp. 664-68, Jan. 2009; R. Ferzli, Z. Ivanovski, and L. J. Karam, "An Efficient, Selective, Perceptual-Based Super-Resolution Estimator," *IEEE International Conference on Image Processing (ICIP)*, pp. 1260-63, Oct. 2008; H. Abbas and L. J. Karam, "Suppression of Mosquito Noise by Recursive Epsilon-Filters," *IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, vol. 1, pp. 773-76, Apr. 2007; C. Q. Zhan and L. J. Karam, "Wavelet-based Adaptive Image Denoising with Edge Preservation," *IEEE International Conference on Image Processing*, vol. 1, pp. 97-100, Sep. 2003; and in Z. Liu, L. J. Karam, G. P. Abousleman, T. Key, and B. Razzouk, "Error-Resilient Video Coding and Application to Telemedicine," *7th IEEE International Conference on Electronics, Circuits, and Systems (ICECS)*, vol. 1, pp. 533-36, Dec. 2000.

12. The developed computer vision and machine learning systems for automated defect detection, 3D characterization, gender/age prediction, and autonomous vehicles were adopted at Intel. The developed image-based non-wet solder joints detection system was granted a Divisional Recognition Award by Intel. More details can be found in A.F. Said, B.L. Bennett, L.J. Karam, and J.S. Pettinato, "Robust Automatic Void Detection in Solder Balls," *IEEE International Conference*

on Acoustics, Speech, and Signal Processing (ICASSP), pp. 1650-53, March 2010; A.F. Said, B.L. Bennett, F. Toth, L.J. Karam, and J.S. Pettinato, "Non-Wet Solder Joint detection in Processor Sockets and BGA Assemblies," Electronic Components and Technology Conference (ECTC), pp. 1147-53, May 2010; and in A.F. Said, B.L. Bennett, L.J. Karam, and J.S. Pettinato, "Automated Detection and Classification of Non-Wet Solder Joints," *IEEE Transactions on Automation Science and Engineering*, vol. 8, no. 1, pp. 67-80, Jan. 2011. The developed image-based automated void detection system helped in enabling two industry standards, JEDEC JC 14-1 void guideline and IPC-7095C. More details can be found in A.F. Said, B.L. Bennett, L.J. Karam, A. Siah, K. Goodman, and J.S. Pettinato, "Automated Void Detection in Solder Balls in the Presence of Vias and Other Artifacts," *IEEE Transactions on Components, Packaging and Manufacturing Technology*, vol. 2, no. 11, pp. 1890-901, Nov. 2012. More details about the developed 3D characterization system, including image-based solder ball height and warpage measurements, can be found in J. Li, B.L. Bennett, L.J. Karam, and J.S. Pettinato, "Stereo Vision Based Automated Solder Ball Height and Substrate Coplanarity Inspection," *IEEE Transactions on Automation Science and Engineering*, vol. 13, no. 2, pp. 757-71, Apr. 2016; and in L. Karam and J. Li, "Stereo Vision Measurement System and Method," U.S. Patent No. 9,704,232 B2, issued July 11, 2017. Details about machine-learning-based computer vision for defect detection

can be found in B.M. Haddad, S. Yang, L.J. Karam, J. Ye, N.S. Patel, and M.W. Braun, "Multi-Feature, Sparse-Based Approach for Defects Detection and Classification in Semiconductor Units," *IEEE Transactions on Automation Science and Engineering*, vol. 15, no. 1, pp. 145-59, Jan. 2018; and in B.M. Haddad, S.F. Dodge, Yang, L.J. Karam, Ye, N.S. Patel, and M.W. Braun, "Locally Adaptive Statistical Background Modeling with Deep Learning-Based False Positive Rejection for Defect Detection in Semiconductor Units," *IEEE Transactions on Semiconductor Manufacturing*, vol. 33, no. 3, pp. 357-72, Aug. 2020.

13. The developed 3D imaging and computer vision systems for autonomous vehicles include Advanced Driver Assist Systems (ADAS) technologies. The developed real-time forward collision warning system prototype was demonstrated by our Intel industry collaborators at the 2015 Consumer Electronics Show (CES) in Las Vegas. More details can be found in C.D. Prakash, J. Li, F. Akhbari, and L.J. Karam, "Sparse Depth Calculation Using Real-Time Key-Point Detection and Structure from Motion for Advanced Driver Assist Systems," *in* G. Bebis et al. (eds.), *Advances in Visual Computing*, ISVC 2014, Lecture Notes in Computer Science, pp. 740-751, Dec. 2014; and in C.D. Prakash, F. Akhbari, and L.J. Karam, "Robust Obstacle Detection for Advanced Driver Assistance Systems Using Distortions of Inverse Perspective Mapping of a Monocular Camera," *Robotics and Autonomous Systems*, vol. 114, pp. 172-86, Apr. 2019.

14. I directed the development of scalable visual compression technologies. The developed codecs were commercialized by General Dynamics. More details can be found in W.-J. Chien, N.G. Sadaka, G.P. Abousleman, and L.J. Karam, "Region-of-Interest-Based Ultra-Low-Bit-Rate Video Coding," SPIE Symposium on Defense & Security, Mar. 2008. I directed the development of perceptual-based visual compression methods and algorithms. The work on JPEG2000 Encoding with Perceptual Distortion Control enabled the integration of adaptive perceptual-based visual processing and compression in the JPEG 2000 image coding standard and demonstrated improved performance in terms of visual quality and compression while maintaining full compatibility with the JPEG 2000 standard. For this perceptual-based image compression work, I received a Technical Innovation Award from the U.S. National Aeronautics and Space Administration (NASA).

15. My work has been published numerous times in prestigious journals, including *IEEE Transactions on Signal Processing*, *IEEE Transactions on Image Processing*, *IEEE Transactions on Pattern Analysis and Machine Intelligence* (PAMI), *IEEE Transactions on Broadcasting*, and the IEEE/CVF Computer Vision and Pattern Recognition (CVPR) Conference. Some selected publications include Y.M.Y. Hassan, L.J. Karam, "Morphological Reversible Contour Representation," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 22, no. 3, pp. 227-240, Mar. 2000; Y.M.Y. Hassan, L.J. Karam, "Morphological Text

Extraction from Images," *IEEE Transactions on Image Processing*, vol. 9, no. 11, pp. 1978-83, Nov. 2000; R. Ferzli, L.J. Karam, "A No-Reference Objective Image Sharpness Metric Based on the Notion of Just Noticeable Blur (JNB)," *IEEE Transactions on Image Processing*, vol. 18, no. 4, pp. 717-28, Apr. 2009; A.F. Said, B.L. Bennett, L.J. Karam, and J.S. Pettinato, "Automated Detection and Classification of Non-Wet Solder Joints," *IEEE Transactions on Automation Science and Engineering*, vol. 8, no. 1, pp. 67-80, Jan. 2011; S. Chikkerur, V. Sundaram, M. Reisslein, and L.J. Karam, "Objective Video Quality Assessment Methods: A Classification, Review, and Performance Comparison," *IEEE Transactions on Broadcasting*, vol. 57, no. 2, pp. 165-182, June 2011; L.J. Karam, N.G. Sadaka, R. Ferzli, and Z.A. Ivanovski, "An Efficient Selective Perceptual-Based Super-Resolution Estimator," *IEEE Transactions on Image Processing*, vol. 20, no. 12, pp. 3470-82, Dec. 2011; G. Sharma, L. Karam, and P. Wolfe, "Select Trends in Image, Video, and Multidimensional Signal Processing," *IEEE Signal Processing Magazine*, vol. 29, no. 1, pp. 174-176, Jan. 2012; Q. Xu, S. Varadarajan, C. Chakrabarti, and L.J. Karam, "A Distributed Canny Edge Detector: Algorithm and FPGA Implementation," *IEEE Transactions on Image Processing*, vol. 23, no. 7, pp. 2944-60 (July 2014); M.M. Subedar and L.J. Karam, "3D Blur Discrimination," *ACM Transactions on Applied Perception*, vol. 13, no. 3, pp. 1-13, Apr. 2016; S.A. Golestaneh and L.J. Karam, "Spatially-Varying Blur Detection

Based on Multiscale Fused and Sorted Transform Coefficients of Gradient Magnitudes," *IEEE Conference on Computer Vision and Pattern Recognition (CVPR),* pp. 596-605, July 2017; S. Dodge, J. Mounsef, and L. Karam, "Unconstrained Ear Recognition Using Deep Neural Networks," *IET Biometrics*, vol. 7, no. 3, pp. 207-214, Jan. 2018; S.F. Dodge and L.J. Karam, "Visual Saliency Prediction Using a Mixture of Deep Neural Networks," *IEEE Transactions on Image Processing*, vol. 27, no. 8, pp. 4080-90, Aug. 2018; S.F. Dodge and L.J. Karam, "Quality Robust Mixtures of Deep Neural Networks," *IEEE Transactions on Image Processing*, vol. 27, no. 11, pp. 5553-62, Nov. 2018; J. Mounsef and L. Karam, "Augmented Sparse Representation Classifier (ASRC) for Face Recognition Under Quality Distortions," *IET Biometrics*, vol. 8, no. 6, pp. 431-442, Oct. 2019; T.S. Borkar and L.J. Karam, "DeepCorrect: Correcting DNN Models Against Image Distortions," *IEEE Transactions on Image Processing*, vol. 28, no. 12, pp. 6022-34, Dec. 2019; and in C.D. Prakash and L.J. Karam, "It GAN Do Better: GAN-based Detection of Objects on Images with Varying Quality," *IEEE Transactions on Image Processing*, vol. 30, pp. 9220-30, Nov. 2021. I also co-authored a machine learning book entitled *Introduction to Machine Learning and Deep Learning: A Hands-On Starter's Guide*, published in 2017, revised in 2019, and available online at https://deeplearningtextbook.org/.

16. I am an inventor, and I have been awarded eight patents in the field of image and video processing, compression, and transmission: U.S. Patent Nos. 6,154,493 ("Compression of Color Images Based on a 2-Dimensional Discrete Wavelet Transform Yielding a Perceptually Lossless Image"), 6,124,811 ("Real Time Algorithms and Architectures for Coding Images Compressed by DWT-Based Techniques"), 6,717,990 B1 ("Communication System and Method for Multi-Rate, Channel-Optimized Trellis-Coded Quantization"), 7,551,671 B2 ("System and Method for Transmission of Video Signals Using Multiple Channels"), 9,082,164 B2 ("Automatic Cell Migration and Proliferation Analysis"), 9,501,710 B2 ("Systems, Methods, and Media for Identifying Object Characteristics Based on Fixation Points"), 9,704,232 B2 ("Stereo Vision Measurement System and Method"), and 11,030,485 B2 ("Systems and Methods for Feature Transformation, Correction and Regeneration for Robust Sensing, Transmission, Computer Vision, Recognition and Classification"). I am also a named inventor on an additional patent application, published as U.S. Patent Application Publication No. 2008/0259796 A1 ("Method and Apparatus for Network-Adaptive Video Coding").

17. Based on my background, experience, education, and professional activities, I consider myself an expert in the fields of signal processing, image and video processing, computer vision (2D and 3D), machine learning, sensing, robotics, and associated computer-implemented control and processing. I am not an attorney

and offer no legal opinions, but, in my work, I have had experience studying and analyzing patents and patent claims from the perspective of a person skilled in the art.

III. Materials Considered

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

Exhibit No.	Description
Ex-1001	U.S. Patent No. 10,791,936 ("the '936 patent")
Ex-1002	Prosecution History of U.S. Patent No. 10,791,936
Ex-1004	International Application Publication No. WO 2007/084727 A1 to Boerjes et al. ("Boerjes")
Ex-1005	U.S. Patent No. 7,474,932 B2 to Geng ("Geng")
Ex-1006	U.S. Patent Application Publication No. US 2005/0283065 A1 to Babayoff ("Babayoff")
Ex-1007	U.S. Patent Application Publication No. US 2007/0236494 A1 to Kriveshko ("Kriveshko")
Ex-1008	U.S. Patent Application Publication No. US 2007/0172112 A1 to Paley et al. ("Paley")
Ex-1009	U.S. Patent Application Publication No. US 2002/0006217 A1 to Rubbert et al. ("Rubbert")
Ex-1010	International Application Publication No. WO 2007/084768 A1 to Dunne et al. ("Dunne")
Ex-1011	U.S. Patent Application Publication No. US 2006/0115793 A1 to Kopelman et al. ("Kopelman-793")

Exhibit No.	Description
Ex-1012	U.S. Patent Application Publication No. US 2008/0131841 A1 to Taub et al. ("Taub-841")
Ex-1013	U.S. Patent No. 7,112,065 B2 to Kopelman et al. ("Kopelman-065")
Ex-1014	U.S. Patent Application Publication No. US 2007/0015111 A1 to Kopelman et al. ("Kopelman-111")
Ex-1015	U.S. Patent Application Publication No. US 2009/0316966 A1 to Marshall et al. ("Marshall")
Ex-1016	U.S. Patent Application Publication No. US 2005/0250075 A1 to Taub et al. ("Taub-075")
Ex-1017	U.S. Patent Application Publication No. US 2005/0153255 A1 to Sporbert et al. ("Sporbert")
Ex-1018	International Application Publication No. WO 2009/085752 A2 to Cinader ("Cinader")
Ex-1019	International Application Publication No. WO 2003/094102 A1 to Rubbert et al. ("Rubbert-102")
Ex-1020	U.S. Patent No. 6,227,850 B1 to Chishti et al. ("Chishti")
Ex-1021	U.S. Patent Application Publication No. US 2010/0281370 A1 to Rohaly et al. ("Rohaly")
Ex-1022	U.S. Patent Application Publication No. US 2003/0232302 A1 to Babayoff et al. ("Babayoff-302")
Ex-1023	Preliminary Claim Constructions in *Align Technology Inc. v. ClearCorrect Operating LLC, et al.*, No. 24-cv-00187-ADA-DTG (W.D. Tex. Jan. 21, 2025)
Ex-1024	U.S. Patent No. 7,382,897 B2 to Brown et al. ("Brown")

IV. Relevant Legal Standards

19. 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.

20. I have been asked to provide my opinions regarding whether claims 1-20 ("the Challenged Claims") of the '936 patent are unpatentable, because they 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.

21. In forming my opinions expressed below, in addition to my knowledge and experience based upon my work in the fields of signal, image, and video processing, computer vision, biomedical signal processing, and 2D and 3D medical imaging, I have considered the documents listed in the Table in Section III above.

22. 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

23. 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 show that the claim would have been "obvious" to a person of ordinary skill in the art at the time of the invention. 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.

24. 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.

25. 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.

26. 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.

27. 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.

B. Level of Ordinary Skill

28. In rendering the opinions set forth in this declaration, I have been asked to consider the ’936 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.

29. I understand that I must evaluate the ’936 patent from the perspective 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. It is my opinion that such a person of ordinary skill in the art as related to the ’936 patent would have been a person having at least a bachelor’s degree in electrical engineering, computer engineering, or a closely related field such as computer science, and two years of work experience in 3D imaging of physical structures, including the generation of 3D models of physical structures and image processing, as of the earliest priority date of the ’936 patent—July 19, 2010. I believe additional education might substitute for less work experience, or vice versa.

30. Based on my educational background and experience, such as my experience with signal, image and video processing, computer vision, and 2D and 3D imaging (*see* paragraphs 4-17), I am qualified as at least a person of ordinary skill in the art with respect to the ’936 patent. 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 ’936 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.

C. Claim Construction

31. 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.

32. 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 have been informed that this additional evidence is often less significant and less reliable than the claims, specification, and prosecution history. 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.

33. 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.

34. I have also been informed that in a parallel district court proceeding, the district court preliminarily construed the meaning of the following terms (Ex-1023, 7):

Claim Term	Court's Preliminary Construction
"replace [replacing] at least a portion of the [removed] surface portion of the model […] using the received second scan data [at least a portion of the second scan data]" Ex-1001, cls. 1 (and dependent claims), 9 (and dependent claims), 17 (and dependent claims)	[register] / [registering] the [received] second scan data with a retained portion of the model after removing the scan data of the removed surface portion
"second scan data of the patient's teeth" Ex-1001, cl. 17 (and dependent claims)	Plain and Ordinary Meaning

35. In my opinion, the claims are unpatentable based on the prior art and grounds discussed below under the plain and ordinary meaning of these terms as well as the court's preliminary constructions, even if those constructions do not apply plain and ordinary meaning.

V. State of the Art

A. Three-Dimensional (3D) Virtual Models of the Intraoral Cavity Were Known and Conventional in Dentistry.

36. Before the priority date for the '936 patent—and as the '936 patent concedes in its Background section—3D virtual models of the intraoral cavity were used in many dental procedures. Ex-1001, 1:26-59. 3D virtual models provide accurate representations of the patient's dentition (i.e., the number, kind, and arrangement of the patient's teeth), which allow for more precise planning and execution of various dental procedures and improve the quality, efficiency, and safety of dental care. *See* Ex-1009, [0013] ("Dentistry and orthodontics is one area where precise knowledge of a patient's dentition is desirable . . . ."); *see also id.*, [0010], [0021], [0225]-[0226], Figs. 1-6 (collectively disclosing systems and methods for generating a highly accurate virtual 3D model of the patient's dentition using hand-held optical scanners); Ex-1010, [0006] ("Recent advances in three dimensional imaging technology have introduced the possibility of a handheld, three-dimensional scanner that can be suitably adapted to acquisition of highly accurate, detailed surface data directly from within a dental patient's mouth – a virtual digital dental impression – that, once captured accurately, will not degrade, and can be easily reviewed, analyzed, and/or transmitted to remote manufacturing facilities."); *see also id.*, [0008] (disclosing systems and methods

"for capturing highly detailed three-dimensional representations of dental subject matter"). An example of a 3D virtual model is shown below from Paley (Ex-1008):

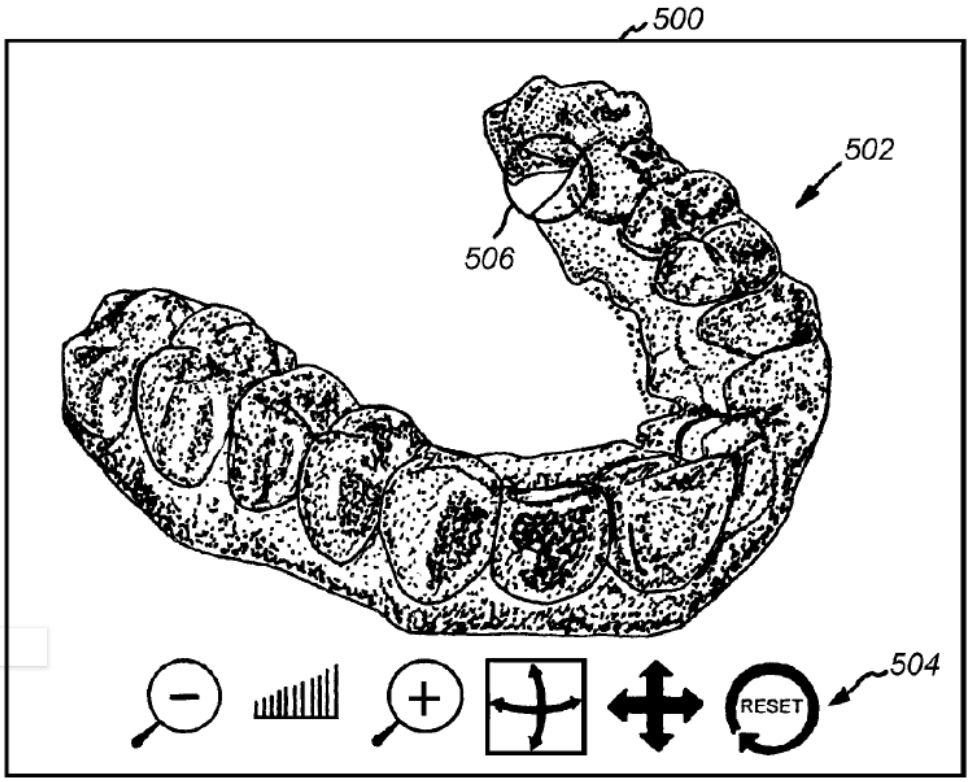


Fig. 5

Ex-1008, Fig. 5 (showing a 3D model of teeth displayed on a user interface).

37. The prior art teaches that using 3D virtual models allows for iterative and interactive imaging, easier and more secure recordkeeping and tracking, computer-assisted analysis and quality assurance, increased patient comfort, and reduced costs, all of which enhance the practice of dental procedures. *See* Ex-1010, [0003]-[0008] (teaching that 3D virtual models reduce manual labor and errors inherent in conventional dentistry, will not degrade, and can be easily reviewed,

analyzed, and/or transmitted to remote manufacturing facilities); Ex-1005, 3:23-34 (teaching that virtual 3D models eliminate the need to take, handle, store, and transport traditional physical dental impressions, e.g., wax molds, and make it possible to perform an entire dental restoration in a single patient visit, thereby improving patients' comfort and reducing costs while also increasing productivity for dental offices and laboratories), 8:64-9:1 (teaching that interactive 3D dental imaging enhances dental examination procedures and related recordkeeping), 9:1-8 (using interactive 3D imaging enhances restorative care, including examination, diagnosis, treatment planning, and treatment), 9:37-10:23 (using 3D dental imaging for dental diagnosis), 10:46-58 (using 3D dental imaging for tracking treatment progress), 10:59-64 ("The contributions of 3D imaging to restorative dental treatments provide significant benefits . . . , [and] dentists will realize significant time and cost savings in their clinical treatment.").

38. The prior art teaches that 3D models were frequently used in prosthodontics. As I understand, "prosthodontics is the dental specialty concerned with artificial replacements of missing parts of the mouth and jaws, such as a tooth or parts thereof." Ex-1011, [0003]. The prior art also teaches that to implant a dental prosthesis in the intraoral cavity, the dental site at which the prosthesis is to be implanted needs to be prepared carefully and accurately so that a prosthesis, such as a crown or bridge, can be properly designed and dimensioned to fit in

place. *Id.*, [0004], [0097]. A virtual or physical model of the site, including the preparation, can be sent to the dental lab, which manufactures the prosthesis based on the model. *Id.*, [0005]. If the model is deficient, or if the preparation is not optimal for receiving the prosthesis, the lab can reject the model and the dental practitioner must rescan the site and/or rework the preparation to produce a suitable prosthesis. *Id.* In dentistry, a "preparation" or "surface preparation" refers to the process of shaping and treating a tooth structure before placing a prosthesis, such as a crown, to ensure proper retention, and fit of the prosthesis. *See e.g.,* Ex-1008, [0030], [0062]-[0068]; Ex-1011, [0005], [0009]-[0010], [0085], [0090]; Ex-1021, [0005], [0054]; Ex-1014, [0012]. The prior art also shows that it was well known that computers or dental professionals could analyze 3D virtual models to determine whether the surface preparation or the prosthesis is acceptable or whether further work at the site is necessary. *See* Ex-1011, Abstract, [0002], [0106], [0117]-[0119], [0121], [0124], [0149], [0180] (collectively teaching using a 3D model to determine whether the geometry of a tooth preparation, such as the finish line, is adequate for the prosthesis, such as a crown); *see also* Ex-1017, [0087]-[0088] (collectively teaching using 3D virtual models for designing and optimizing prosthetic devices by evaluating occlusal and interproximal contacts between the device and other teeth).

39. As the prior art shows, it was also well known that 3D virtual models of a patient's dentition (also called digital impressions), including a "preparation" or "surface preparation," could be used for the design and manufacture of dental prostheses (e.g., crowns, bridges, copings). *See* Ex-1005, 3:23-4:2, 10:59-12:7, 12:20-50 (collectively teaching using 3D virtual models of the patient's teeth for treatment preparation and manufacturing custom-designed prostheses); Ex-1012, [0002]-[0004], [0007] (collectively teaching using 3D virtual models for designing dental prostheses, such as crowns and orthodontic braces); Ex-1013, Abstract, 1:32-41, 2:18-44, 6:28-44, Figs. 3, 5 (collectively teaching using 3D digital data of dentition including a surface preparation to determine a finish line for generating virtual crown data and using the virtual crown to construct a physical crown to fit over the preparation); Ex-1014, Abstract, [0003]-[0005], [0055] (collectively teaching that a 3D virtual model allows for a more precisely defined finish line and thus using a 3D virtual model in place of a traditional plaster model for the design and manufacture of a prosthesis); Ex-1007, [0105] (teaching using a digital 3D surface map of a dental bite registration for fabricating dental prosthetics); Ex-1015, [0144]-[0146] (teaching using 3D dental models for designing and producing customized versions of restorative appliances for mounting to a preparation site on the patient's dentition, e.g., a dental crown); Ex-1016, [0005],

[0008]-[0009] (collectively teaching using a 3D virtual model for fabricating a physical model for preparing a crown, a bridge, or other dental procedure).

B. Hand-Held Intraoral Scanners for Obtaining 3D Virtual Models of the Intraoral Cavity Were Known and Conventional.

40. Before the priority date for the ’936 patent, using hand-held intraoral scanners to scan intraoral structures and obtain 3D virtual models was also well known as the prior art shows. *See* Ex-1009, [0114]-[0118], [0131]-[0134], Figs. 1-5; *see also* Ex-1004, [0065]-[0066], [00135], Fig. 1 (teaching using a hand-held intraoral scanner for obtaining a 3D virtual model of one or more intraoral structures, such as a tooth surface prepared for a dental restoration); Ex-1019, 2:8-15 (teaching that hand-held scanners for *in-vivo* scanning of dentitions were available and allow for scans of the dentition in a relatively short time frame, and a 3D virtual model of the patient’s dentition can be derived from the original scan); Ex-1014, [0006], [0071]-[0072], Figs. 2-3 (teaching using a hand-held scanner to acquire the 3D data for obtaining a 3D virtual model of the intraoral cavity); Ex-1011, [0083] (teaching using a hand-held scanner to acquire 3D data of the oral cavity); Ex-1006, [0113]-[0137], [0155]-[0156] (teaching using a 3D hand-held surface scanner for providing a 3D model of a target dental surface within the intraoral cavity); Ex-1017, [0061], [0069], Fig. 10 (teaching using a hand-held scanner for *in-vivo* scanning of a patient to obtain 3D virtual models of the teeth);

Ex-1007, [0052], Fig. 1 (teaching using a hand-held scanner with a freely positionable probe for obtaining data that can be resolved into a 3D model).

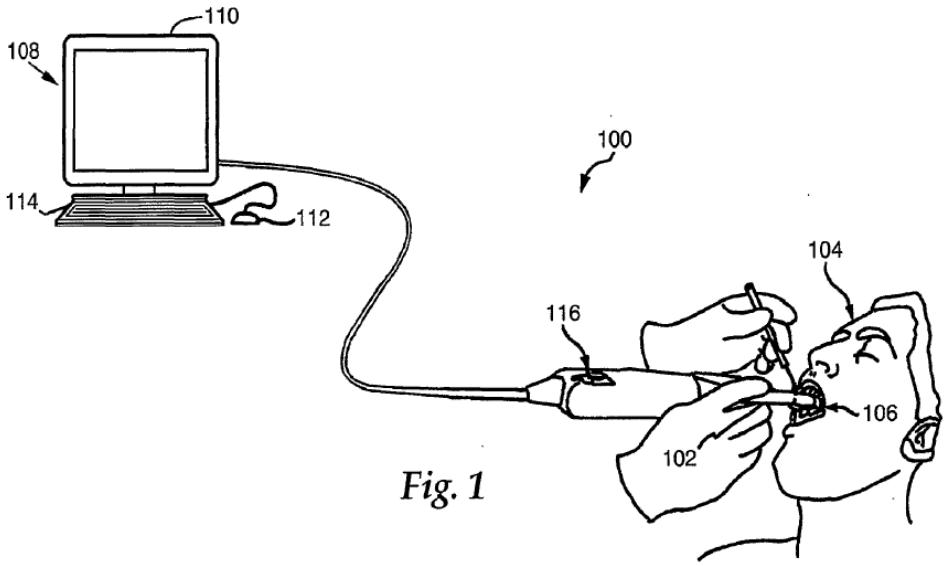


Fig. 1

Ex-1004, Fig. 1 (showing a hand-held intraoral scanner).

41. Typically, as the prior art demonstrates, a hand-held scanner communicates with a computer system, which receives the scanning data from the scanner, processes the data, derives a 3D virtual model based on the scan data, and displays the 3D virtual model. For example, as shown in Figure 1 above from Boerjes, a hand-held scanner captures data from an intraoral cavity and forwards the captured data to a computer. *Id.*, [00132]. The computer processes the data and generates a 3D virtual model of the intraoral structure in real time. *Id.*, [00131]-[00133], [00142]-[00150]. The computer's display presents the 3D virtual model to a user. *Id.*, [00129], [00145], [00150]; *see also* Ex-1007, [0051]-[0052], [0058],

Fig. 1 (collectively teaching that the hand-held scanner forwards the captured data to a computer for deriving a 3D virtual model); Ex-1009, [0114], [0122], [0226], Figs. 1-2 (collectively teaching a scanner system that includes a hand-held scanner and a computer that processes data received from the scanner and generates a 3D computer model of the dentition for diagnosis, planning treatment, and monitoring care for the patient); Ex-1015, [0056]-[0065] (collectively teaching using a scanner and a computer to produce an electronic dental model of a patient's dentition). The scanner may include suitable processing for deriving the 3D model from a set of two-dimensional images or employ structured light, laser scanning, direct ranging, or any other technology suitable for acquiring 3D data. Ex-1004, [00133].

42. The prior art teaches that it was well known before the '936 patent that users can communicate with the computer through user input devices and interact with the 3D model. *Id.*, [00132], [00142]. For example, Boerjes explains that its display can be a touchscreen adapted to receive a user input to manipulate the 3D model, such as to change the orientation of the visualization of the 3D model; define, edit, or annotate a margin line; highlight inadequate areas; or remove unwanted or unneeded areas of the 3D model. *Id.*, [00147]-[00148], [00196]-[00199]; *see also* Ex-1007, [0072], [0091]-[0093], [0101] (collectively teaching that the computer has a user interface for displaying the model and for the user to rotate, translate, or scale the 3D model, or select a point or region on the 3D

model for reacquisition through user input devices, such as a touchscreen display); Ex-1005, 2:21-31, 4:54-65, 6:26-41, 7:12-51 (collectively teaching that a computer has a graphical user interface and user input devices for a user to manipulate a 3D virtual model based on the user input, such as modifying and/or eliminating undesirable areas, and removing abnormal data points on the 3D model); Ex-1021, [0057], [0111]-[0115], [0119]-[0122] (collectively teaching that a user may directly edit the digital model using interactive model editing tools, such as to identify artificial objects (e.g., cord, saliva, blood) or edit a margin line); Ex-1020, 3:15-23, 9:3-40 (collectively teaching that a user can, through a graphical user interface, modify a 3D model of the teeth, such as by removing an unwanted portion on the model); Ex-1015, [0060], [0068]-[0069], [0088]-[0089], [0100], [0117]-[0119] (collectively teaching that a user can interact with the 3D model using input devices, such as to translate and/or orient the model, or selecting points on the model to remove, isolate, or delete); Ex-1009, [0116], [0128], [0324]-[0328] (collectively teaching that the computer has a monitor for displaying a 3D model of dentition in real time as the scanning is occurring and a user interface for the user to manipulate the 3D model, such as erasing unwanted areas of the 3D model by highlighting unwanted areas and clicking an erase icon); Ex-1014, [0006]-[0007], [0070], [0078]-[0083] (collectively teaching a user interface that allows the user to demarcate portions of a dental model by visually identifying a demarcation line).

C. Performing Additional Scans to Supplement or Correct an Existing 3D Virtual Model Was Known and Conventional.

43. It was well known before the '936 patent that a 3D virtual model derived from scan data can have defects, such as missing or inaccurate areas, due to inadequate scanning or dental procedures, as the prior art shows. Ex-1007, [0005]-[0006] (collectively teaching that a single 3D model can have errors or gaps); Ex-1008, [0059] (teaching identifying a region of omitted or missing scan data in the digital model); Ex-1011, [0165]-[0168] (teaching that a virtual model lacks certain surface areas because a part of the target zone is missed during scanning); Ex-1014, [0007], [0023], [0078] (collectively teaching that the finish line of the virtual model may be obscured by deformed soft tissues, saliva, blood, lubricant, etc.); Ex-1021, [0005], [0102], [0111] (collectively teaching that 3D models can have errors resulting from physical obstacles that accumulate and obscure portions of the margin of a prepared tooth, such as a collapsed tissue wall around the prepared tooth, blood, and saliva); Ex-1004, [0037], [0041]-[0042], [00188]-[00198] (collectively teaching analyzing the virtual model and determining adequacy/suitability of a tooth preparation for a dental restoration). For example, Paley's Figure 5 shows region 506 that is inadequate because of missing data. Kopelman's Figure 4 shows a portion of the finish line S of a prepared tooth is obscured by other material 550, such as soft tissue. In such

situations, as discussed below and shown in the prior art, additional scans were commonly used to supplement or replace such defective areas in the 3D virtual model.

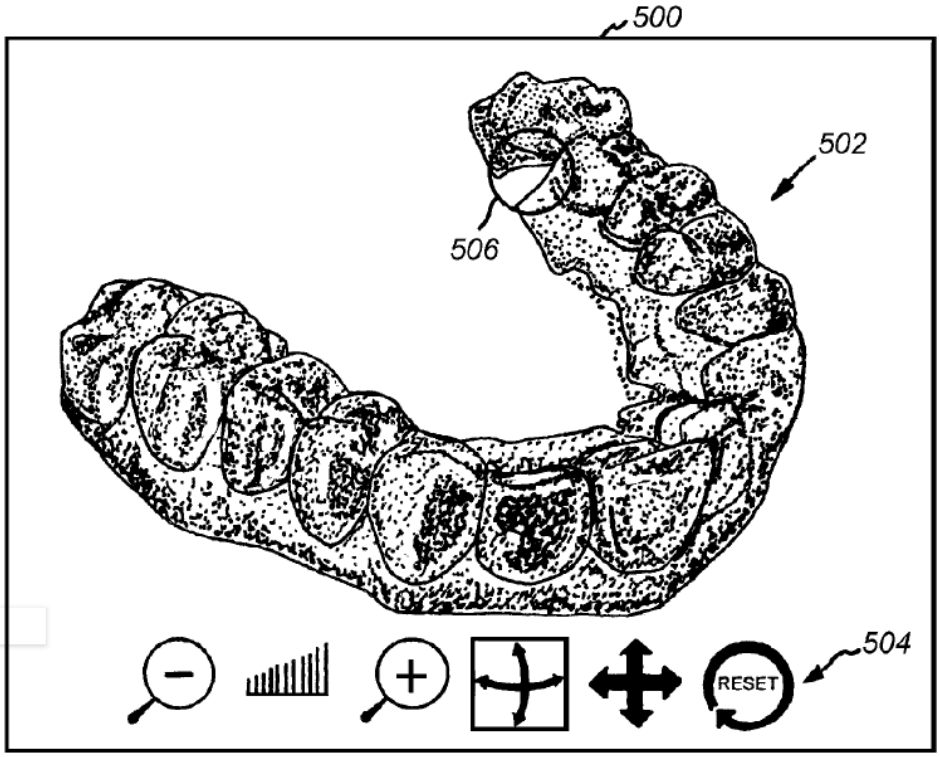


Fig. 5

Ex-1008, Fig. 5 (showing an inadequate region 506); *see also id.* ¶¶ [0059]-[0060].

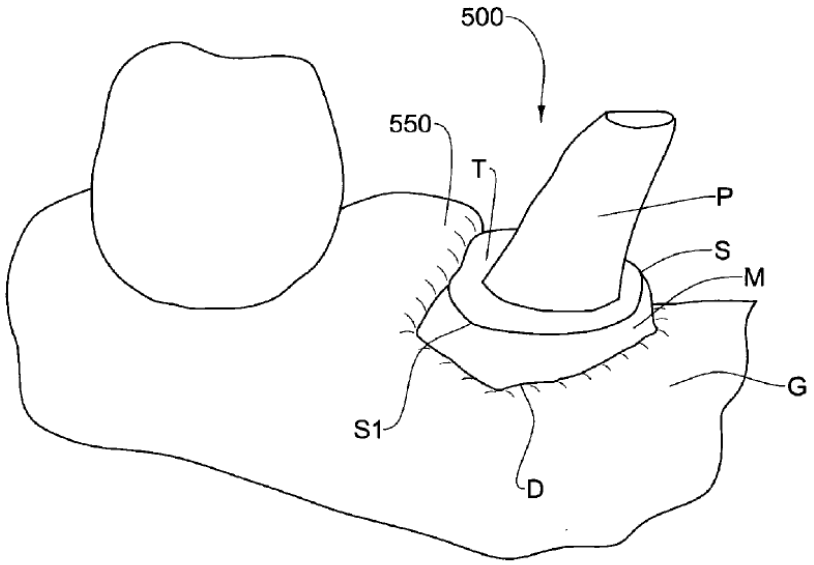


FIG. 4

Ex-1014, Fig. 4 (showing a portion of the finish line S obscured by material 550); *see also id.*, [0070], [0078], Figs. 1, 5, 7.

44. It was well known to take an additional scan or scans to update, supplement, or replace defective areas in a virtual 3D model. For example, Boerjes teaches performing a quality control process to determine whether a scan and/or surface preparations are satisfactory, and if not, performing additional scanning to replace the questionable, erroneous, or inadequate scan data. Ex-1004, [00189]-[00199]. Boerjes explains that inadequate areas in the virtual model can be due to scan deficiencies, such as holes in the surface, or due to inadequate tooth preparation resulting in an inadequate margin for fitting the dental restoration to the tooth surface. *Id.*, [0037], [0041]-[0042], [00189], [00192]-[00195]. In the

latter case, Boerjes teaches taking additional scans after further surface preparation, such as additional reduction or shaping of the prepared tooth surface. *Id.*, [00189], [00194]-[00196]; *see also* Ex-1007, [0005] (teaching using a new scan to replace defective results), [0099] ("[M]ultiple scans of an object, including scans taken at different times, may be interpreted as a single scan. For example, in a dental application, a tooth surface may be scanned before and after a surface preparation for dental prosthetic. By starting the second, post-preparation scan, by reacquiring a scan of an unprepared tooth surface, the pre-scan and post-scan structure of the prepared surface may be combined into a single surface representation …."); Ex-1015, [0049]-[0054], [0113]-[0119] (teaching using 3D dental scan data to supplement missing or inaccurate data in a 3D medical scan); Ex-1008, [0060], [0073], [0077] (teaching acquiring additional data where a void or deviation is detected either automatically or through human visual inspection).

45. As the prior art shows, many prior art dental scanning systems provide visual feedback or guidance on the displayed 3D virtual model in real time to facilitate the additional scanning or preparation. For example, Boerjes's user interface provides real-time feedback to the user, identifying the scan deficiencies in the virtual model that require additional scanning and/or surface preparation. Ex-1004, [0041], [00190]-[00196]; *see also* Ex-1007, [0049] (teaching providing real-time visual feedback to indicate whether the fitting of the additional 3D data to

the existing 3D model is successful), [0059], [0076] (teaching providing visual feedback to a user to guide the user to an appropriate scan location in reacquiring 3D data for the original 3D model); Ex-1008, [0038], [0043] (teaching providing visual feedback to a user to assist in navigating back to a scan location on the subject where the reacquisition is being attempted), [0055]-[0056], [0070] (providing feedback indicating gaps in the surface data so the user can rescan surfaces for which data was captured or inadequate or defective); Ex-1011, [0103], [0112]-[0113], [0180] (teaching providing feedback regarding the definition, quality, and clearness of the finish line), [0115], [0118] (teaching providing feedback indicating where to modify the finish line or shoulder to achieve better results), [0120] (teaching providing feedback regarding the suitability of the preparation to accept a prosthesis), [0168] (teaching providing feedback identifying missing areas in the virtual model to the user to perform additional scans of the intraoral cavity to provide the missing surface data), [0172] (teaching providing feedback to facilitate the acquisition of data for constructing the 3D model), [0176]-[0177] (teaching providing feedback in an interactive manner together with a material-removing process to facilitate the performance of the dental procedure).

46. Furthermore, the prior art teaches that using image registration and stitching to replace portions of 3D dental models, such as defective portions, with

additional scan data was well known. For example, Kriveshko teaches a landing mode where a new 3D model derived from newly scanned data is registered and stitched to the original 3D model. Ex-1007, [0059], [0066], [0074]-[0075], [0086], [0097]-[0101]; *see also* Ex-1004, [00144] (teaching fitting or stitching newly acquired 3D data to existing 3D data); Ex-1008, [0036] (similarly teaching fitting or stitching newly acquired 3D data to existing 3D data); Ex-1006, [0037]-[0039], [0044]-[0047], [0176]-[0180] (teaching stitching 3D models together by registering the 3D models containing overlapping zones to form a global 3D model). It was also known to perform registration and stitching after the defective areas are removed from a virtual model. *See* Ex-1015, [0118]-[0119] (teaching deleting data points in a second scan data set to produce a new data set, and then replacing the removed data points with data points from a first scan data set that represents the same area).

47. A person of ordinary skill in the art would have understood that image registration is a process that aligns multiple images into a single coordinate system based on corresponding data or features between the images. *See, e.g.*, N. Gelfand, N.J. Mitra, L.J. Guibas, and H. Pottmann, "Robust Global Registration," *Eurographics Symposium on Geometry Processing*, vol. 2, no. 3, pp. 197-206, at 201 (July 2005). A person of ordinary skill in the art would also have understood that image registration is typically used in conjunction with image stitching, where

multiple images are aligned and combined into a single image. *See, e.g.*, C.-Y. Chen, R. Klette, "Image Stitching—Comparisons and New Techniques," in F. Solina and A. Leonardis (eds.), *Computer Analysis of Images and Patterns*, CAIP 1999, Lecture Notes in Computer Science, vol. 1689, pp. 615-22 (Springer, Berlin, Heidelberg 1999), https://doi.org/10.1007/3-540-48375-6_73; R. Szeliski, "Image Alignment and Stitching: A Tutorial," *Foundations and Trends® in Computer Graphics and Vision*, vol. 2, no. 1, pp. 1-104 (2007), http://dx.doi.org/10.1561/0600000009. Image registration and stitching were commonly known and used in computer vision, image processing, and medical imaging. *See, e.g.*, Ex-1004, [00144]; Ex-1006, [0037]-[0039], [0044]-[0047], [0176]-[0180]; Ex-1007, [0066], [0074], [0086], [0097]; Ex-1008, [0036]; Vladan Rankov, Rosalind J. Locke, Richard J. Edens, Paul R. Barber, and Borivoj Vojnovic, "An Algorithm for image stitching and blending," Proc. SPIE 5701, Three-Dimensional and Multidimensional Microscopy: Image Acquisition and Processing XII (Mar. 24, 2005); https://doi.org/10.1117/12.590536.

VI. The '936 Patent

A. Overview of the '936 Patent

48. The '936 patent claims priority to July 19, 2010. Ex-1001, p. 2, (60).

49. The '936 patent describes systems and methods for scanning a physical structure in the intraoral cavity for a dental procedure, such as preparing a

tooth for a dental prosthesis (e.g., a crown). *Id.*, Abstract, 17:48-67. The system includes a hand-held intraoral scanner 31 that uses any suitable scanning technique to acquire scan data of the physical structure. *Id.*, 18:32-47, Figs. 3, 5. The scan data acquired by the scanner can include 3D data (e.g., depth data and 2D image data) and can also include color data. *Id.*, 18:32-19:13, 19:27-50.

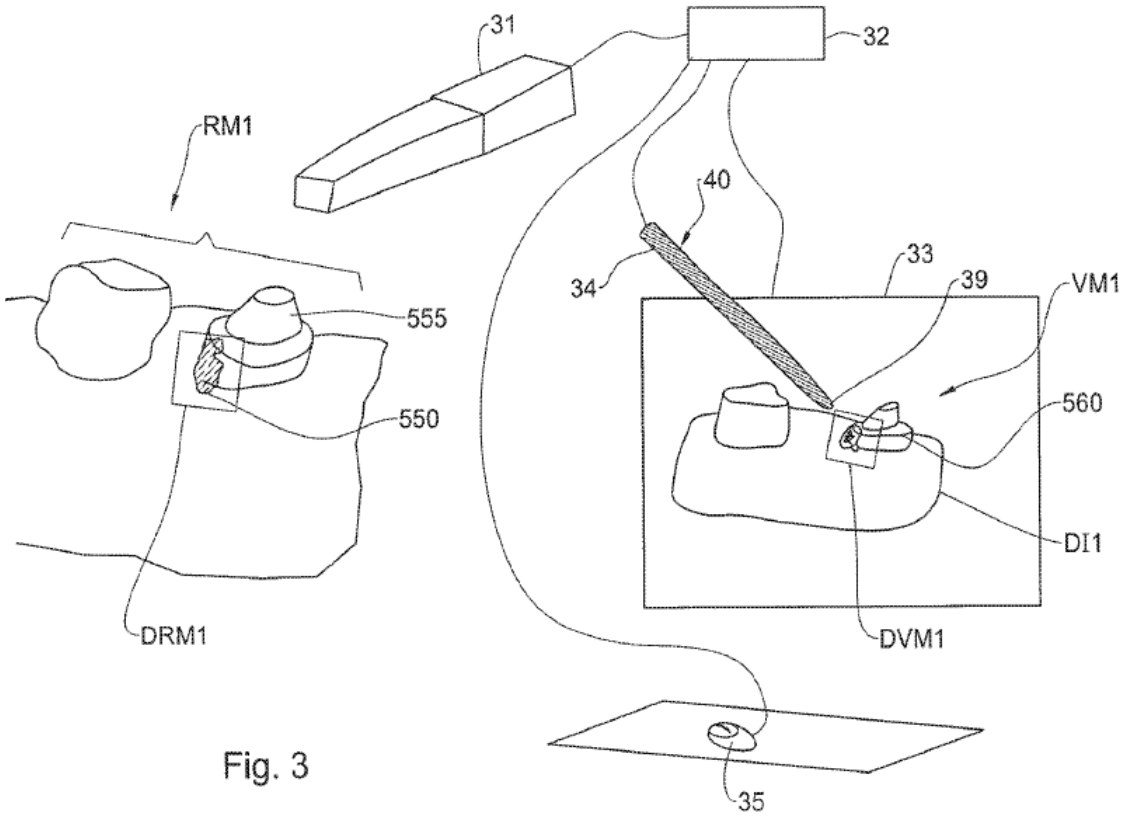


Fig. 3

Id., Fig. 3.

50. The system generates a 3D virtual model of all or part of the intraoral cavity from the scan data received from the scanner. *Id.*, 17:48-54, 19:5-20, Figs. 1, 3. Computer system 32 includes a display 33 that displays the 3D virtual

model and an input device 40, such as a mouse 35 or a touchscreen, to allow the user to visually check and interact with the displayed model. *Id.*, 19:14-26, 20:30-58, Figs. 1, 3, 9.

51. The ’936 patent notes that the term “3D virtual model” is used “synonymously with digital model, virtual model, 3D virtual model, 3D model, three dimensional model, 3D numerical entity, numerical entity, computer model, 3D computer model, dimensional data, 3D digitized data, 3D representation, and other such terms, and relates to a virtual representation in a computer environment of a real object.” *Id.*, 3:26-35.

52. For example, the ’936 patent discloses that the 3D virtual model from an initial scanning can be defective, such as due to inadequate surface preparation for a dental procedure, the physical structure being covered or obscured, e.g., by saliva, blood, soft tissue, or due to defective scanning. *Id.*, 12:15-63, 16:17-29, 20:64-21:17, 22:44-48, 27:17-34, Figs. 3, 8. When the defect is due to inadequate tooth preparation, the ’936 patent describes that its system and method allow a dental practitioner to check and modify the tooth preparation repeatedly until it is adequate for receiving a prosthesis, such as a crown. *Id.*, 16:50-55, 26:47-65, 27:40-65. When the defect is due to obscuring a finish line, the ’936 patent describes that its system and method allow a dental practitioner to perform

checking, cleaning up, and rescanning repeatedly as desired until the model is acceptable. *Id.*, 5:46-59, 21:4-11, 22:38-43, 23:53-58.

53. For example, as shown below in Figure 3, the ’936 patent describes a first virtual model VM1, which represents the surface of a physical part RM1 (e.g., a surface preparation 700 as also shown below in Figure 8), is considered not suitable for a dental procedure, such as due to an inadequate structure for a prosthesis, such as a crown. *Id.*, 26:47-27:34, Figs. 3, 5, 8. The practitioner interacts with the displayed virtual model VM1 and identifies an unsuitable portion of the dental preparation, i.e., area DVM1, of the first virtual model VM1, which is then deleted, removed, or replaced, resulting in a modified virtual model VM1’ as shown in Figure 4 below. *Id.*, 21:18-59, 27:17-22, Figs. 1, 3, 4. The practitioner physically modifies the area unsuitable for the prosthesis, such as a material removal operation, and provides a modified physical preparation 700’. *Id.*, 27:17-28, Figs. 3-4. Thereafter, a second virtual model VM2 corresponding to the modified preparation 700’ is obtained by scanning the newly worked area and additional part 750 that was not modified. *Id.*, 27:29-34, Figs. 5, 8.

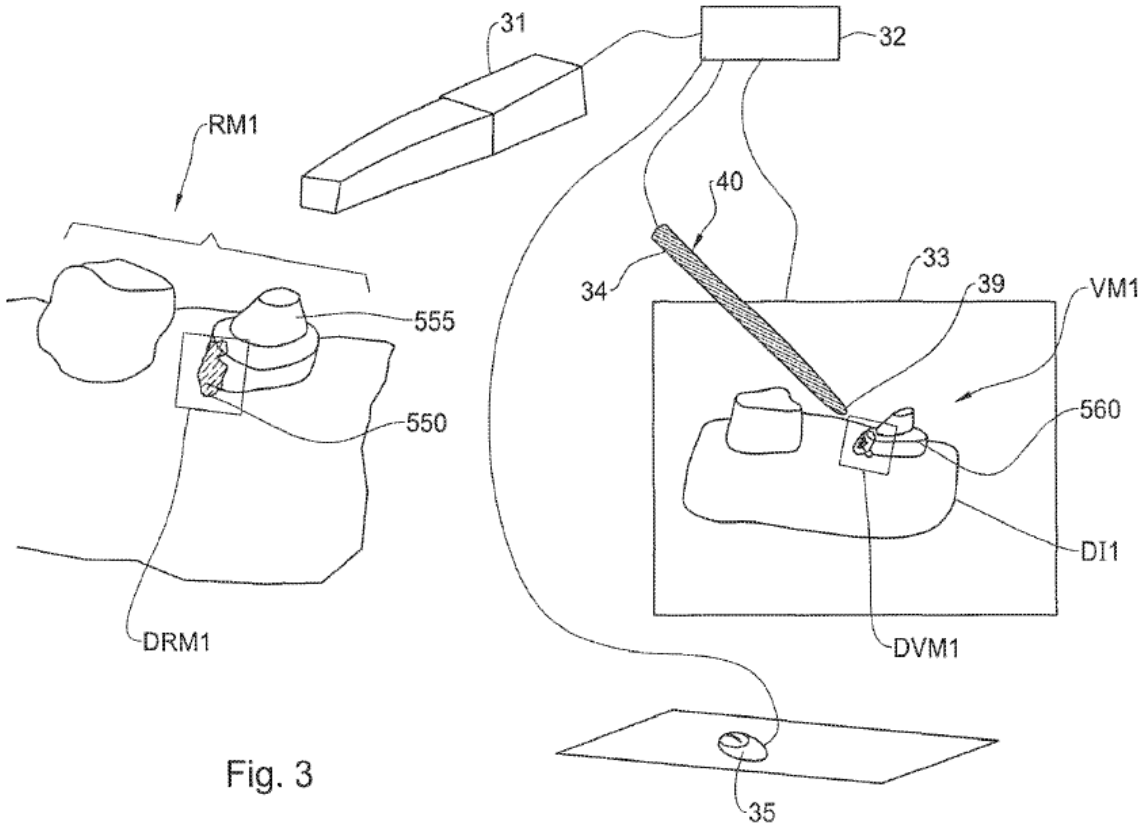


Fig. 3

Id., Fig. 3.

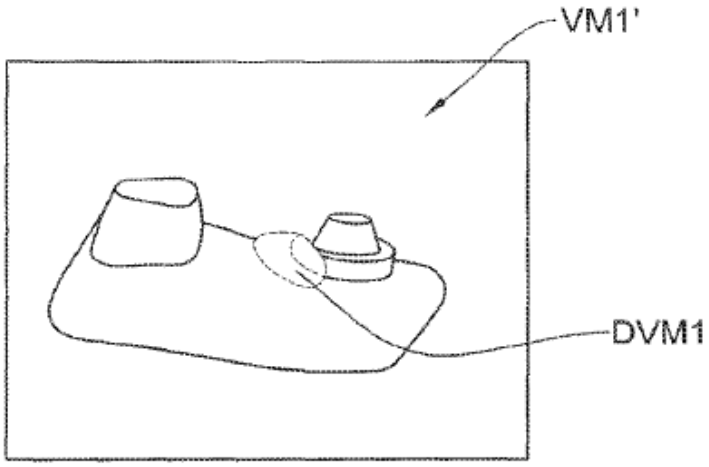


Fig. 4

Id., Fig. 4.

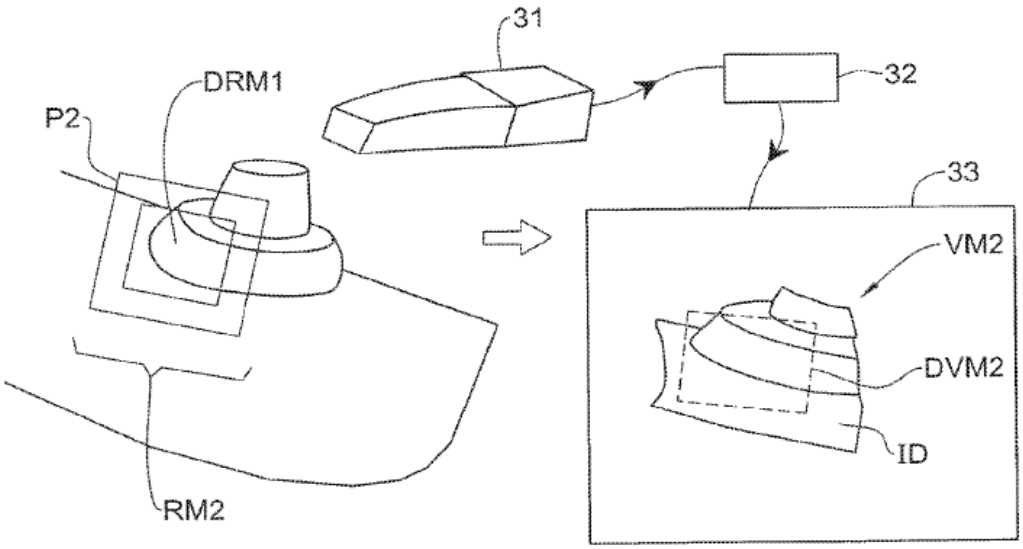


Fig. 5

Id., Fig. 5.

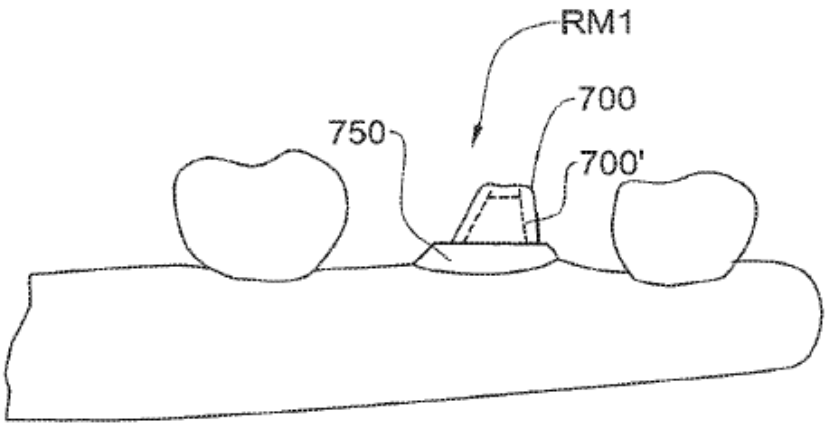


Fig. 8

Id., Fig. 8.

54. As shown below in Figure 6, a new virtual model VM3 is then obtained by registering the second virtual model VM2 to the first modified virtual model VM1' and replacing the removed/deleted area DVM1 with a corresponding part DVM2 of the second virtual model VM2. *Id.*, 22:61-23:15, 27:35-39, Figs. 1, 5, 6. The '936 patent teaches that the replacement can occur concurrently with deleting or removing the defective portion, or after it has been removed. *Id.*, 22:61-23:15, 27:17-39, Fig. 9; *see also id.*, 25:2-4 (describing "a unified replacement function" in which part of a model is replaced "in one operation").

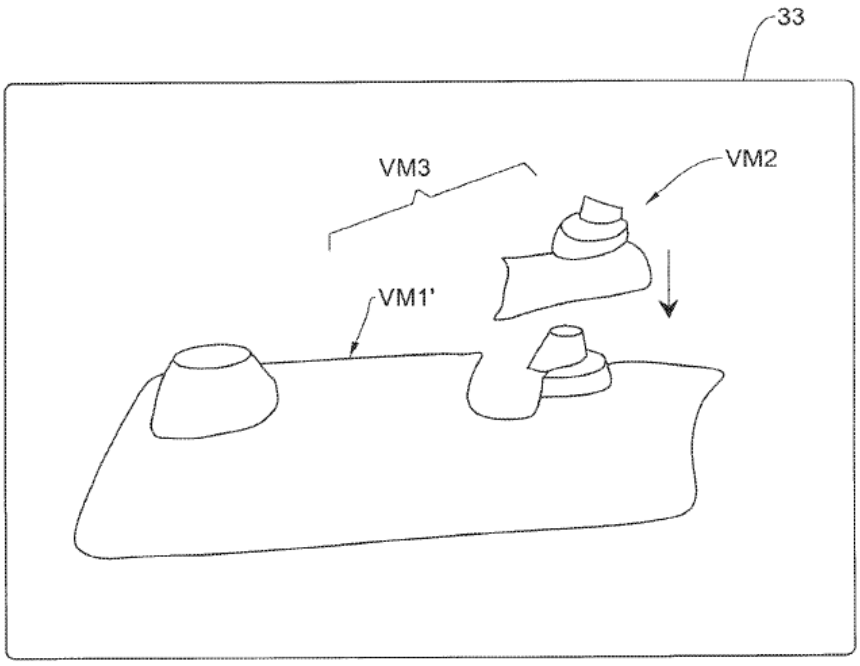


Fig. 6

Id., Fig. 6.

55. The ’936 patent does not suggest that this use case involving a physically changed portion of the patent’s intraoral cavity requires any different technical capabilities or methods compared to the patent’s general disclosures regarding how to modify a virtual model of a patient’s intraoral cavity. The ’936 patent describes that its system and method allow the practitioner to modify a part of a dental preparation, such as a part of the finish line, in a quick and easy manner with minimum scanning after the initial scan, without the need to rescan the whole physical structure again each time. *Id.*, 15:33-36, 16:56-17:3, 27:51-65, 29:45-52.

B. Prosecution History

56. U.S. Application No. 16/586,528 ("the '528 application"), which issued as the '936 patent, lists on its face a claim of priority to U.S. Provisional Application No. 61/365,556 filed on July 19, 2010. *See id.*, cover (21), p. 2 (60); Ex-1002, 10, 66, 79. I reviewed the prosecution history of the '528 application. Ex-1002. In the Notice of Allowance, the Examiner noted that the "claims as recited distinguish over the art of record . . . via reciting the updating scans to be directed to scenarios where the intra-oral cavity (e.g.[,] dentition) is modified in between the scans (e.g.[,] subjected to a surface preparation)." *Id.*, 238-39. The Examiner further explained that this feature of the claims distinguishes over the art of record because those references "deal only with recapturing scans of a static intra-oral region" and do not provide for generating a composite scan after intra-oral modifications are made, by using a second scan to update the changed region from the first scan. *Id.* As discussed below, the prior art relied on in the grounds presented herein discloses this feature of the claims that the Examiner referred to in the Notice of Allowance as well as all other features of the claims.

VII. Overview of the Prior Art

A. Boerjes (Ex-1004)

57. Boerjes is an International Patent Application that was published on July 26, 2007 (Ex-1004, cover (43)), more than one year before the earliest priority

date of the ’936 patent. I have thus been informed that Boerjes qualifies as prior art to the ’936 patent.

58. Boerjes discloses scanning systems and methods for capturing highly detailed digital dental models for a wide array of dental procedures, such as preparing a tooth surface for a dental prosthesis. Ex-1004, Abstract, [0006]-[0007], [00107], [00169], [00185]-[00189], [00210]-[00216], Fig. 1. Boerjes’s scanning system includes a hand-held intraoral scanner for acquiring surface scan data of a tooth of a dental patient. *Id.*, [0012], [0040], [0074], [0076], [0086], [00127], [00132]-[00135], Fig. 1. The scanned area of the tooth can include a tooth surface prepared for a dental restoration. *Id.*, [00162]-[00163]. A computer program stored in a computer-readable medium of a computer acquires the data from the scanner and converts the data into a digital model of the tooth. *Id.*, [0021]-[0023], [00131]-[00132], [00141], Fig. 1. The computer program also generates a visualization of the digital model and provides the visualization as a display signal to a display of the computer to display the digital model to the user. *Id.*, [00127]-[00129], [00131]-[00132], [00142], [00145].

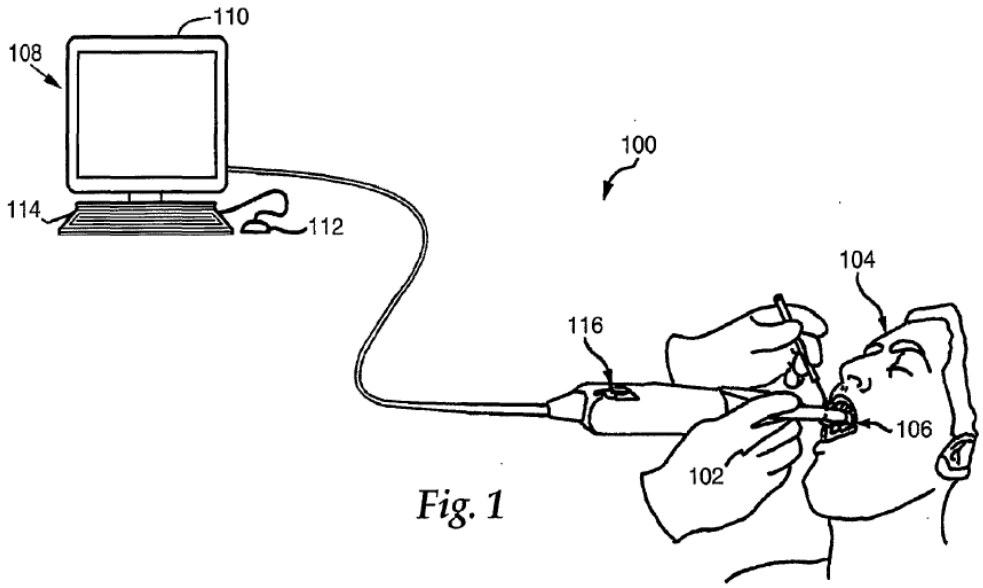


Fig. 1

Id., Fig. 1.

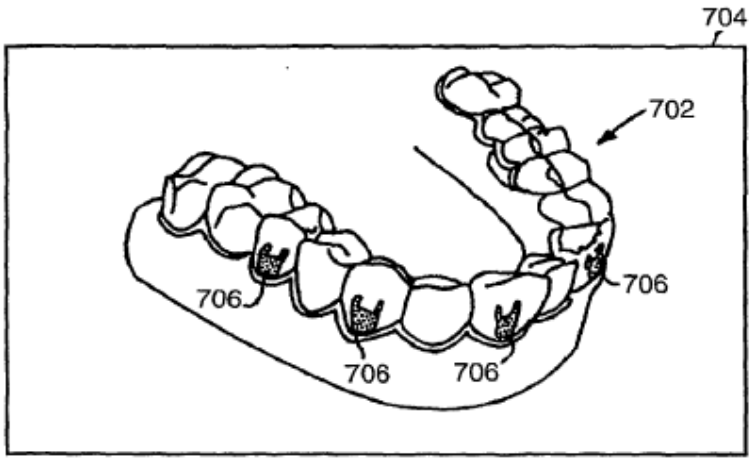


Fig. 7A

Id., Fig. 7A; *see also id.*, [00221] ("A three-dimensional representation 702 of dentition and surrounding soft tissue may be acquired from a dental patient as described generally above, and rendered within a user interface 704 on a computer

such as the image capture system 100 described above, or more generally, the client 202 described above.").

59. Boerjes further teaches a user interface with which the user can interact through a touchscreen to measure, mark, annotate, or otherwise manipulate the displayed model. Ex-1004, [00120], [00142], [00146]-[00148], [00182], [00192], [00196], [00198], [00208], [00221], Fig. 3. The user interface is used in a quality control process, where the model can be automatically, semi-automatically, or manually evaluated, such as an evaluation of adequacy of a surface prepared for receiving the dental restoration. *Id.*, [0042], [0083], [00162], [00188]-[00196], [00199]-[00200], Fig. 4. For example, as shown in Figure 4 below, the user can perform a quality check of the model (step 408), and if the scan and/or surface preparations are not satisfactory (step 412), such as because "additional surface preparation" is required—the process may "proceed to step 414 where the digital model may be supplemented or replaced with new scan data." *Id.*, [00196], [00199]-[00200], Fig. 4. The new scan data may include "scanning to replace apparently erroneous or inadequate scan data, or a new scan of the dental subject matter following, e.g., additional surface preparation consistent with errors identified during quality control." *Id.*, [00199]. A new digital model (where the existing digital model is updated, with the user-identified portion being replaced with new scan data) is then obtained and displayed for evaluation. *Id.*, [00162],

[00169], [00190], [00193], [00199]-[00200], Fig. 4; *see also id.* [00163] ("[A] scan may be obtained of a prepared surface during the scheduled visit, and the temporary restoration (or a final restoration) may be fabricated, such as at the dental office during the visit, by combining historical three-dimensional data with a three-dimensional representation of the prepared surface."). The new scan data is "stitched" with the prior scan data to create an updated digital model that is displayed. *Id.*, [00144] ("The three-dimensional data for each newly acquired two-dimensional image set may be derived and fitted or 'stitched' to existing three-dimensional data using a number of different techniques."), [00145].

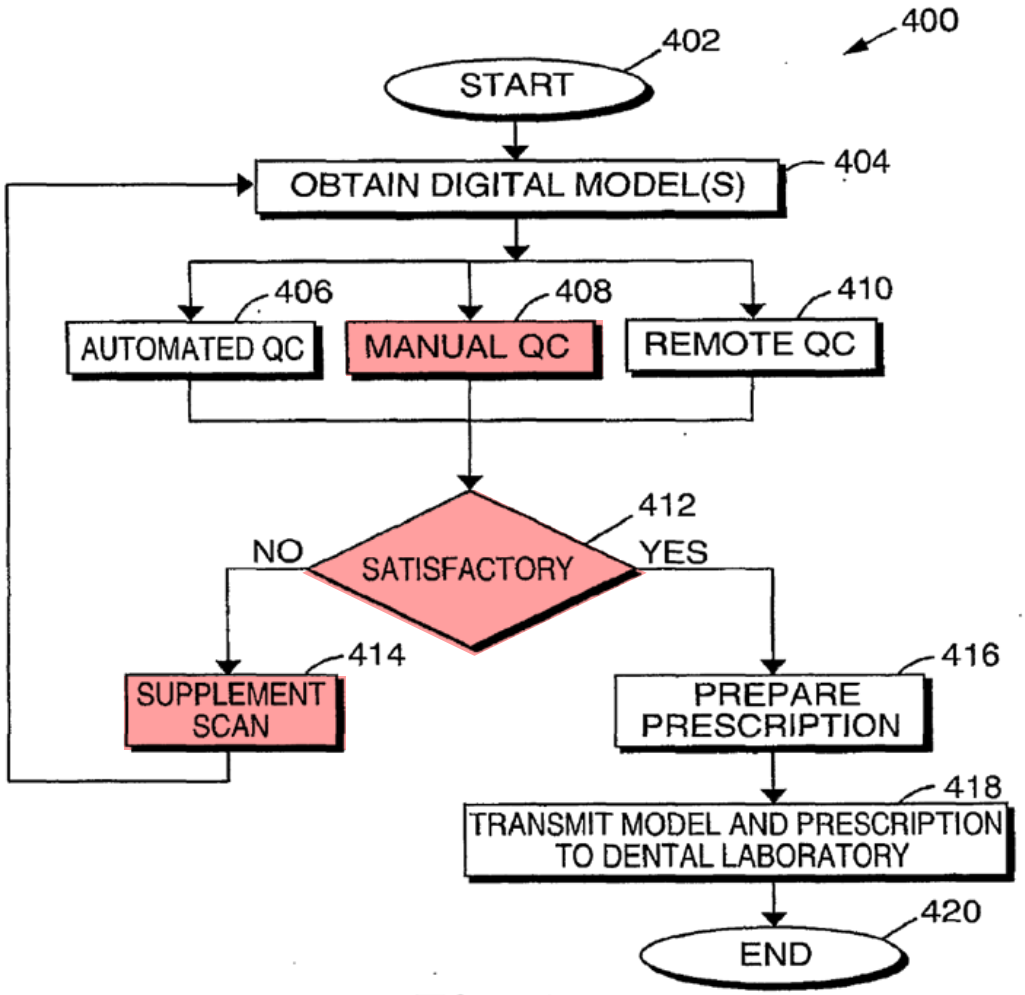


Fig. 4

Ex-1004, Fig. 4 (annotated); *see also id.*, [0037], [00196].

60. Boerjes teaches that its systems and methods allow for real-time display and feedback during a scan or between successive scans within a patient's single visit, reducing or eliminating the need for follow-up dental visits for additional scanning. *Id.*, [0041], [0074], [00150], [00190], [00198].

61. Boerjes is analogous to the '936 patent because it is in the same field of endeavor as the '936 patent. And like the '936 patent, as explained above,

Boerjes discloses using an intraoral hand-held scanner to obtain a virtual model of the teeth and performing additional scanning to update the virtual model after physical changes or if the scan quality is not satisfactory. *Id.*, [0012], [0040], [0042], [0074], [0076], [0083], [0086], [00127], [00132]-[00135], [00162], [00188]-[00196], [00199]-[00200], Figs. 1, 4.

B. Geng (Ex-1005)

62. Geng was filed on October 25, 2004, and issued on January 6, 2009 (Ex-1005, cover (22), (45)). Geng was filed and issued before the earliest priority date of the ’936 patent. I have thus been informed that Geng qualifies as prior art to the ’936 patent.

63. Geng discloses systems and methods for interactive 3D dental imaging for dental prostheses treatment. *Id.*, Abstract, 2:61-3:13, 3:48-4:2, 12:38-56, Fig. 1. Geng’s system includes a camera 104 to acquire image data of a patient’s dentition. *Id.*, 3:48-4:30, Fig. 1. The camera is communicatively coupled to a computer 112 such that the acquired image data can be provided to the computer. *Id.*

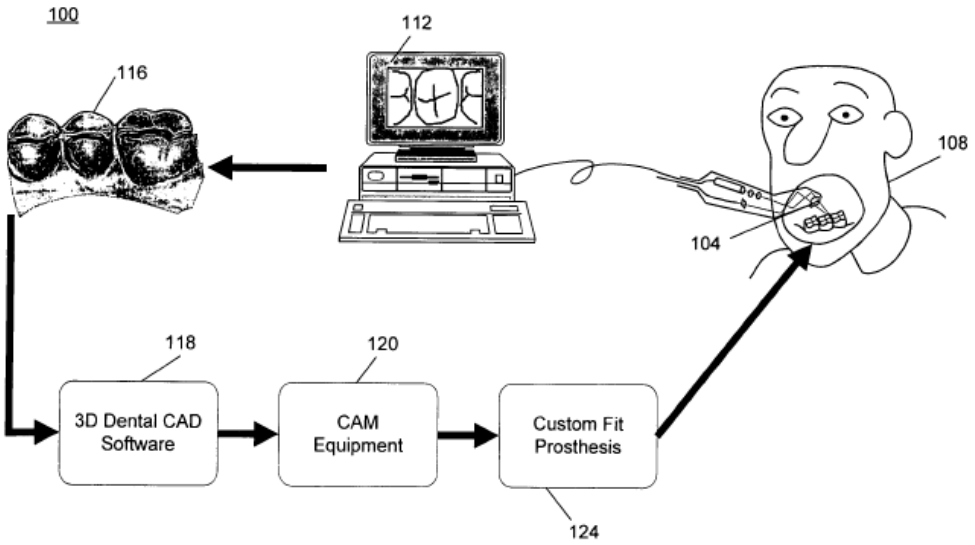


Fig. 1

Ex-1005, Fig. 1 (showing an intraoral hand-held scanner including a camera 104).

64. The computer includes software for processing the image data to form a 3D image. *Id.*, 3:48-4:36, Fig. 1. The computer also includes software applications on a computer-readable medium that provides a graphical user interface for displaying and manipulating the 3D image. *Id.*, 2:21-31, 3:14-34, 4:37-5:21, 6:15-51, 7:12-51, Figs. 2-3. The user can manipulate or interact with the displayed 3D image via a user access interface, such as a touchscreen, that receives user input. *Id*. For example, the user can use an editor tool to manipulate or edit the 3D image model, such as by modifying and/or eliminating undesirable areas on the original 3D image. *Id.*, 7:38-8:3, Fig. 3. The user can also use a merger tool that

integrates multiple 3D images into a single 3D image via registration using common points between the images. *See, e.g.*, *id.*, 7:57-8:3, Fig. 3.

65. Geng teaches that its system and methods allow for interactive design and fabrication of dental prostheses using virtual 3D models. This advantageously allows dental restoration procedures to be performed in a patient's single visit, improves accuracy and quality of dental care, reduces dental costs, and eliminates unnecessary time waste for dentists and patients. *Id.*, 1:22-32, 15:41-57.

66. Geng is analogous to the '936 patent because it is in the same field of endeavor as the '936 patent. And like the '936 patent, as explained above, Geng discloses using an intraoral hand-held scanner to obtain a virtual model of the teeth and modifying the displayed model according to user input. *Id.*, 2:21-31, 3:14-5:21, 6:15-51, 7:12-8:3, Figs. 1-3.

C. Babayoff (Ex-1006)

67. Babayoff was filed on June 17, 2005, and published on December 22, 2005 (Ex-1006, cover (22), (43)), more than one year before the earliest priority date of the '936 patent. I have thus been informed that Babayoff qualifies as prior art to the '936 patent.

68. Babayoff discloses systems and methods for providing a 3D surface representation of the oral cavity for various dental procedures, such as dental

restoration or orthodontic treatment planning. Ex-1006, Abstract, [0001], [0005]-[0007], [0101], [0171]-[0172], Fig. 1.

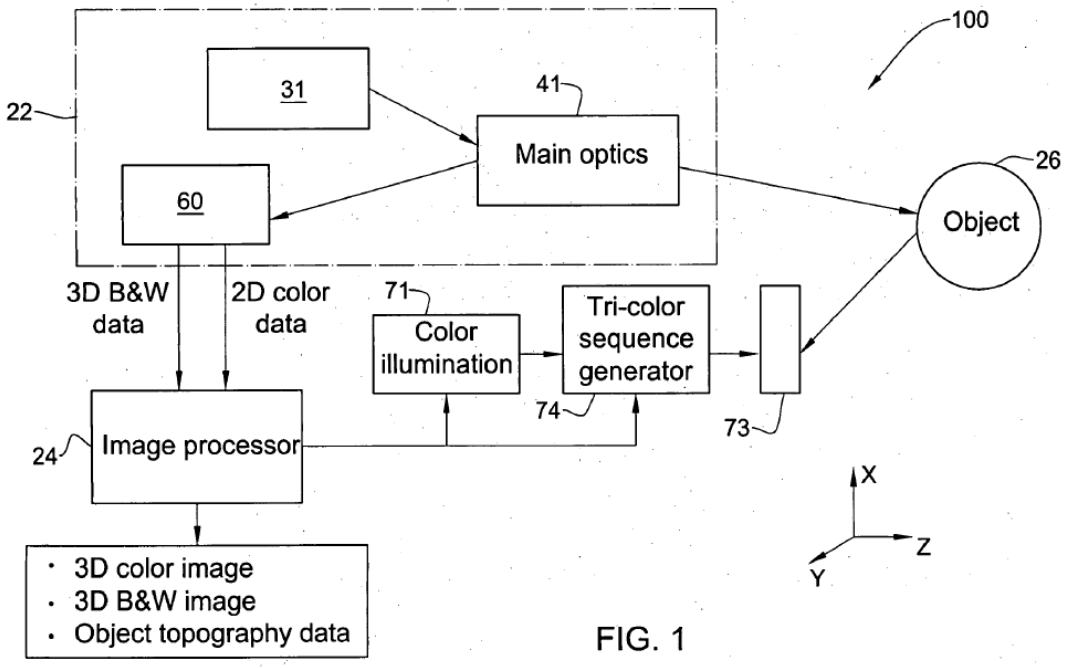


FIG. 1

Id., Fig. 1.

69. Babayoff's system includes a hand-held intraoral 3D surface scanner for acquiring image data. *Id.*, [0104], [0113]-[0136], [0156], Figs. 4A, 5A-8. As shown in Figure 4A below, the hand-held intraoral scanner includes a probing member 46, an optical sensor 68 (e.g., charge-coupled device or CCD), an illumination source 31, light focusing optics 41 defining focal planes, and a motor 72 for changing the focal plane location. *Id.*

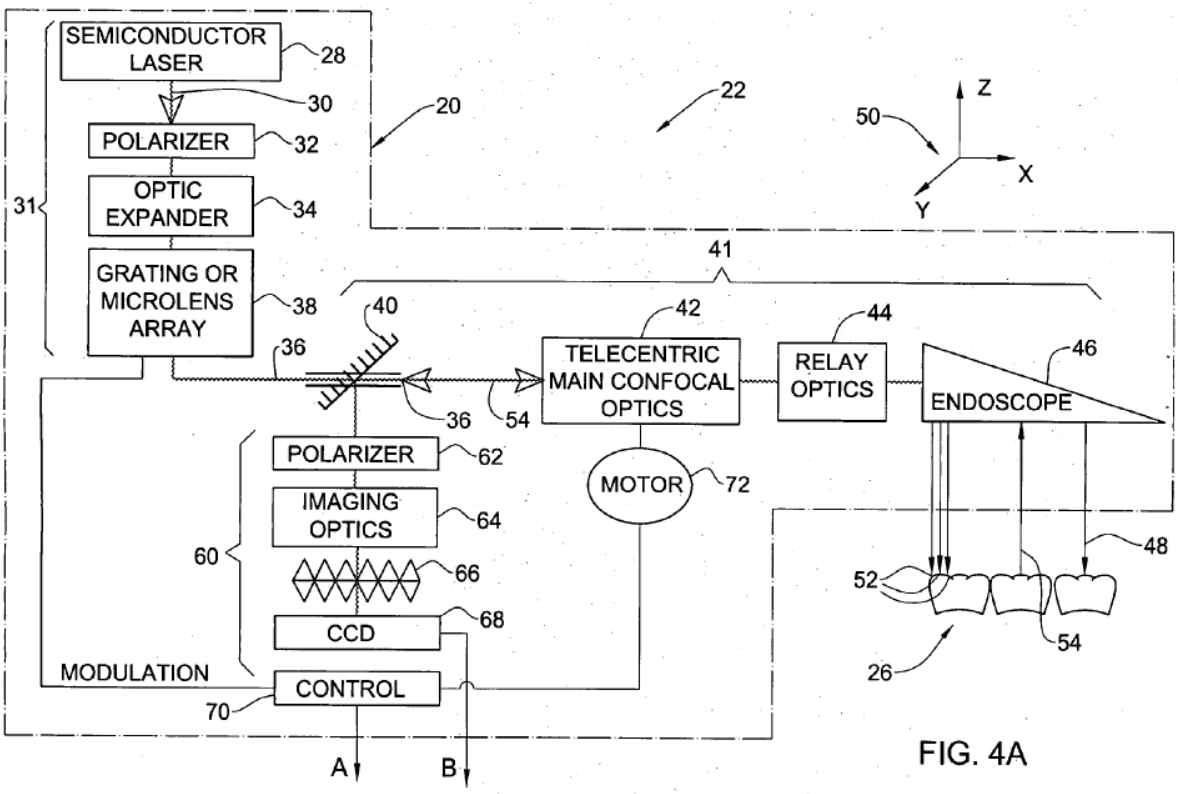


FIG. 4A

Id., Fig. 4A.

70. Babayoff's system includes a processor coupled to the scanner that receives and manipulates the image data to provide the 3D surface representation. *Id.*, [0070]-[0072], [0107]-[0109]. The 3D representation can be viewed on a display and manipulated by the user. *Id.*, [0121]. Babayoff further discloses stitching two 3D surface representations of adjacent portions of an intraoral cavity that contain overlapping areas. *Id.*, [0006]. To perform the stitching, Babayoff discloses registering portions of the two 3D surface representations comprising the overlapping area (e.g., overlapping hard tissues), stitching the two 3D surface representations based on the registration, and discarding data points that are

repeated. *Id.*, [0006], [0022], [0024]-[0027], [0037]-[0039], [0044]-[0047], [0176]-[0181].

71. Babayoff is analogous to the ’936 patent because it is in the same field of endeavor as the ’936 patent. And like the ’936 patent, as explained above, Babayoff discloses using a hand-held intraoral scanner to obtain a virtual model (i.e., 3D surface representation) of the teeth and combining two models using image registration and stitching. Ex-1006, [0006], [0022], [0024]-[0027], [0037]-[0039], [0044]-[0047], [0070]-[0072], [0104], [0107]-[0109], [0113]-[0136], [0156], [0176]-[0181], Figs. 4A, 5A-8.

VIII. Ground of Unpatentability

72. Based on my review of the materials set forth above, including my application of the knowledge of a person of ordinary skill in the art, it is my opinion that the Challenged Claims of the ’936 patent would have been obvious based on certain prior art to one of ordinary skill in the art.

73. In particular, it is my opinion that the Challenged Claims of the ’936 patent would have been obvious to one of ordinary skill in the art, based on the grounds shown below:

Ground	Claims Challenged	35 U.S.C.	Reference(s)
1	1, 4-6, 8-12, 14-16	§ 103	Boerjes

2	1, 4-6, 8-12, 14-16	§ 103	Boerjes and Geng
3	2-3, 7, 13, 17-20	§ 103	Boerjes and Babayoff
4	2-3, 7, 13, 17-20	§ 103	Boerjes, Geng, and Babayoff

IX. Claims 1-20 of the '936 Patent Are Unpatentable

74. In my opinion, claims 1-20 of the '936 patent would have been obvious based on the teachings of Boerjes, Geng, and Babayoff for the reasons I provide in each ground of unpatentability below.

A. [Grounds 1-2]: Claims 1, 4-6, 8-12, and 14-16 Would Have Been Obvious Based on Boerjes (Ground 1) or Boerjes and Geng (Ground 2)

75. In my opinion, claims 1, 4-6, 8-12, and 14-16 would have been obvious over Boerjes (**Ground 1**). As discussed below, Boerjes discloses identifying and replacing a user-identified portion of a 3D model of the intraoral cavity, and a person of ordinary skill in the art would have found it obvious to remove the user-identified portion concurrently or before replacing that portion. Boerjes also discloses registering 3D data to an aggregate 3D model as well as stitching 3D data to an existing 3D model (*see supra* Section VII.A), and a person of ordinary skill in the art would have found it obvious to use such known

registration and stitching methods in Boerjes's process of replacing the user-identified portion of Boerjes's 3D model.

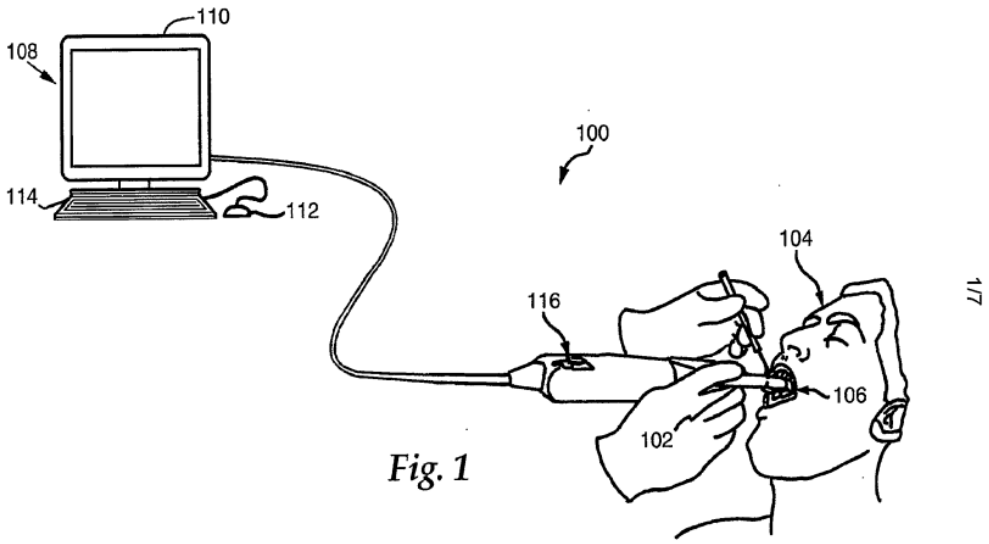
76. In my opinion, claims 1, 4-6, 8-12, and 14-16 also would have been obvious over Boerjes in view of Geng (**Ground 2**). Geng discloses eliminating undesirable areas of a 3D model of the intraoral cavity, including removing a user-identified portion of the model, as discussed below in limitations 1[e] and 1[f] (*see infra* Section IX.A.1.f), for example. Geng also discloses a merger function that provides additional implementation details for Boerjes's replacing user-identified portion of the 3D model as discussed below in limitation 1[h] and claim 4. For example, Geng's merger function uses registration to align and combine multiple 3D images, as discussed below in limitation 1[h] and claims 4-5 (*see infra* Sections IX.A.1.h, IX.A.2, IX.A.3). While those features of Geng are disclosed in or obvious over Boerjes, Geng provides express disclosure of those features. In my opinion, a person of ordinary skill in the art would have found it obvious to implement those features of Geng in Boerjes as discussed in more detail below.

1. Independent Claim 1

a. 1[pre]: A system for scanning a patient's teeth for a dental procedure, the system comprising:

77. Boerjes discloses this limitation.

78. Boerjes describes "systems and methods" that employ "a scanning system for capturing highly detailed digital dental models" for a dental procedure. Ex-1004, [0006]-[0007], Fig. 1; *see also supra* Section VII.A.



Ex-1004, Fig. 1, [00118] (showing "a dental image capture system"). Boerjes's scanning system "captures images from a surface 106 of a subject 104," such as a dental patient's teeth, and "forwards the images to a computer 108, which may include a display 110 and one or more user input devices such as a mouse 112 or a keyboard 114." *Id.*, [00132], [00139].

b. 1[a]: a hand-held intraoral scanner; and

79. Boerjes discloses this limitation.

80. Boerjes discloses that "scanner 102 is a handheld, freely positionable probe." *Id.*, [00135], Fig. 1. Boerjes uses this hand-held "intraoral scanner for

acquiring a three-dimensional representation of one or more intraoral structures of a dental patient." *Id.*, [0012]; *see also id.*, [0007], [0016]; *see also supra* Section VII.A.

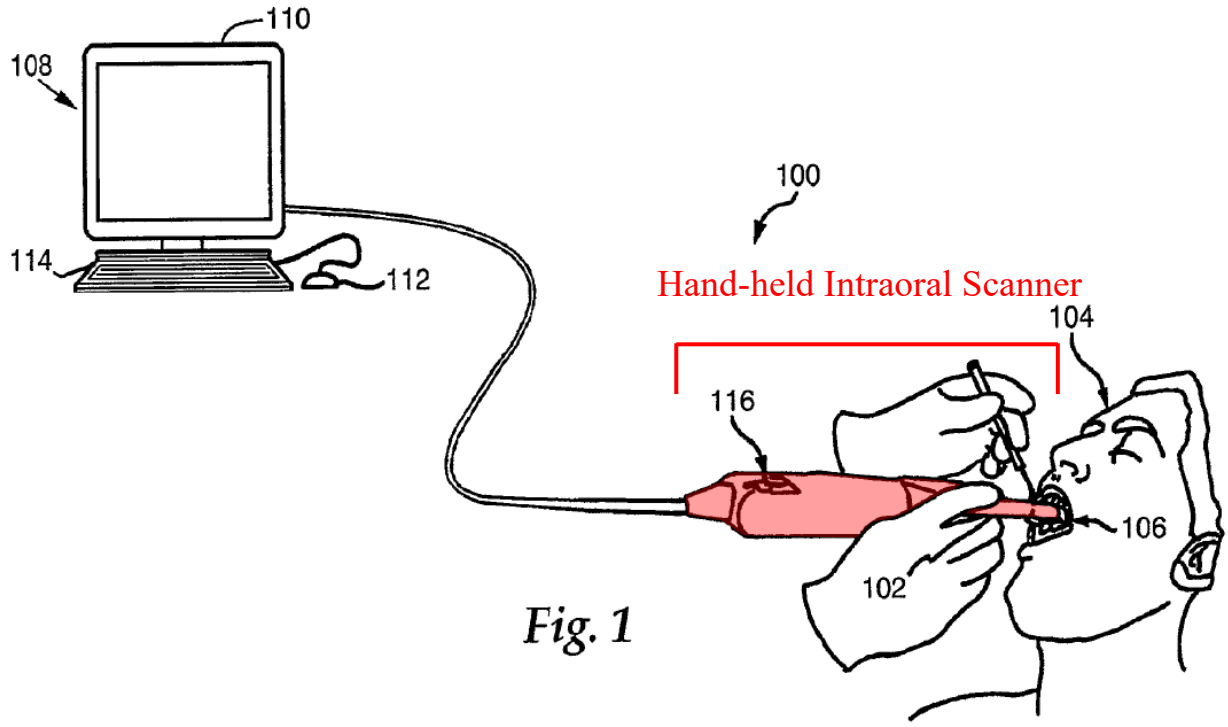


Fig. 1

Ex-1004, Fig. 1 (annotated). As Boerjes explains, the intraoral scanner is specifically "shaped and sized for intraoral scanning and data capture, such as by insertion into a mouth of an imaging subject and passing over an intraoral surface." *Id.*, [00135]. As the intraoral scanner passes over the imaging surface, it "acquire[s] surface data from teeth, gums, and so forth." *Id.*

c. 1[b]: a computer readable medium including instructions that when executed by a computer system, cause the computer system to:

81. Boerjes discloses this limitation.

82. Boerjes discloses a computer-readable medium including instructions that, when executed by a computer system, cause the computer system to perform certain functions, such as image acquisition, processing, display, and manipulation according to the instructions stored on its computer-readable medium. *Id.*, [0010], [0038], [0061], [00146]-[00148], Fig. 1. For example, Boerjes "includes computer executable code embodied in *a computer readable medium that, when executed on one or more computer devices, may perform the steps* of: acquiring one or more images of one or more intraoral structures of a dental patient from an intraoral scanner; converting the one or more images into a three-dimensional representation of the one or more intraoral structures . . ." *Id.*, [0010] (emphasis added).

d. 1[c]: receive first scan data of the patient's teeth from the hand-held intraoral scanner;

83. Boerjes discloses this limitation.

84. Boerjes's scanner 102 captures surface data of the teeth, gums, and so forth of a dental patient. *Id.*, [0074], [0076], [0086], [00127], [00132]-[00135], [00144]. This surface data amounts to "first scan data of the patient's teeth from the hand-held intraoral scanner." *Id.* Boerjes's computer 108 communicates with scanner 102, receives image data acquired by the scanner, and converts the received image data into a digital model of the intraoral structure for display and

evaluation. *Id.*, [0076]-[0077], [00130]-[00132], [00141]-[00145], [00188]-[00196], Figs. 1, 4.

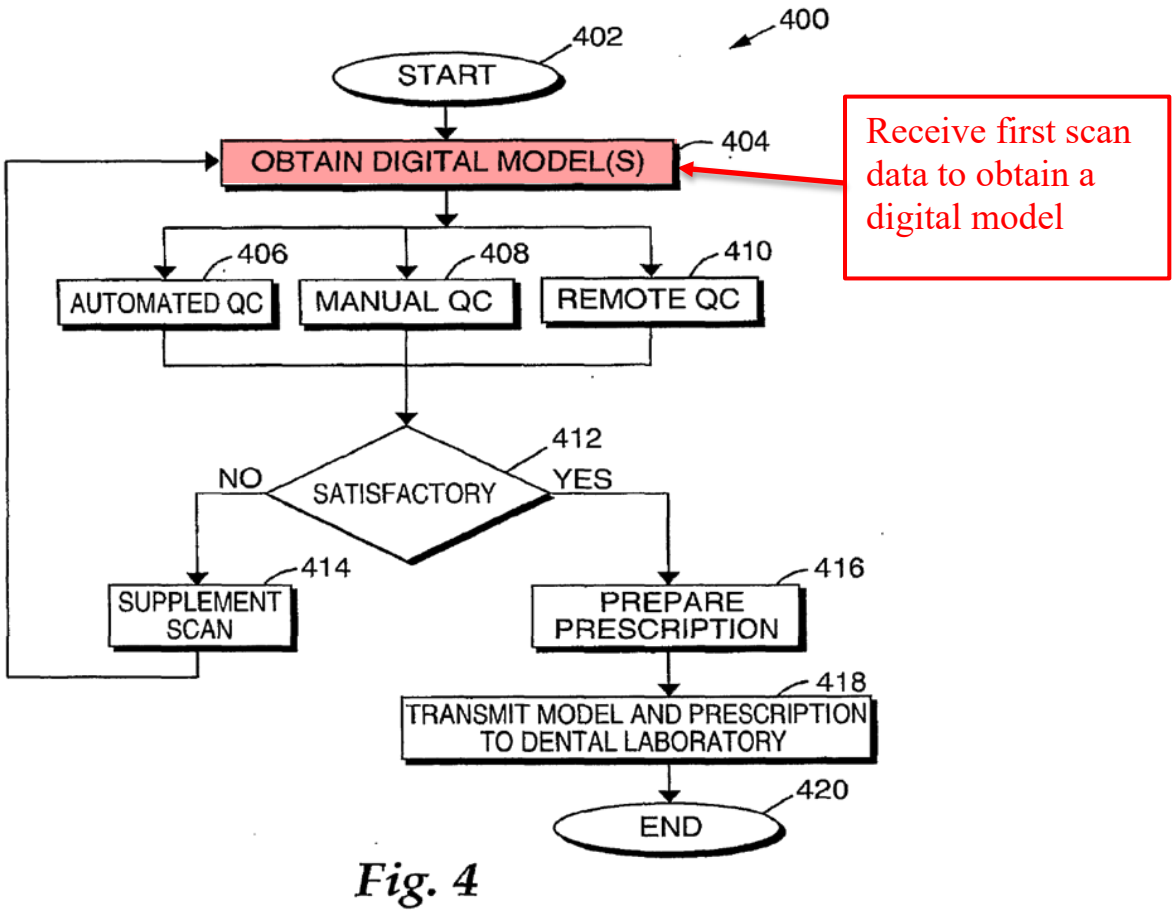


Fig. 4

Id., Fig. 4 (annotated).

e. 1[d]: display, to a display, a model of the patient's teeth, wherein the model of the patient's teeth is based on the received first scan data of the patient's teeth;

85. Boerjes discloses this limitation.

86. Boerjes discloses creating a digital model of a patient's teeth from the captured, i.e., received, first scan data and displaying the digital model on a

display. *Id.*, [0040], [00139], Fig. 1. Once scan data is acquired, Boerjes's computer 108 receives the captured scan data, derives a digital model of the patient's teeth based on the received first scan data, and displays the model on display 110. *Id.*, [0040], [0061], [00132].

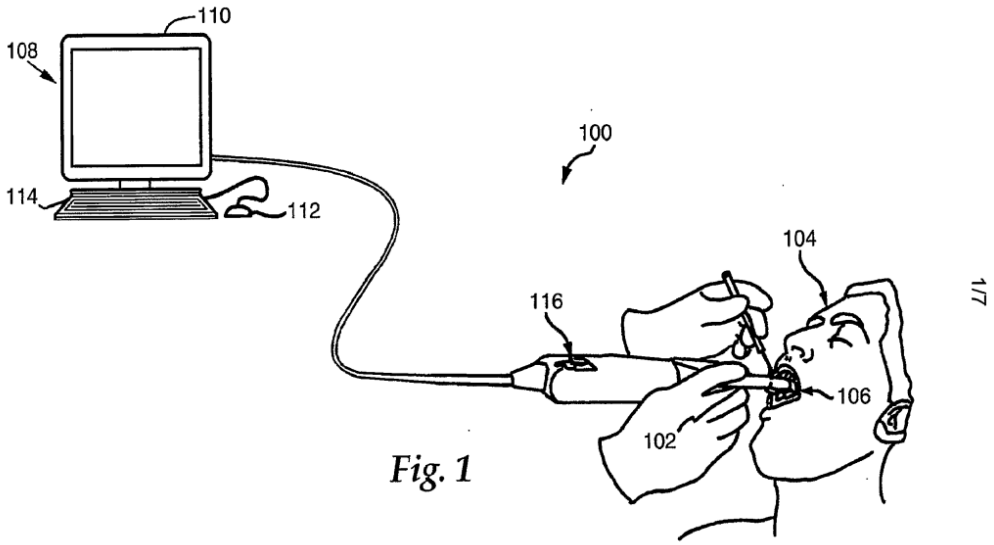


Fig. 1

Id., Fig. 1. Boerjes explains that the computer "generate[s] a visualization of the three-dimensional representation" and "provide[s] the visualization as a display signal" to be sent to a display and "convert[ed] . . . into a viewable image." *Id.*, [0040], [0076], [0145]. For example, the model displayed may be a dentition model 702, such as in Figure 7A:

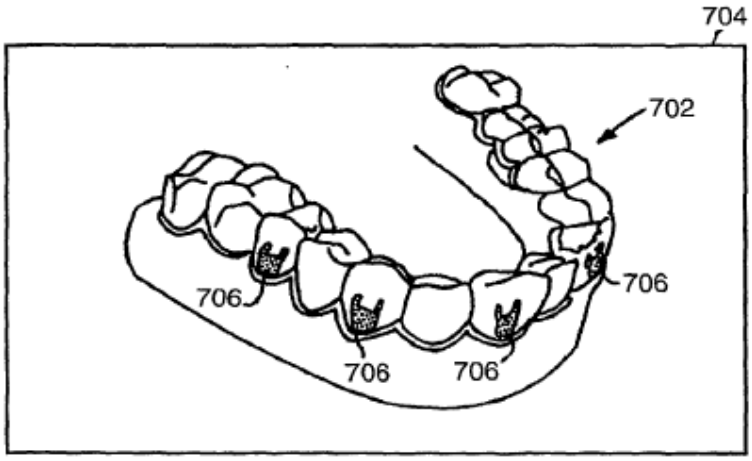


Fig. 7A

Id., Fig. 7A, [00221]-[00222] (depicting a "three-dimensional representation 702 of dentition and surrounding soft tissue").

f. 1[e]: receive user input defining a portion of the model to be removed;
1[f]: remove, from the displayed model, a removed surface portion of the model to be removed according to the user input;

87. Boerjes alone renders obvious these limitations (**Ground 1**). Alternatively, Boerjes in view of Geng renders obvious these limitations (**Ground 2**).

i. Boerjes renders obvious 1[e]-1[f] (Ground 1)

88. Boerjes discloses a process in which the system receives user input defining a portion of the model to be replaced with new scan data following physical changes to the intraoral cavity. *Id.*, [00196], [00199]. As shown in Figure 4 below, Boerjes discloses that once a model is obtained from a first scan,

Boerjes's process proceeds to quality control steps (e.g., steps 406, 408, 412). *Id.*, [00188]-[00197].

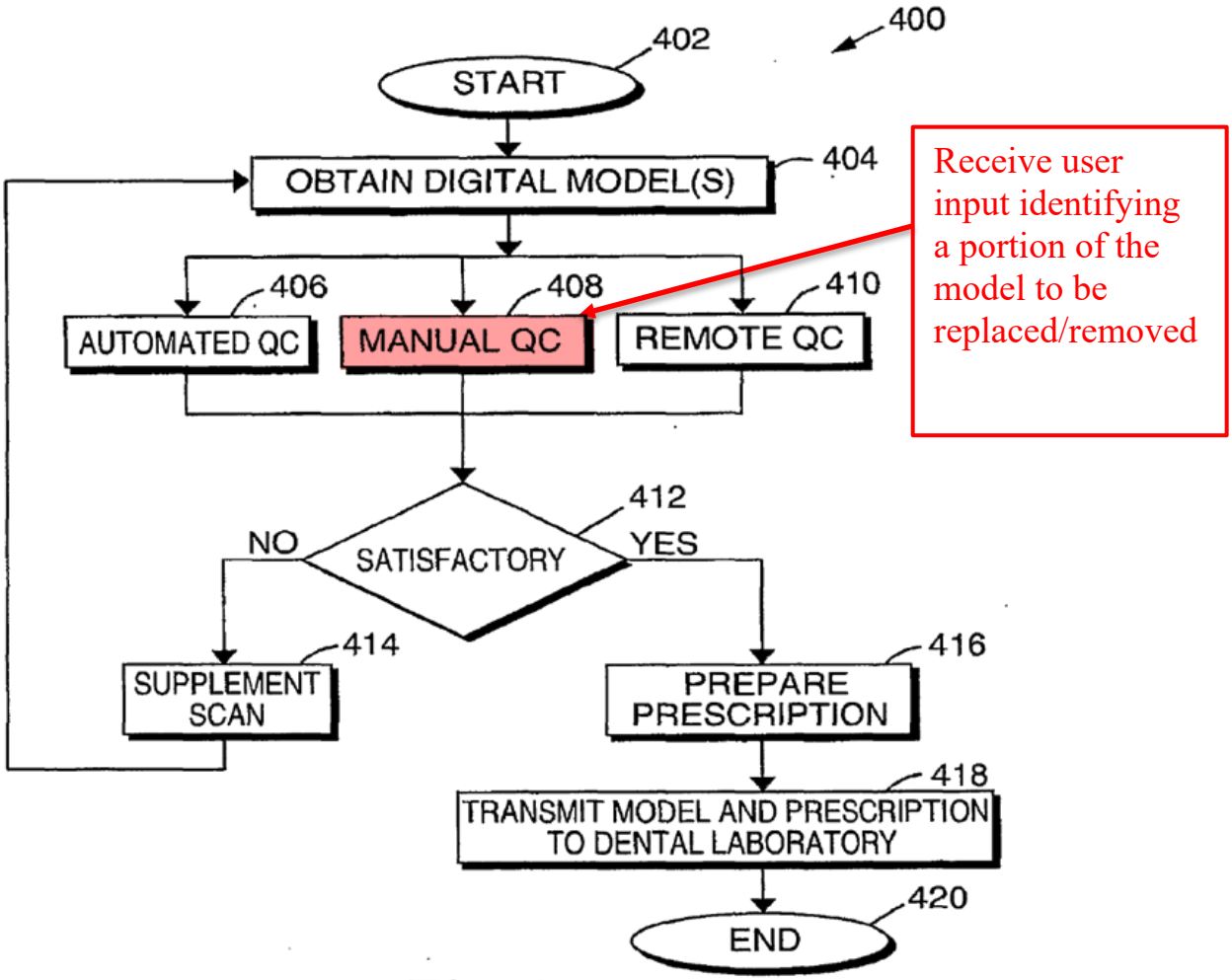


Fig. 4

Id., Fig. 4 (annotated). The quality control steps include rendering the model on the display and allowing the user to manually locate potential defects or inadequacies in the model (e.g., step 408) by interacting with the displayed model. *Id.*, [00188]-[00197], Fig. 4; *see also id.*, [0043], [00129], [00147]. For instance, a user may inspect the model and identify areas that need replacing, such as "a margin line" to

be removed, "areas of poor margin preparation," and "holes or areas of incomplete scan[s]." *Id.*, [00189], [00192]-[00193]. Boerjes also specifically describes a user "identif[ying] . . . regions of a prepared tooth surface requiring additional preparation[s]" and "supplemental scanning." *Id.*, [00196].

89. Boerjes's user interface provides "a number [of] interactive, three-dimensional tools such as markup tools" that "a dentist or other dental professional" could use to identify, during the quality control process, unsatisfactory areas, which could use supplemental scanning. *Id.*, [00192]. Boerjes's user interface, e.g., a touchscreen display, is "capable of receiving user input." *Id.*, [00142], [00148], [00192]. A person of ordinary skill in the art would have understood that the user would interact with the displayed model, such as by marking or otherwise identifying on the displayed model "regions of a prepared tooth surface requiring additional preparation or reduction, or regions of a digital model requiring additional or supplemental scanning" via the user interface, such as by providing "graphical feedback . . . highlighting questionable or erroneous areas of a preparation within a rendered display of scan data" (*id.*, [00196]), to indicate areas of the model to be replaced. *Id.*, [00196]-[00197]. A person of ordinary skill in the art would have understood Boerjes's user input identifying regions of the model to be replaced as identifying a surface portion of the model to be replaced. This is because Boerjes's digital model is a three-dimensional surface

representation containing surface data acquired from scanning the tooth, a prepared tooth surface, gum, or other intraoral structures. *Id.*, [0059]-[0064], [00127]-[00128], [00135]. Such an identification of areas of the model to be replaced also would have been obvious to a person of ordinary skill in the art in view of the general capabilities well-known in the art to identify defective areas of a model and replace them using image registration as discussed above in Section V.C.

90. As discussed below, a person of ordinary skill in the art would have understood that Boerjes's identifying a surface portion of the model to be replaced suggests removing the user-identified surface portion from the model. And a person of ordinary skill in the art would have removed the user-identified surface portion from the model before replacing it with new scan data to improve the accuracy and efficiency of replacing the user-identified surface portion, thereby improving time and cost efficiency and patients' comfort. *Id.*, [00190], [00194], [00196], [00198]; Ex-1005, 3:26-34, 10:59-11:2, 15:41-57.

91. For instance, a person of ordinary skill in the art would have understood that *removing* the user-identified portion would have been a suitable way to allow new scan data to take the place of the data in the identified, unwanted surface portion of the model. A person of ordinary skill in the art would have understood that the old data in Boerjes's identified portion would have included duplicated, questionable, or erroneous data (Ex-1004, [00196]), and would have

been unnecessary to keep. Thus, a person of ordinary skill in the art would have removed this old unnecessary data, e.g., by fully overwriting or substituting old data with new data, because keeping it would result in confusing and incoherent data. For example, keeping the old data can cause the new data to overlap with the unwanted old data, causing the replaced portion to have ghosting, edge, or other visible artifacts. *See, e.g.*, D.C. Barratt, C.S.K. Chen, P.J. Edwards, G.P. Penney, M. Slomczykowski, T.J. Carter, D.J. Hawkes, "Instantiation and registration of statistical shape models of the femur and pelvis using 3D ultrasound imaging," *Medical Image Analysis*, vol. 12, pp. 358-74, at 366 (1999) (teaching that "[f]ollowing manual alignment, some outliers were clearly visible … seemingly due to a combination inaccurate tracking data and incorrect identification of interfaces that did not correspond to bones … These points were removed manually using custom-written interactive software."); *see also, e.g.,* C. Studholme, D.L.G. Hill, D.G. Hawkes, "An overlap invariant entropy measure of 3D medical image alignment," *Pattern Recognition,* vol. 32, no. 3, pp. 71-86, at 74 (1999) (teaching that "[a]s the images are brought into alignment the duplication of features is reduced and the combined image is simplified, as shown in Fig. 3" with Fig. 3 illustrating "the removal of duplicated regions" to reduce ghosting, edge, or other visible artifacts).

92. Also, a person of ordinary skill in the art implementing Boerjes would have found it preferable and obvious to *remove* the user-identified surface portion from the model before *replacing* it with new scan data. This is because removing the questionable or erroneous data would improve the accuracy and efficiency of replacing the user-identified surface portion with new scan data in Boerjes.

93. For instance, a person of ordinary skill in the art would have understood that removing a user-identified portion would visually aid the user in locating the portion of the model that need to be rescanned. This would conserve time for performing the additional scanning and obtain a final model, which would reduce the overall time for the dental procedure and improve patients' comfort. *See* Ex-1005, 3:23-34; Ex-1008, [0055]-[0056] (teaching providing visual feedback to the user in real time to guide the user to perform an adequate scan); *see also* Ex-1007, [0059], [0076] (teaching providing visual feedback to the user to guide the user to an appropriate scan location in reacquiring 3D data for the original 3D model); Ex-1011, [0168] (providing feedback identifying missing areas in the virtual model to the user to perform additional scans of the intraoral cavity to provide the missing surface data).

94. Thus, when implementing Boerjes's replacement process, a person of ordinary skill in the art would have been motivated to remove the surface portion identified by the user to be replaced with new scan data to improve the accuracy

and efficiency of the data replacement, reduce time for the dental procedure, and improve patients' comfort. *See* Ex-1005, 3:23-34.

95. A person of ordinary skill in the art also would have had a reasonable expectation of success in including, in Boerjes's system, the function to remove the user-identified portion from the model before replacing it with new scan data. As discussed *supra* in Section V.B, removing portions, including a surface portion, from a displayed model has been a well-known and routine technique in the art in the field of 3D modeling, including 3D dental modeling. *Id.*, 7:38-51 (teaching that a user can use a graphical user interface and user input devices to modify and/or eliminate undesirable areas, removing abnormal data points on the 3D model); Ex-1009, [0324]-[0328] (teaching that a user can use a user interface to erase unwanted areas of a displayed 3D model by highlighting unwanted areas and clicking on an erase icon); Ex-1015, [0068]-[0069], [0088]-[0089], [0117]-[0119] (teaching that a user can use input devices to select points on the displayed model to remove, isolate, or delete the identified data points); Ex-1020, 9:3-40 (teaching that a user can use a graphical user interface to delete unwanted sections of a displayed model). And Boerjes's system is already equipped with a tool to remove an unwanted or unneeded portion from the model. Ex-1004, [0043]-[0044], [00208]. Thus, implementing the function of removing the user-identified portion in Boerjes's process of replacing a user-identified portion, such as by using

Boerjes's user interface, input devices, and computer, would have been well within the skills of a person of ordinary skill in the art.

96. For at least these reasons, when implementing Boerjes's replacing a surface portion of the model according to a user input defining that portion of the model to be replaced, a person of ordinary skill in the art would have understood that Boerjes at least suggests removing that portion of the model and would have found it obvious to remove that portion from the model according to the user input.

ii. Boerjes in view of Geng renders obvious 1[e]-1[f] (Ground 2)

97. Geng discloses receiving user input defining a surface portion of the model to be removed and removing that surface portion from the displayed model. Ex-1005, 2:21-31, 4:54-65, 6:26-41, 7:12-48. A person of ordinary skill in the art would have been motivated to implement, in Boerjes's system, the functionality for identifying and removing the identified surface portion as disclosed in Geng.

98. Like Boerjes, Geng discloses a system for scanning a patient's teeth with a hand-held intraoral scanner: Geng's system includes a computer-readable medium that stores instructions that, when executed by a computer, cause the system to receive image data of a patient's teeth from an intraoral scanner and display a model of the patient's teeth created from the image data. *See id.*, 2:61-3:13, 3:48-4:2, Fig. 1; *see also supra* Section VII.B.

99. Geng's system also includes a user interface for evaluating a 3D image of prepared teeth to ensure the image is accurate and suitable for fabricating dental prostheses. *Id.*, 2:21-31, 3:14-4:53, 7:12-51, 15:41-57, Figs. 1-2. Geng's user interface allows the user to manipulate or edit the 3D image model, such as by modifying and/or *removing* undesirable areas on the model "interactively and conveniently," (*id.*, 6:15-41, 7:38-51, Figs. 1-3, 5), for example, to provide a clear visual guidance for the areas to be modified. Geng explains that "[k]nown editing functions can be employed, including typical editing functions that provide for *deleting*, creating, and modifying objects." *Id.*, 7:46-48 (emphasis added).

100. Geng further explains that its systems and methods "can dramatically reduce dental costs, eliminate unnecessary time waste for both dentists and patients, and create new business opportunities in dentistry." *Id.*, 15:53-57. A person of ordinary skill in the art would have understood that Geng also discloses removing undesirable data points to reduce the size of image files. *Id.*, 7:40-44 ("The editor (312) allows operators to modify and/or eliminate any undesirable area(s) on the original 3D image obtained from the camera (104; FIG. 1), remove abnormal data point(s), and clean up the acquired image data to reduce the sizes of image data files.").

101. Boerjes and Geng are both analogous art to the '936 patent and to each other. *See supra* Sections VII.A, VII.B. A person of ordinary skill in the art

would have been motivated, when implementing Boerjes's replacement process, to use Geng's editing function to remove the user-identified, undesirable portion from the model to improve efficiency and accuracy of the replacement process, and improve patients' comfort for the reasons discussed above (*see supra* Section IX.A.1.f.i) and further below.

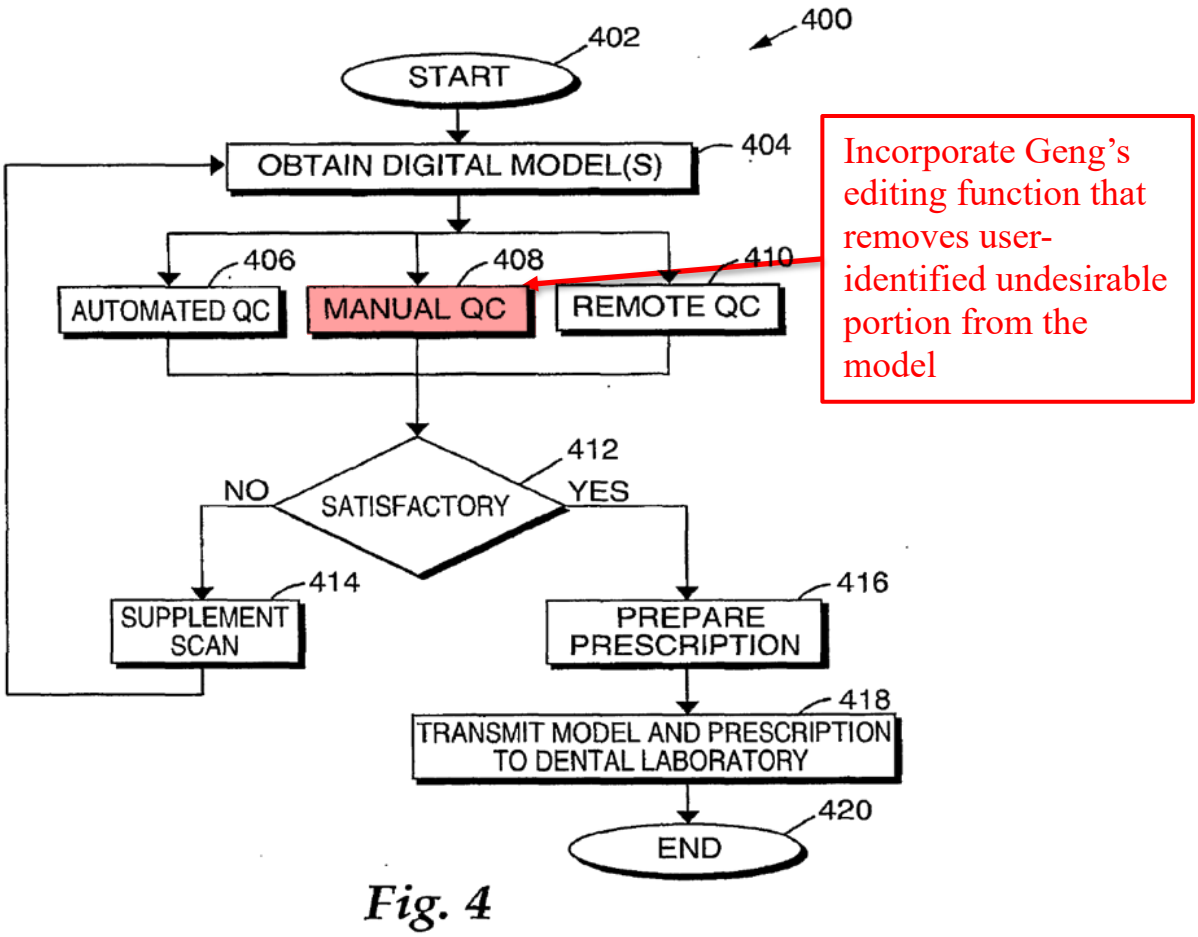


Fig. 4

Ex-1004, Fig. 4 (annotated to show the combination).

102. First, as discussed above, a person of ordinary skill in the art would have understood that *removing* the user-identified portion from the model so that

the new scan data would take the place of old data in the user-identified portion instead of overlaying new data over old data, would be a suitable option for implementing Boerjes's replacement process. Second, a person of ordinary skill in the art would have understood that, when implementing Boerjes's replacement process, removing the user-identified portion from the model would improve the accuracy and efficiency for replacing the identified portion with newly scanned data. *See supra* Section IX.A.1.f.i.

103. Furthermore, a person of ordinary skill in the art would have understood that removing the user-identified portion from the model would have removed undesirable, excess or unused data. This would have conserved computer resources and would have allowed for faster processing because the computer has less data to sift through when processing or updating the model. Likewise, the time for transferring data or images would be similarly reduced with less image data to transfer. Ex-1004, [00194] (teaching remote quality control by a remote dental laboratory or a fabrication facility for evaluation of adequacy of the scan). A person of ordinary skill in the art would have also understood that to the extent that a model is created or updated more quickly, the time patients need to be in the chair would be reduced, thereby improving patients' comfort and costs. *See id.*, [00198]; Ex-1005, 3:23-33.

104. In addition, a person of ordinary skill in the art would have had a reasonable expectation of success when combining Boerjes's system with Geng's teachings, which allow a user to interactively remove undesirable portions from the model. Boerjes's system, like Geng's system, is readily equipped for such modification. Both systems include an intraoral imaging device, a computer with a user interface and a processor for implementing software functions for manipulating and editing the displayed 3D model, and a display (e.g., a touchscreen). *See supra* Sections VII.A, VII.B. In fact, Boerjes's system already provides a tool to remove an unwanted or unneeded portion from the model. Ex-1004, [0043]-[0044], [00208]. A person of ordinary skill in the art would have readily incorporated the editing functionality as disclosed in Geng into Boerjes's user interface, which is similar to Geng's user interface for displaying and manipulating the 3D model. A person of ordinary skill in the art would have known how to program Boerjes's software executed by Boerjes's processor to implement Geng's function via Boerjes's user interface using ordinary computer-programming skills. As such, the modification of Boerjes's system to use the editing functionality as disclosed in Geng in its replacement process would have required no more than ordinary skill.

105. Implementing Geng's function in Boerjes's system would have involved only applying known techniques—Geng's teaching of an editing

function—to improve a known and similar system—Boerjes's system—in the same way. And implementing Geng's teaching of an editing function in Boerjes's system would also have been simply combining known techniques—Boerjes's system and Geng's function—with each performing the same function it had been known to perform, and would have yielded predictable results of removing and replacing a user-identified portion from the model in Boerjes. And, as discussed above, it was also known and conventional for dental scanning systems to be equipped with software tools that allow the user to manipulate and edit the displayed model to remove undesirable or inadequate areas from the model. *See supra* Sections V.B., V.C; *see also* Ex-1020, 2:4-7, 3:15-23, 9:3-40; Ex-1009, [0116], [0128], [0324]-[0328]. Indeed, removing a defective area of a model before replacing that area was known and performed in dental scanning systems. *See* Ex-1015, [0118]-[0119] (teaching deleting data points in a second scan data set to produce a new data set, and then replacing the removed data points with data points from a first scan data set that represent the same area).

g. 1[g]: receive second scan data of the patient's teeth from the hand-held intraoral scanner, the second scan data including surface data of a physically changed portion of the patient's intraoral cavity;

106. Boerjes discloses, or at least renders obvious, this limitation.

107. As explained above, Boerjes discloses that its scanner can capture surface data of a patient's teeth and display a digital model of the patient's teeth. Ex-1004, [0041], Figs. 1, 4; *see supra* Sections IX.A.1.d, VII.A. Also, during the quality control steps, a user can identify regions of the model that require "additional or supplemental scanning," such as regions that require "additional [surface] preparation or reduction." Ex-1004, [00163], [00166]-[00169], [00189]-[00196]; *see supra* Sections VII.A, IX.A.1.f. For example, in Boerjes's manual quality control process, the dentist identifies areas that require additional preparations, completes the required preparations, and then rescans these areas. Ex-1004, [00193], [00196], [00199]. This additional scanning will capture "new scan data" (i.e., second scan data) "following, e.g., additional surface preparation consistent with errors identified during quality control," and "the digital model may be supplemented or replaced with new scan data." *Id.*, [00199]. A person of ordinary skill in the art would have understood that, like the first scan data, the "new scan data" (i.e., second scan data) would include surface data of a tooth or a prepared tooth surface captured by Boerjes's scanner after additional surface preparation ("a physically changed portion of the patient's intraoral cavity"). *Id.*, [0059]-[0064], [00127]-[00128], [00135].

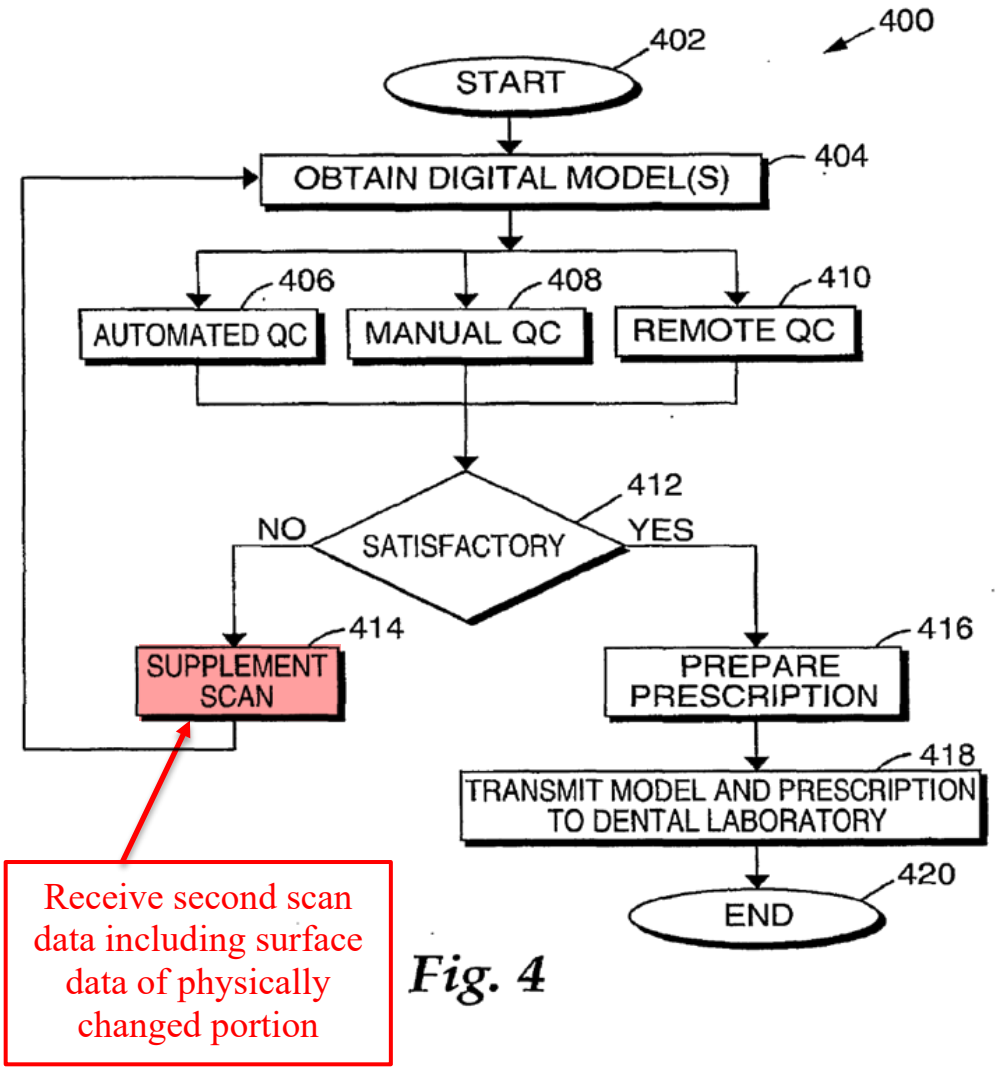


Fig. 4

Id., Fig. 4 (annotated), [00199] ("If the data is not satisfactory, the process 400 may proceed to step 414 where the digital model may be supplemented or replaced with new scan data. This may include, for example, new scanning to replace apparently erroneous or inadequate scan data, or a new scan of the dental subject matter following, e.g., additional surface preparation consistent with errors identified during quality control. The process 400 may then return to step 404 where a new digital model is obtained."). Thus, Boerjes discloses receiving second

scan data including the surface data of the patient's intraoral cavity after a physical change, e.g., after an additional surface preparation or reduction is performed.

h. 1[h]: replace at least a portion of the removed surface portion of the model using the received second scan data of the patient's teeth including surface data of a physically changed portion of the patient's intraoral cavity; and

108. Boerjes discloses, or at least renders obvious, limitation 1[h] (**Ground 1**). Alternatively, Boerjes in view of Geng renders obvious limitation 1[h] (**Ground 2**).

i. Boerjes discloses, or at least renders obvious, 1[h] (Ground 1)

109. Boerjes discloses receiving second scan data of the patient's teeth including surface data of a physically changed portion of the patient's intraoral cavity. *See supra* Section IX.A.1.g. As discussed above, Boerjes discloses obtaining new scan data, i.e., second scan data, to "*replace*[]" the portion identified by the user following additional surface preparations to correct deficiencies of the tooth preparation—i.e., after a portion of the patient's intraoral cavity has been "physically changed." Ex-1004, [00196], [00199] (emphasis added). Boerjes discloses quality control steps that include a user (i) identifying regions of the first scan data that "requir[e] additional preparation[s]," (ii) completing the required additional preparations to correct the deficiencies, and (iii) subsequently

conducting "additional or supplemental scanning" to *replace* the inadequate regions. *Id.*, [00189]-[00199].

110. Indeed, Boerjes discloses, that, during quality control, the user may perform manual evaluation and identify "regions of a prepared tooth surface requiring additional preparation or reduction, or regions of a digital model requiring additional or supplemental scanning due to incomplete, erroneous, or potentially erroneous data." *Id.*, [00196]. And as shown in Figure 4 below, Boerjes further discloses that after determining "whether a scan and/or surface preparations are satisfactory" in step 412, the process proceeds to step 414, "where the digital model may be supplemented or *replaced* with new scan data." *Id.*, [00199] (emphasis added). Boerjes describes, for example, "new scanning to replace apparently erroneous or inadequate scan data, or a new scan of the dental subject matter following, e.g., additional surface preparation consistent with errors identified during quality control." *Id.*, [00199], Fig. 4. A person of ordinary skill in the art would have understood that in Boerjes, when the user identifies a portion of the model requiring additional preparation or reduction, new scanning following additional surface preparation consistent with the user's identification would be performed, and that the new scan data would be used to replace the user-identified portion of the model to obtain an updated digital model in step 404. *Id.*, [00196]-[00199]; *see also id.* [00144] ("The three-dimensional data for each newly

acquired two-dimensional image set may be derived and fitted or 'stitched' to existing three-dimensional data using a number of different techniques."); [00163] ("[A] scan may be obtained of a prepared surface" followed by "combining historical three-dimensional data with a three-dimensional representation of the prepared surface.").

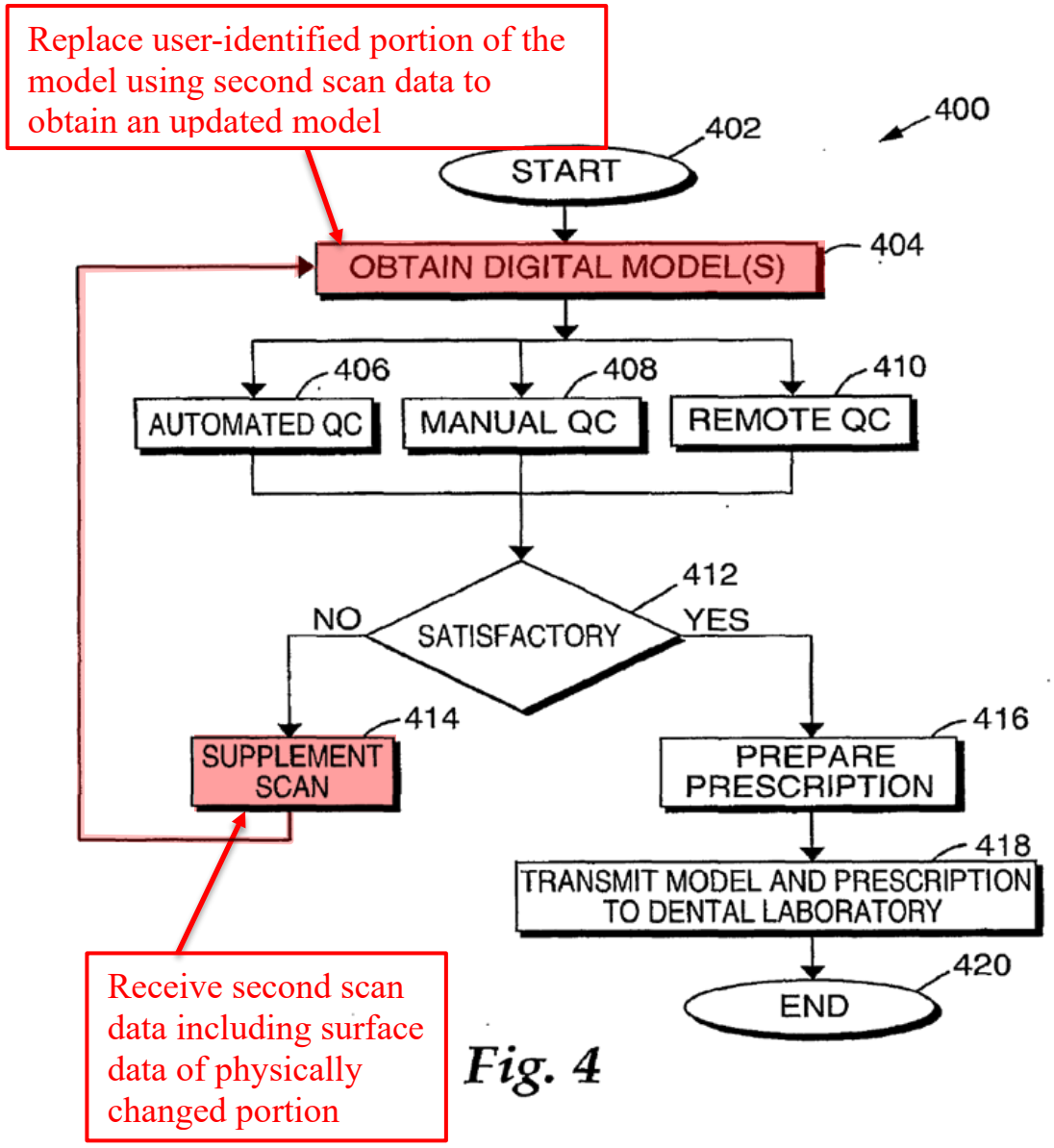


Fig. 4

Id., Fig. 4 (annotated), [00199]. Thus, Boerjes discloses using the second scan data, received after the patient's intraoral cavity is physically changed, to replace at least a portion of the identified surface portion of the model. And as discussed above, Boerjes renders obvious removing the identified surface portion from the model. *See supra* Section IX.A.1.f.i. Thus, Boerjes renders obvious replacing at least a portion of the removed user-identified surface portion of the model using the received second scan data.

111. I was asked to opine on whether Boerjes renders obvious limitation 1[h] under the district court's construction of limitation 1[h], which construes this limitation to require "[register] / [registering] the [received] second scan data with a retained portion of the model after removing the scan data of the removed surface portion." *See supra* Section IV.C. Boerjes renders obvious this limitation under this construction as well.

112. A person of ordinary skill in the art would have understood that the well-known image registration and stitching techniques disclosed in Boerjes would be used to replace at least a portion of the user-identified portion of the model with the new scan data. First, Boerjes discloses registering and combining 3D data into an aggregate 3D model. Ex-1004, [00126], [00218]. Boerjes also discloses that new 3D data can be fitted or "stitched" to existing 3D data. *Id.*, [00144]. A person

of ordinary skill in the art would have found it obvious to use conventional and known methods, such as "register[ing]" and "stitch[ing]," as disclosed in Boerjes (*id.*, [00126], [00144], [00218]), to perform Boerjes's replacement of the user-identified portion in the model. And as explained in Section V.C *supra*, both image registration and stitching were commonly known and used in computer vision and image processing applications, and a person of ordinary skill in the art would have known that image stitching is often performed with image registration to align multiple images based on common features or data and further combines the aligned images into a single image. When implementing replacement of the user-identified portion with the new scan data in Boerjes, a person of ordinary skill in the art would have understood image registration and stitching, as disclosed in Boerjes and known and routinely used in the art, as a suitable solution for performing the replacement.

113. And for reasons discussed above in Section IX.A.1.f, a person of ordinary skill in the art would have removed the user-identified portion from the model. And a person of ordinary skill in the art would have been motivated to register the new scan data with the model *after* the user-identified portion is removed from the model ("a retained portion of the model *after* removing the scan data of the removed surface portion") such that the new scan data would be properly aligned with and stitched into the model for at least the following reasons.

114. First, a person of ordinary skill in the art would have understood that removing the questionable or erroneous data in the user-identified portion from the model would reduce the risk of improper or failed registration of the new scan data to the model. For example, if the erroneous data in the identified portion is not removed, an image registration algorithm would attempt to match or align features in the erroneous data in the model with features in the new scan data despite the fact that the features in the erroneous data do not actually correspond to the features in the new scan data. This can lead to misalignment, where the new scan data does not register or align with the model correctly, and can also increase the time for the computation of a proper alignment. Additionally, if the erroneous data in the identified portion is not removed, an image registration algorithm would identify incorrect features in the erroneous data, causing errors in the alignment of the features in the new scan data with corresponding features in the model. *See, e.g.*, R. Szeliski, "Image Alignment and Stitching: A Tutorial," *Foundations and Trends® in Computer Graphics and Vision*, vol. 2, no. 1, pp. 1-104 (2007), http://dx.doi.org/10.1561/0600000009, at Fig. 5.2 (teaching that "accidental matching of [] features can lead to matches between pairs of images that do not actually overlap") and at pp. 78-79 (teaching reducing artifacts when registering and compositing two images by "decid[ing] which objects to keep and which ones to erase" and by removing "regions of difference (RODs) where the images

disagree"); Ex-1024, 3:43-4:6, 4:41-51 (teaching eliminating erroneously identified matches and removing outliers).

115. Further, a person of ordinary skill in the art would have understood that keeping the questionable or erroneous data in the user-identified portion would further lead to inefficiencies in registering new scan data with the model. This is because erroneous data can cause the image registration algorithm to perform unnecessary calculations or optimization processes, which would increase computation time and result in longer time for registering the new scan data with the model and longer time for obtaining an updated, more accurate model. In some instances, erroneous data can cause failure in the image registration, which would require the user and the system having to repeat the additional scanning and replacing processes. *See, e.g.*, R. Szeliski, "Image Alignment and Stitching: A Tutorial," *Foundations and Trends® in Computer Graphics and Vision*, vol. 2, no. 1, pp. 1-104 (2007), http://dx.doi.org/10.1561/0600000009, at Fig. 5.2 (teaching that "accidental matching of [] features can lead to matches between pairs of images that do not actually overlap").

116. Finally, a person of ordinary skill in the art would have had a reasonable expectation of success in applying these well-known techniques to update a model using the new scan data in Boerjes. A person of ordinary skill in the art would have understood that Boerjes's system is readily equipped for such

modification, having a computer with a computer-readable medium and a processor for implementing image processing functions. Ex-1004, [0036]-[0039], [00150]-[00151], [00189]-[00192] (teaching various processing performed by Boerjes's system). A person of ordinary skill in the art having Boerjes and the common knowledge of a person of ordinary skill in the art therefore simply would have applied ordinary computer-programming skills to implement image registration and stitching in Boerjes's replacement of the removed surface portion of the model using the received new scan data (second scan data) of the patient's teeth.

117. Accordingly, Boerjes discloses or at least renders obvious this limitation under the plain and ordinary meaning of this limitation as well as the district court's construction that requires registering the second scan data with a retained portion of the model after removing the scan data of the removed surface portion.

ii. Boerjes in view of Geng renders obvious 1[h] (Ground 2)

118. Boerjes in view of Geng also renders obvious this limitation. As discussed above for limitations 1[e]-[f], a person of ordinary skill in the art would have found it obvious to implement, in Boerjes's system, the functionality for identifying and removing the identified surface portion from the model as

disclosed in Geng. *See supra* Section IX.A.1.f.ii. And as discussed above, Boerjes discloses or at least renders obvious limitation 1[h] under the plain and ordinary meaning of this limitation as well as the district court's construction. *See supra* Section IX.A.1.h.i. In addition, Boerjes in view of Geng renders obvious limitation 1[h] under the district court's construction. A person of ordinary skill in the art would also have found it obvious to implement, in Boerjes's system, the merger functionality as disclosed in Geng in performing the replacement of the user-identified portion using new scan data (second scan data) in Boerjes. As such, Boerjes combined with Geng's merger function renders obvious limitation 1[h], under the district court's construction, which construes this limitation to require "[register] / [registering] the [received] second scan data with a retained portion of the model after removing the scan data of the removed surface portion."

119. Geng's system is equipped with merger tool (320) "that enable[s] operators to integrate multiple uncalibrated 3D images into a single 3D digital

impression (116; FIG. 1)." *See, e.g.*, Ex-1005, 7:57-8:3, Fig. 3 (reproduced below).

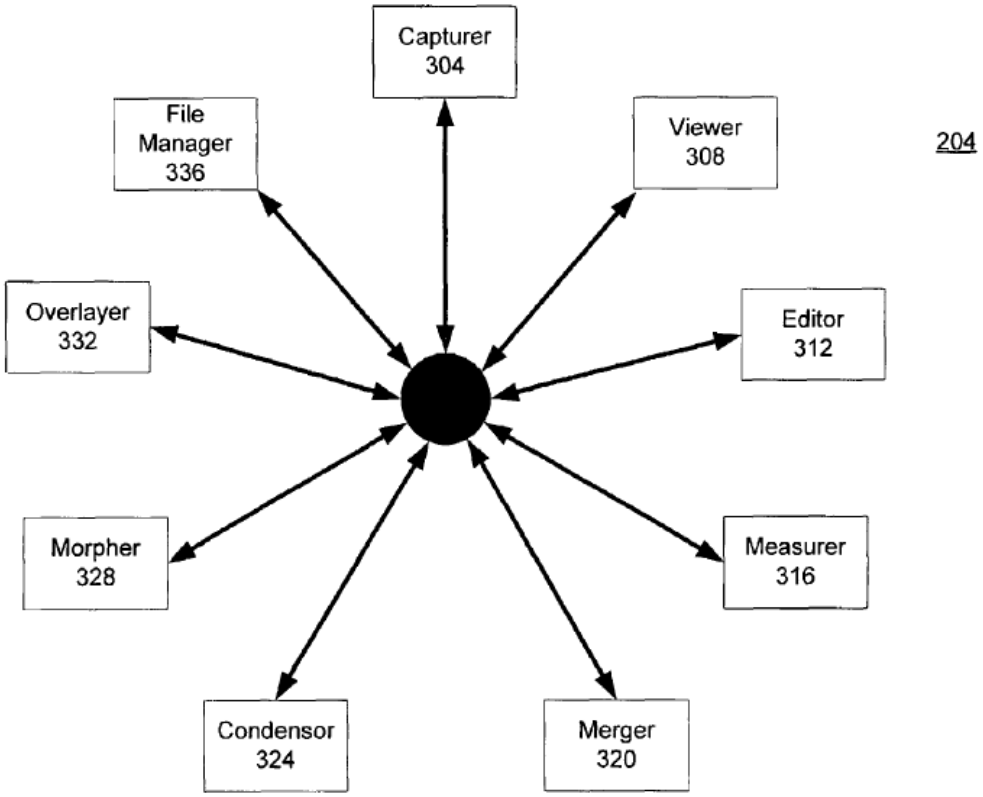


Fig. 3

Id., Fig. 3. A person of ordinary skill in the art would have found it obvious to use Geng's merger function to implement the replacement of the undesired portion in the model with the second scan data in Boerjes for reasons discussed below.

120. As explained above, Boerjes and Geng are analogous art to the '936 patent and to each other. *See Supra* Sections VII.A, VII.B. Geng discloses that the system "is able to bring the 3D images together and optimize the geometric registration of these images." *Id.*, 7:57-8:3. In one example, the system "searches

[for] the common points among multiple images based on their geometric features," and from the common points, "the acquired set of multiple 3D images can be merged automatically." *Id.* Geng also explains that "*image registration* techniques known to those skilled in the art can be used to merge the acquired images together to form the 3D digital impression (116; FIG. 1)." *Id.* (emphasis added).

121. As discussed above, a person of ordinary skill in the art would have known to use conventional and known image registration methods in replacing Boerjes's user-identified portion of the model with new scan data, i.e., second scan data. And a person of ordinary skill in the art would have understood Geng's merger function as a known, suitable option because it allows for aligning and integrating the new scan data ("second scan data") to the existing model in Boerjes. As illustrated below, in Boerjes's system combined with Geng's teachings, the second scan data would be registered to a retained portion of the existing model that has the user-identified portion removed, to replace this removed portion with the new scan data, thereby obtaining an updated digital model of the teeth, e.g., after additional surface preparation, as disclosed in Boerjes. *See supra* Section IX.A.1.f (discussing the combination of Boerjes's system with Geng's editing function).

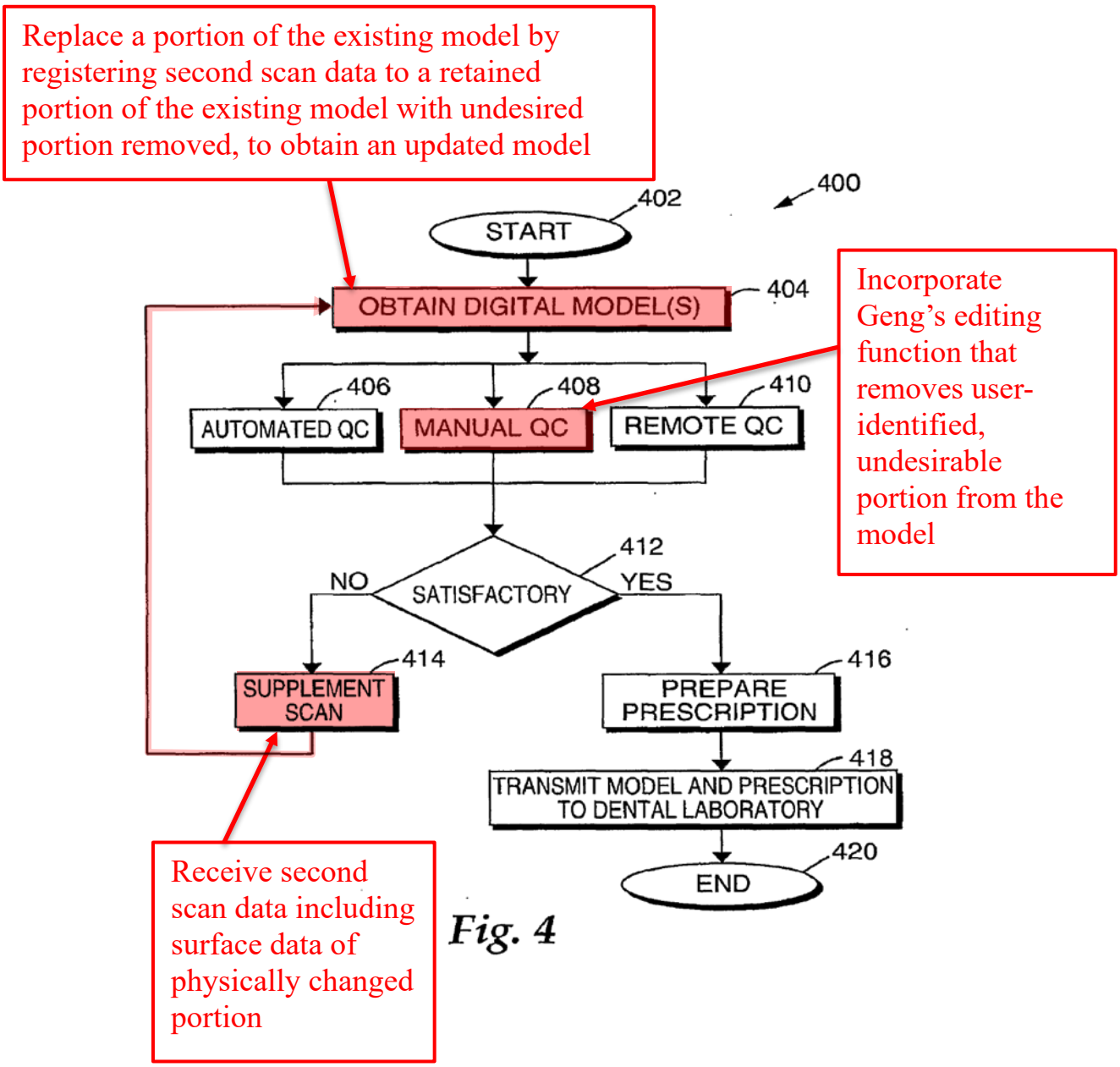


Fig. 4

Ex-1004, Fig. 4 (annotated to show the combination).

122. A person of ordinary skill in the art would have been motivated to remove the user-identified portion before registration to reduce the risk of improper or failed registration of the new scan data to the model and improve computation efficiency, as discussed in Section IX.A.1.h.i, *supra*. A person of

ordinary skill in the art would have understood that when implementing Geng's merger function in Boerjes's system, the common points between the model with the identified portion removed ("a retained portion of the model after removing the scan data of the removed surface portion") and the new scan data ("second scan data") would be used by the merger function for aligning the new scan data with the model. A person of ordinary skill in the art would have understood that other known image registration techniques that can be used to merge 3D images together as recognized by Geng would also be suitable in Boerjes because such known image registration techniques were conventional and routinely used in the art. *See also* Ex-1007, [0058]-[0059], [0086]-[0087], [0095]-[0098]; Ex-1006, [0006], [0037]-[0039], [0044]-[0048], [0176]-[0181]; Ex-1021, [0045], [0100]; Ex-1015, [0048]-[0049], [0102]; Ex-1008, [0022], [0036], [0038].

123. A person of ordinary skill in the art would have expected success in implementing Geng's merging function in Boerjes's system because such modification requires nothing more than ordinary computer-programming skills for similar reasons discussed above for implementing Geng's editing function in Boerjes's system. *See supra* Section IX.A.1.f.ii. For example, a person of ordinary skill in the art would have known how to program Boerjes's software stored in its computer-readable medium and executed by the processor to implement Geng's merger function using ordinary computer-programming skills. Implementing

Geng's merger function in Boerjes's system would have only involved applying known techniques—Geng's merger function—to improve a known and similar system—Boerjes's system, and it would also have been simply combining known techniques, Boerjes's system and Geng's merger function, with each performing the same function it had been known to perform, and would have yielded predictable results of replacing the user-identified portion with new scan data in Boerjes.

i. 1[i]: output, to the display, the model of the patient's teeth with the portion of the removed surface portion replaced using the received second scan data.

124. Boerjes alone (**Ground 1**) or Boerjes in view of Geng (**Ground 2**) renders obvious this limitation.

125. As discussed above in limitations 1[e] and 1[g], Boerjes alone or Boerjes in view of Geng renders obvious removing the user-identified portion of the model of the patient's teeth and replacing the removed surface portion using the second scan data. *See supra* Sections IX.A.1.f, IX.A.1.g. And as discussed in limitations 1[g] and 1[h], the second scan data can include surface data of a physically changed portion of the patient's intraoral cavity. *See supra* Sections IX.A.1.g, IX.A.1.h. Boerjes also discloses displaying the updated model after the user-identified portion is replaced with new scan data. Boerjes also discloses that this process can be repeated (i.e., acquiring new scan data, replacing user-identified

portion of the model with new scan data, and displaying the updated model) until the displayed model is satisfactory to the user under the quality control process. Ex-1004, [00193]-[00199], Fig. 4. For example, Boerjes discloses that once the new scan data ("second scan data") replaces the user-identified portion of the model, the process 400 returns to step 414 where a new digital model (an updated model where the user-identified portion is replaced by new scan data) is obtained and output to display 110. Ex-1004, [00199], Figs. 1, 4; *see also id.*, [0029], [0040], [0059], [00139], [00169]. Thus, Boerjes alone or Boerjes in view of Geng renders obvious outputting, to the display, the model with the removed surface portion replaced using the received second scan data.

2. Dependent Claim 4: The system of claim 1, wherein the instructions to replace the at least the portion of the removed surface portion of the model using the received second scan data comprise instructions to register the received second scan data with the model.

a. Boerjes alone renders obvious claim 4 (Ground 1)

126. Boerjes alone renders obvious this limitation for the reasons disclosed above for limitations 1[b] and 1[e]-1[h]. *See supra* Sections IX.A.1.c, IX.A.1.f.i, IX.A.1.g, IX.A.1.h.i. As discussed above, Boerjes discloses or renders obvious a computer-readable medium including instructions that, when executed by a computer system, cause the computer system to replace at least a portion of a removed surface portion of the model using the received second scan data. *See*

supra Sections IX.A.1.c, IX.A.1.f.i, IX.A.1.g, IX.A.1.h.i. And as discussed above, the district court's construction of limitation 1[h] requires "[register] / [registering] the [received] second scan data with a retained portion of the model after removing the scan data of the removed surface portion." *See supra* Section IX.A.1.h.i. And for reasons discussed above (*see supra* Section IX.A.1.h.i), Boerjes renders obvious registering the received second scan data with a retained portion of the model after removing the user-identified portion from the model, and a person of ordinary skill would have used ordinary software-programming skills to implement the registration function. *Id.* Thus, Boerjes alone renders obvious instructions to register the received second scan data with the model.

b. Boerjes in view of Geng renders obvious claim 4 (Ground 2)

127. Boerjes in view of Geng renders obvious this limitation for the reasons disclosed above for limitations 1[b] and 1[e]-1[h]. *See supra* Sections IX.A.1.c, IX.A.1.f.ii, IX.A.1.g, IX.A.1.h.ii. As discussed above, Boerjes in view of Geng renders obvious a computer-readable medium including instructions that, when executed by a computer system, cause the computer system to replace at least a portion of the removed surface portion of the model using the received second scan data. *See supra* Sections IX.A.1.c, IX.A.1.f.ii, IX.A.1.g, IX.A.1.h.ii. Under the district court's construction of limitation 1[h], the replacing includes

registering the second scan data with a retained portion of the model after removing the scan data of the removed surface portion. *See supra* Sections IX.A.1.h.ii. And as discussed above, a person of ordinary skill in the art would also have found it obvious to implement, in Boerjes's system, the merger functionality as disclosed in Geng, and Boerjes combined with Geng's teaching of the merger function renders obvious registering the received second scan data with the model after the user-identified portion is removed. *See supra* IX.A.1.h.ii. And a person of ordinary skill would have used ordinary software-programming skills to implement Geng's merger function, including registration in Boerjes's data replacement. *Id.* Thus, Boerjes combined with Geng's teaching renders obvious computer instructions to register the received second scan data with the model to replace at least a portion of the removed surface portion of the model using new scan data, i.e., second scan data.

3. Dependent Claim 5: The system of claim 4, wherein the received second scan data is registered with the model by aligning identifying data of the received second scan data with corresponding parts of the model.

a. Boerjes alone renders obvious claim 5 (Ground 1)

128. Boerjes alone renders obvious this limitation for the reasons disclosed above for limitation 1[h] and claim 4 and the additional reasons below. *See supra* Sections IX.A.1.h.i, IX.A.2.

129. As discussed in Section V.C, a person of ordinary skill in the art would have understood that image registration is a process that aligns multiple images into a single coordinate system based on corresponding data points or features ("identifying data") between the images. *See, e.g.*, Ex-1005, 7:57-67 (teaching registering 3D image data using common points); Ex-1006, [0006], [0022], [0024]-[0027], [0037]-[0039], [0044]-[0047], [0176]-[0181] (teaching registering portions of 3D image data based on overlapping areas). A person of ordinary skill in the art would have understood that such conventional alignment of the corresponding data points or features ("identifying data"), such as common data points or features in an overlapping area between two models or datasets, would be required to ensure proper alignment of the full images or data sets during image registration. *See, e.g.*, Richard Szeliski, "Image Alignment and Stitching: A Tutorial," *Foundations and Trends® in Computer Graphics and Vision*, vol. 2, no. 1, pp. 1-104 (2007), http://dx.doi.org/10.1561/0600000009; *see, e.g., id.* at Abstract, teaching that "alignment [is] produced by such registration algorithms" and that "[i]mage stitching algorithms take such alignment estimates produced by such registration algorithms and blend the images in a seamless manner").

130. Indeed, Boerjes suggests aligning identifying data of the received second scan data with corresponding parts of the model because Boerjes discloses using a stitching process for combining 3D models or data sets into a single model.

Ex-1004, [00144]. As discussed above in limitation 1[h] (Section IX.A.1.h.i), a person of ordinary skill in the art would have understood that the well-known image registration and stitching techniques disclosed in Boerjes would be used to replace at least a portion of the removed surface portion of the model with the new scan data (i.e., second scan data). A person of ordinary skill in the art also would have understood that to stitch the new scan data (i.e., second scan data) to the existing model that has the user-identified portion removed, Boerjes's system would identify corresponding points or features ("identifying data") between the new scan data and the retained portion of the existing model, and align the corresponding points or features ("identifying data") of the new scan data (second scan data) to the corresponding points or features ("corresponding parts") of the retained portion of the model, thereby registering the new scan data with the model.

b. Boerjes in view of Geng renders obvious claim 5 (Ground 2)

131. Boerjes in view of Geng renders obvious this limitation for similar reasons as discussed in limitation 1[h] and claim 4 above and the additional reasons below. *See supra* Sections IX.A.1.h.ii, IX.A.2.

132. As explained above, a person of ordinary skill in the art would have found it obvious to implement the merger functionality as disclosed in Geng, in

replacing the removed portion of the model using the new scan data in Boerjes's system. *See supra* Section IX.A.1.h.ii. Geng's merger function performs registration by searching for common points based on their geometric features ("identifying data") among multiple images or scans. Ex-1005, 7:57-8:3, Fig. 3. Based on these common points and their geometric features, the multiple images and scans can be merged together to form one 3D digital representation. *Id.*

133. A person of ordinary skill in the art would have understood that Geng's use of the common points and their geometric features ("identifying data") for registering the images would ensure proper alignment of the 3D images to be integrated. Thus, in Boerjes combined with Geng's merger function, the common points and their geometric features ("identifying data") of the second scan data would be aligned with the common points and their geometric features ("corresponding parts") of the retained portion of the model such that the removed portion of the model would be replaced using the second scan data at the correct locations and pixels.

4. Dependent Claim 6: The system of claim 5, wherein the instructions to replace the at least the portion of the removed surface portion of the model using the received second scan data comprise instructions to further stitch a portion of the received second scan data with the model.

a. Boerjes alone renders obvious claim 6 (Ground 1)

134. Boerjes alone renders obvious this limitation for the reasons disclosed above for limitation 1[h], claim 4, claim 5, and additional reasons below. *See supra* Sections IX.A.1.h.i, IX.A.2, IX.A.3.

135. As discussed above, Boerjes discloses that new 3D data can be fitted or "stitched" to existing 3D data. Ex-1004, [00144]. A person of ordinary skill in the art would have found it obvious to use conventional and known methods, such as "stitch[ing]," as disclosed by Boerjes, as part of Boerjes's replacement of the user-identified portion in the model. *Id.* And as explained in Section V.C, a person of ordinary skill in the art would have known that image registration is commonly performed in connection with image stitching, and that both image registration and stitching were conventional and well-known techniques in the art. Thus, a person of ordinary skill in the art would have applied ordinary skills to include computer instructions in Boerjes's system to stitch at least a portion of the received second scan data with the model such that the user-identified, removed surface portion of the model would be replaced with the second scan data. *See supra* Sections IX.A.1.h.i, IX.A.2, IX.A.3.

b. Boerjes in view of Geng renders obvious claim 6 (Ground 2)

136. Boerjes in view of Geng renders obvious this limitation for the reasons disclosed above for limitation 1[h], claim 4, claim 5, and additional reasons below. *See supra* Sections IX.A.1.h.ii, IX.A.2, IX.A.3. As discussed above, Boerjes discloses "stitch[ing]" new 3D data to existing 3D data (Ex-1004, [00144]), and a person of ordinary skill in the art would have found it obvious to implement the merger functionality as disclosed in Geng in replacing the removed portion of the model using new scan data in Boerjes's system. *See supra* Sections IX.A.1.h.i, IX.A.1.h.ii. Geng also explains that "[k]nown techniques for merging or overlaying images" can be implemented to form an integrated 3D model. Ex-1005, 5:28-40. A person of ordinary skill in the art would have understood that the conventional, known stitching technique as recognized in Boerjes would have been a suitable technique for merging two 3D images as contemplated by Geng. *See supra* Section V.C. In Boerjes's system combined with Geng's teachings, a person of ordinary skill in the art would have applied ordinary skills to include computer instructions to stitch the received second scan data with the model after registering the second scan data with the retained portion of the model such that the user-identified, removed surface portion of the model would be replaced with the second scan data.

5. Dependent Claim 8: The system of claim 1, wherein the computer readable medium further includes instructions that when executed by the computer system, cause the computer system to: mark, on the displayed model, the user input defined portion, after receiving the user input and before removing the removed surface portion of the model.

137. Boerjes discloses or at least renders obvious this limitation of claim 8. Ex-1004, [00188]-[00196]. Additionally, Boerjes in view of Geng renders obvious this limitation of claim 8.

138. Boerjes discloses receiving first scan data and displaying a model of a patient's teeth based on that data. *Id.*, [00184]-[00186], [00190]; *see supra* Sections IX.A.1.d, IX.A.1.e. Boerjes teaches that, once the digital model is displayed, during the quality control process, the user can evaluate the model to identify potential regions of the tooth requiring further preparation (physical changes) and/or additional scanning. *Id.*, [00188], [00196], [00199]. Boerjes's system is then "capable of receiving user input," such as through physical interaction with a touchscreen display, to identify certain surface portions, such as those portions containing questionable or erroneous areas of the model ("the user input defined portion"). *Id.*, [00142], [00148], [00196]. This allows a user to measure, mark, annotate, or otherwise manipulate the digital model of the patient's teeth on the display. *Id.*, [00192].

139. The computer displays this feedback concerning the user-identified portion for additional scanning and/or additional surface preparation ("mark, on the displayed model, the user input defined portion"). *Id.*, [0060]-[0061], [00196]. As one example, Boerjes's computer can cause the computer-readable medium to highlight the identified regions through "color, texture, or explicit annotations, arrows, callouts, or the like" on the displayed model. *Id.*, [00196]. Moreover, Boerjes discloses that this marking occurs after receiving the user input because Boerjes's display provides for real-time updates, "generally with no observable latency between processing and display." *Id.*, [00141], [00190]. Thus, a person of ordinary skill in the art would have understood that Boerjes updates the displayed model after the user input defining a portion of the model is received, i.e., marking the model according to the user input after the user input is received.

140. A person of ordinary skill in the art would have further understood that in Boerjes, the marking of the user-identified portion according to the received user input would be before other action is taken, such as replacing the user-identified portion, because Boerjes discloses presenting the marking, e.g., highlighting, to the user on the display during the quality control process as feedback for further actions. *Id.*, [00196]. And as illustrated below, the user's manual quality control (steps 408 and 412), such as by marking a portion for further preparation and rescanning, would be before performing the additional scan

in step 414 and replacing the identified portion with new scan data in step 404. *Id.*, [00193], [00199], Fig. 4. And as discussed above in limitations 1[e], 1[f], and 1[h] (Sections IX.A.1.f, IX.A.1.h), a person of ordinary skill in the art would have found it obvious to remove the user-identified portion of the model to replace it using new scan data based on Boerjes (**Ground 1**) or based on Boerjes in view of Geng (**Ground 2**). Thus, a person of ordinary skill in the art would have understood that Boerjes's marking of the user-identified portion would also mark the user-identified portion to be removed. And a person of ordinary skill in the art would have understood that, in Boerjes or Boerjes combined with Geng, such marking of a portion to be removed and replaced would be before the action of removing and replacing that portion.

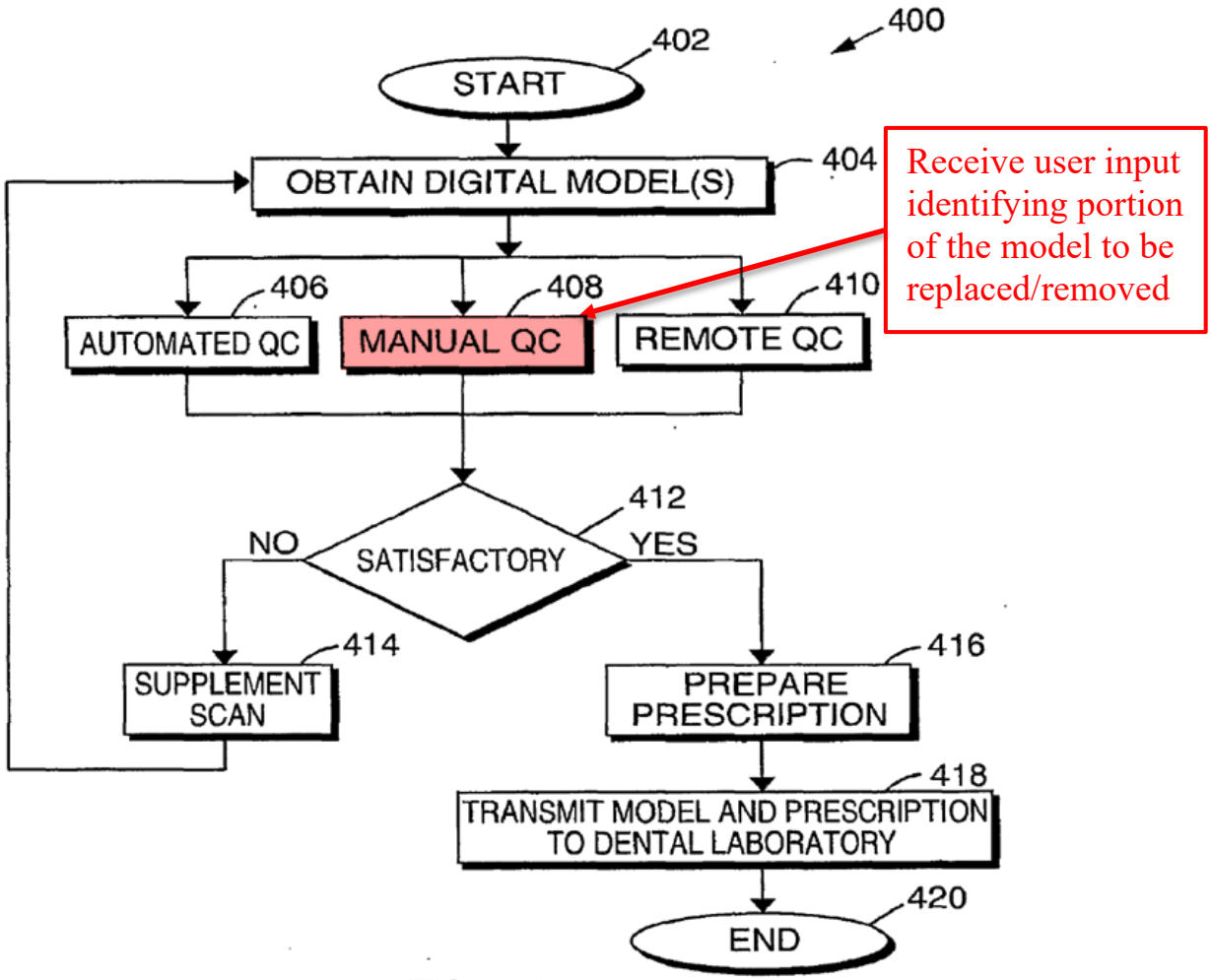


Fig. 4

Id., Fig. 4 (annotated).

141. In addition, a person of ordinary skill in the art would have understood that marking the display prior to removing the user-identified portion would visually aid the user in understanding which portion of the scan they have defined for additional scanning and replacement. It would also allow the user to correct any inadvertently marked portions before they are ultimately removed and replaced. *See* Ex-1009, [0324]-[0328] (teaching that a user can use a user interface

to highlight unwanted areas before clicking on an erase icon to confirm erase). Further, a person of ordinary skill in the art would have understood it as a suitable option to remove and replace the user-identified portion of the model after marking that portion on the display. A person of ordinary skill in the art would have understood that it would allow the user and other remote users to visualize the portion that has been identified and know immediately if the portion was correctly identified or if changes or further identifications are necessary. Ex-1004, [00196]; Ex-1009, [0324]-[0328]. Indeed, Boerjes discloses that marking, such as highlighting, provides visual feedback identifying questionable or erroneous areas of the model to the user such that the user may perform corrective actions. Ex-1004, [00196]. Thus, Boerjes discloses or at least suggests marking, on the displayed model, the user input defined portion before removing and replacing that portion of the model.

6. Independent Claim 9

a. 9[pre]: A method for scanning a patient's teeth for a dental procedure, the method comprising:

142. This limitation is nearly identical to limitation 1[pre] above, except that claim 9 is a method claim. Boerjes discloses this limitation for the reasons discussed in limitation 1[pre]. *See supra* Section IX.A.1.a; Ex-1004, [0006]-[0007], Figs. 1, 4; *see also supra* Section VII.A.

b. 9[a]: receiving first scan data of the patient's teeth from a hand-held intraoral scanner;

143. This limitation is encompassed in limitations 1[a] and 1[c]. Boerjes discloses this limitation for the reasons discussed in limitations 1[a] and 1[c]. *See supra* Sections IX.A.1.b, IX.A.1.d.

c. 9[b]: displaying, to a display, a model of the patient's teeth, wherein the model of the patient's teeth is based on the received first scan data of the patient's teeth;

144. This limitation is nearly identical to limitation 1[d]. Boerjes discloses it for the reasons discussed in limitation 1[d]. *See supra* Section IX.A.1.e.

d. 9[c]: receiving user input via the displayed model demarcating a portion of the model to be retained and a surface portion of the model to be replaced;

145. Boerjes discloses, or at least renders obvious, this limitation.

146. As discussed in limitation 1[e], Boerjes discloses receiving user input identifying a portion of the displayed model to be replaced with new scan data by interacting with the user interface displaying the model. Ex-1004, [00142], [00148], [00192]-[00197]; *see supra* Section IX.A.1.f.i. A person of ordinary skill in the art would have understood that this user input would include demarcating portions and, more specifically, would include marking, circling, outlining, annotating, delimiting, highlighting, or otherwise identifying portions of the model in need of replacement with additional scan data. Ex-1004, [00193] ("[A] dentist may inspect a scan in an interactive, three-dimensional environment to visually

identify, e.g., holes or areas of incomplete scan needed for an intended dental procedure."), [00194] ("feedback may be provided to a dentist such as an identification of regions requiring further reduction," "additional surface scanning[,] or surface preparation"), [00196] (the user can "highlight[] questionable or erroneous areas of a preparation within a rendered display of scan data").

147. A person of ordinary skill in the art would have understood from Boerjes that by demarcating the portions of the model to be replaced, the user would have likewise demarcated the portions of the model to be retained. For instance, marking points on the displayed model to identify an area of the model to be replaced would have also demarcated portions of the model to be retained, such as the remaining portions on the displayed model not to be replaced. Ex-1014, [0078], [0083], Figs. 1, 5, 7. This is consistent with the '936 patent's disclosure. For instance, the '936 patent explains that a portion of the model may be designated as "unsuitable or undesired," and thus be marked for "deletion, removal[,] or replacement." Ex-1001, 20:59-63, 21:30-40. But it only explains that it will concurrently retain the other undesignated portions. *Id.*, 20:59-63.

148. Moreover, to the extent something more is required, it would have been obvious to a person of ordinary skill in the art to identify on the display a portion of the model to be retained as well as the portion to be replaced according

to the user input. Such a system would present the user with useful graphical information for complex situations where additional information is needed to identify which portions of the model will be replaced and which portions will be retained. A person of ordinary skill in the art would have known how to incorporate this change into Boerjes's system because doing so would have required no more than ordinary computer-programming skills, updating the software of the system to expand on Boerjes's graphical feedback tools. Ex-1014, [0078], Figs. 1, 4, 5 (teaching a user may visually identify a demarcation line that separates a displayed model into two parts). Accordingly, a person of ordinary skill in the art would have expected success with such an ordinary improvement of Boerjes by using an ordinary programming update to yield the predictable results of demarcating a portion of the model to be retained and a surface portion of the model to be replaced according to the user input.

e. 9[d]: receiving second scan data of the patient's teeth from the hand-held intraoral scanner, the second scan data including surface data of a physically changed portion of the patient's intraoral cavity;

149. This limitation is nearly identical to limitation 1[g]. Boerjes discloses it, or at least renders obvious, this limitation for the reasons discussed in limitation 1[g]. *See supra* Section IX.A.1.g.

f. 9[e]: replacing at least a portion of the surface portion of the model to be replaced according to the user input using at least a portion of the second scan data of the patient's teeth including the physically changed portion; and

150. Limitation 9[e] is similar to limitation 1[h] except that it recites "to be replaced" instead of "removed." Boerjes discloses, or at least renders obvious, this limitation (**Ground 1**), and Boerjes in view of Geng (**Ground 2**) renders obvious this limitation under the plain and ordinary meaning of this limitation as well as under the district court's construction for the reasons discussed in limitation 1[h]. *See supra* Section IX.A.1.h.

g. 9[f]: outputting, to the display, the model of the patient's teeth with the at least the portion of the surface portion replaced using the second scan data.

151. Limitation 9[f] is similar to limitation 1[i] except that it recites "the at least the portion of the surface portion" instead of "the portion of the removed surface portion." Boerjes discloses, or at least renders obvious, this limitation (**Ground 1**) and Boerjes in view of Geng (**Ground 2**) renders obvious this limitation for the reasons discussed in limitation 1[i]. *See supra* Section IX.A.1.i.

7. Dependent Claim 10: The method of claim 9, further comprising marking an area on the displayed model associated with the received user input.

152. Claim 10 is encompassed within claim 8. For the reasons discussed regarding claim 8, Boerjes discloses or at least renders obvious this limitation of claim 10. *See supra* Section IX.A.5.

8. Dependent Claim 11: The method of claim 9, wherein replacing the at least the portion of the surface portion of the model to be replaced according to the user input using at least the portion of the second scan data comprises registering the second scan data with the model by aligning identifying data of the second scan data with corresponding parts of the model.

153. For the reasons discussed in limitation 1[h] and claims 4 and 5, Boerjes alone (**Ground 1**) or in view of Geng (**Ground 2**) renders obvious these limitations. *See supra* Sections IX.A.1.h, IX.A.2, IX.A.3.

9. Dependent Claim 12: The method of claim 11, wherein replacing the at least the portion of the surface portion of the model to be replaced according to the user input using at least the portion of the second scan data further comprises stitching the at least the portion of the second scan data with the model.

154. For the reasons discussed in limitation 1[h] and claims 4-6, Boerjes alone (**Ground 1**) or in view of Geng (**Ground 2**) renders obvious this limitation. *See supra* Section IX.A.1.h, IX.A.2-IX.A.4.

10. Dependent Claim 14: The method of claim 9,

a. 14[a]: wherein the model of the patient's teeth comprises a tooth preparation having a finish line,

155. Boerjes discloses, or at least renders obvious, this limitation.

156. Boerjes discloses that the model of the patient's teeth can comprise a tooth preparation having a margin line. Ex-1004, [0037], [0078], [00148], [00189], [00195]-[00196]. Boerjes's system receives and displays a model of at least one tooth prepared for a dental restoration using scan data from the intraoral scanner. *Id.*, [0043]. Once the model is displayed, Boerjes explains that the system may, either manually or automatically, identify a "margin line." *Id.*, [0043]-[0046], [00189]-[00194].

157. A person of ordinary skill in the art would have understood that a "margin line" in the context of Boerjes is a boundary of the contact area between a prepared tooth and a dental restoration. *Id.*, [00189] (teaching examining "a prepared tooth surface to ensure that a margin line is present all the way around a preparation, or examin[ing] the prepared surface to ensure that adequate material has been removed to accommodate a restoration"). Thus, a person of ordinary skill in the art would have understood Boerjes's margin line to be the same as the "finish line" referenced in the '936 patent, which represents the "transition boundary between the prosthesis and the dental preparation." Ex-1001, 1:50-54;

Ex-1014, [0005] (teaching that the "finish line" is the "transition boundary between the prosthesis and the dental preparation"), [0066] (teaching that a "finish line" is also referred to as a "margin line"); Ex-1012, [0016], [0054] (using "finish line" and "margin line" interchangeably).

158. Boerjes further explains that the user may want to visually inspect the margin line and may use a tool "to ensure that a margin line is present all the way around a preparation." Ex-1004, [00189], [00195]; *see also* Ex-1021, [0005] (teaching that the tissue wall around the prepared tooth, blood, saliva, and the like may accumulate and obscure portions of the margin); Ex-1014, [0007], [0023], [0078], [0081] (teaching that the finish line may be obscured by saliva, blood, lubricant, etc.).

b. 14[b]: wherein a portion of the finish line is obscured or distorted, and

159. Boerjes discloses, or at least renders obvious, this limitation.

160. Boerjes further discloses that the margin line (i.e., finish line) can be obscured or distorted. Boerjes explains that the quality control steps include ensuring that a margin line is present all the way around the preparation. Ex-1004, [00189]. The quality control process may also "locate areas of potential problems, such as occlusal high spots, occlusal clearance, occlusal irregularities, *areas of poor margin preparation*, . . . and so forth." *Id.* (emphasis added).

161. A person of ordinary skill in the art would have understood that areas of poor margin preparation could include portions of the margin line (i.e., finish line) that are obscured or distorted. For instance, Boerjes explains that during the quality control steps, a user may "visually confirm [the] accuracy of a scan by inspection for gross errors or omissions such as holes, gaps, *distortions*, twists, and the like." *Id.*, [00195] (emphasis added). A user would want to confirm that the finish line on the displayed scan is not distorted, twisted, obscured, or filled with holes or gaps because a distorted or obscured finish line could render the scan incomplete and unusable. To correct such an insufficient finish line, a user may "requir[e] additional preparation" of "a prepared tooth surface" before "additional or supplemental scanning" is completed. *Id.*, [00196]; Ex-1021, [0005] (teaching that the tissue wall around the prepared tooth, blood, saliva, and the like may accumulate and obscure portions of the margin); Ex-1014, [0007], [0023], [0078], [0081] (teaching that the finish line may be obscured by saliva, blood, lubricant, etc.).

c. 14[c]: wherein the physical change results in the finish line not being obscured or distorted.

162. Boerjes discloses, or at least renders obvious, this limitation.

163. Boerjes discloses identifying an inadequate margin line so that it can be physically changed and corrected and no longer obscured or distorted. Ex-1004,

[00189], [00194]-[00199]. Boerjes teaches that after a first scan is complete, some corrective action may be required to correct deficiencies within the digital model of the patient's tooth. *See supra* Section IX.A.1.h.i. For instance, the "corrective action[s] may include additional surface preparation of the at least one tooth" before an additional scan is performed. Ex-1004, [0037].

164. More specifically, a corrective action may be needed when the initial scan is deficient due to "areas of poor margin preparation." *Id.*, [00189]. Boerjes teaches that the user may complete additional preparations of the tooth surface, correcting the deficiencies, before rescanning. *Id.*, [00189]-[00196], [00199]. A person of ordinary skill in the art would have understood Boerjes to be teaching—and would have found it to be common sense—for the physical materials that impact the quality of imaging, causing image obscurement or distortion, to be removed. Ex-1022, Abstract, [0009], [0012], [0023], [0032] (teaching that the dental practitioner removes the saliva, mucous, or blood that impairs imaging to obtain clear images for constructing a 3D model of the teeth).

165. Boerjes teaches that during quality control, once the updated model with the additional "scan and/or surface preparations are satisfactory," the dental procedure can be completed. Ex-1004, [00199]-[00200].

11. Dependent Claim 15: The method of claim 9,

a. 15[a]: wherein the model of the patient's teeth comprises a tooth preparation that accurately represents a surface of a physical preparation of the patient, and

166. Boerjes discloses, or at least renders obvious, this limitation.

167. Boerjes discloses a system to obtain a model of the patient's teeth where the tooth preparation results in a model that accurately represents a surface of a physical preparation of the patient. Boerjes discloses using a quality control procedure where a scan is taken following tooth preparation and is analyzed. *Id.*, [00188]-[00200]. If the preparation is inadequate, additional preparation is performed after which additional scanning is performed and used to replace or supplement the inadequate portion of the prior model. *Id.*, [00196], [00199]. Boerjes teaches repeating these steps until the model shows that the "surface preparations are satisfactory," meaning the tooth preparation accurately represents a surface of a physical preparation of a patient. *Id.*, [00199]-[00200].

168. Boerjes's model depicts an accurate representation of a surface of a physical preparation of the patient because Boerjes explains that for "a surface preparation or other area of diagnostic or treatment significance," the user can "scan[] at a relatively higher accuracy" with the intraoral scanner. *Id.*, [00151]. Boerjes also explains that "certain areas such as the surface preparation may be

designated for supplemental postprocessing to achieve enhanced accuracy or spatial resolution." *Id.* Thus, a person of ordinary skill in the art would have understood that the desired level of accuracy could depend on the particular use case, and when Boerjes's system is used for preparing a prescription of and fabricating a prosthetics, Boerjes's model would accurately represent the "one or more prepared surfaces, such as a single tooth surface prepared for a crown, or a number of tooth surfaces prepared for a multi-unit bridge." *Id.*, [0011], [00131], [00139], [00185], [00200], Fig. 4.

169. Indeed, dental scanning systems are designed with the purpose of providing 3D virtual models of high accuracy to improve the quality, efficiency, and safety of dental care. *See supra* Section V.A; Ex-1010, [0006] ("Recent advances in three dimensional imaging technology have introduced the possibility of a handheld, three-dimensional scanner that can be suitably adapted to acquisition of highly accurate, detailed surface data directly from within a dental patient's mouth – a virtual digital dental impression – that, once captured accurately, will not degrade, and can be easily reviewed, analyzed, and/or transmitted to remote manufacturing facilities.").

b. 15[b]: wherein the method further comprises analyzing the tooth preparation of the model to determine whether the surface of the physical preparation is suitable for a dental prosthesis; and

170. Boerjes discloses, or at least renders obvious, this limitation.

171. Boerjes discloses a method of analyzing the tooth preparation of the model to determine whether the surface of the physical preparation is suitable for a dental prosthesis. As discussed above, Boerjes's system scans and depicts a model of at least a patient's tooth surface prepared for a dental procedure. *See supra* Section VII.A. This covers an array of dental procedures, including preparation for "*a dental prosthesis*, a dental implant, a dental appliance, a dental restoration, a restorative component, or an abutment." Ex-1004, [0022] (emphasis added).

172. Once the model of the patient's teeth is complete and displayed, Boerjes describes subsequent quality control steps. During quality control, either the system or the user will ensure that the surface of the physical preparation is suitable for a dental prosthesis. *Id.*, [00195]-[00196]. For instance, Boerjes discloses that the user will receive feedback on or will identify deficient areas of model, such as inadequate surface preparation that require corrective action. *Id.*, [0037], [00196]. If no corrective action is required, then the physical preparation is suitable for completion of the dental procedure (which may include a dental prosthesis). *Id.*, [00103], [00199]-[00200], Fig. 4. Boerjes explains that if a

corrective action is required, the dentist may undertake "additional surface preparation[s] of the at least one tooth" to correct the deficiency and make the surface suitable for a dental prosthesis. *Id.*, [0037]. Once the additional surface preparations are complete, Boerjes explains that the dentist can complete supplemental or replacement scanning and obtain an updated model of the patient's tooth. *Id.*, [00199], Fig. 4.

c. 15[c]: wherein the physical change is a physical modification of the surface of the physical preparation of the patient.

173. Boerjes discloses, or at least renders obvious, this limitation.

174. Boerjes discloses that the physical change includes a physical modification of the surface of the preparation of the patient. Boerjes discloses that, after receiving first scan data and obtaining a model based on the first scan data, some corrective action may be required to correct deficiencies with the surface preparation of the patient's tooth. *See supra* Sections IX.A.1.f, IX.A.1.g, IX.A.1.h.i; Ex-1004, [00189]-[00199], Fig. 4. For instance, the "corrective action[s] may include additional surface preparation of the at least one tooth" before additional scanning is performed. Ex-1004, [0037], [00196], [00199].

175. A person of ordinary skill in the art would have understood that the physical change resulting from performance of additional surface preparations or reductions is a physical modification of the surface. For instance, the initial surface

preparation described in Boerjes includes a physical change of the surface of a tooth to prepare it for the dental prosthesis. *Id.*, [00185]. Thus, additional surface preparations or reductions would be further physical changes to the surface of the initial preparation to correct deficiencies and ensure that the physical preparation is suitable for the dental prosthesis. *Id.*, [00189]-[00196].

12. Dependent Claim 16: The method of claim 15,

a. 16[a]: wherein the dental prosthesis comprises a dental crown and

176. Boerjes discloses, or at least renders obvious, this limitation. Boerjes discloses that the dental prosthesis can be a dental crown. *Id.*, [00101]; *see also id.* (stating that "[t]he artificial dental object may include . . . a *crown*," among other things (emphasis added)); *see also id.*, [00102]-[00111], [00130].

b. 16[b]: wherein the tooth preparation analysis comprises analysis of the model with respect to a virtual model of an opposing dentition of an opposite jaw to determine whether the tooth preparation would result in an inadequate structure for the dental crown.

177. Boerjes discloses, or at least renders obvious, this limitation. For instance, where the dental prosthesis is a crown, Boerjes describes scanning the crown using "image capture system 100," such that the crown "may be test fit to the digital model." *Id.*, [00209]-[00211]. The "test fitting may include measuring dimensional accuracy of the [crown]," the "fit between adjacent teeth," or "contact

points with teeth of an opposing arch when the [crown] is fitted." *Id.*, [00212]. A person of ordinary skill in the art would have understood that Boerjes's system includes an analysis of the model of a crown with respect to the model of the patient's surrounding and opposing dentitions to ensure that the dental crown and opposing dentition do not improperly contact or interfere. Indeed, Boerjes explains that the dentist would want to use the system's models to evaluate the patient's bite with the crown in place to ensure appropriate "mating of lower and upper arches." *Id.*, [00211]. A person of ordinary skill in the art would have understood that this would have provided quality control benefits by at least preventing costly errors from unforeseen collisions or interference between the dental crown and opposing dentitions.

178. Thus, because Boerjes evaluates the dental models with the crown or prosthesis in place to ensure that "contact points with teeth of an opposing arch when the [crown] is fitted" provide a proper fit without unwanted contact with teeth of the opposing arch, Boerjes discloses, or at least renders obvious, this limitation. *Id.*, [00212].

B. [Grounds 3-4]: Claims 2-3, 7, 13, and 17-20 Would Have Been Obvious Based on Boerjes and Babayoff (Ground 3) or Boerjes, Geng, and Babayoff (Ground 4)

179. Boerjes and Babayoff (**Ground 3**) and Boerjes, Geng, and Babayoff (**Ground 4**) render obvious claims 2-3, 7, 13, and 17-20.

180. Babayoff discloses a hand-held intraoral scanner as disclosed in claims 2 and 18 and discloses discarding the remainder of second scan data after registration and stitching as recited in claim 7, claim 13, and limitation 17[j]. A person of ordinary skill in the art would have found it obvious to use Babayoff's hand-held intraoral scanner in Boerjes or Boerjes combined with Geng (*see infra* Section IX.B.1.b) and would have found it obvious to modify Boerjes or Boerjes combined with Geng to further discard the remainder of the second scan data after registering and stitching the second scan data to the model as discussed in detail below (*see infra* Sections IX.B.3, IX.B.4).

1. Dependent Claim 2: The system of claim 1, wherein the hand-held intraoral scanner comprises a probing member with a sensing face, an illumination unit, a light focusing optics defining one or more focal planes forward the sensing face, and a translation mechanism for displacing the one or more focal planes relative to the sensing face.

a. Babayoff discloses claim 2

181. Babayoff discloses the limitations of claim 2.

182. Babayoff discloses "a hand-held device" including an endoscope 46, illumination unit 31, main optics 41, color illumination 71, and tri-color sequence generator used to illuminate and scan objects 26 of the intraoral cavity, making it a hand-held intraoral scanner. Ex-1006, [0107], [0156].

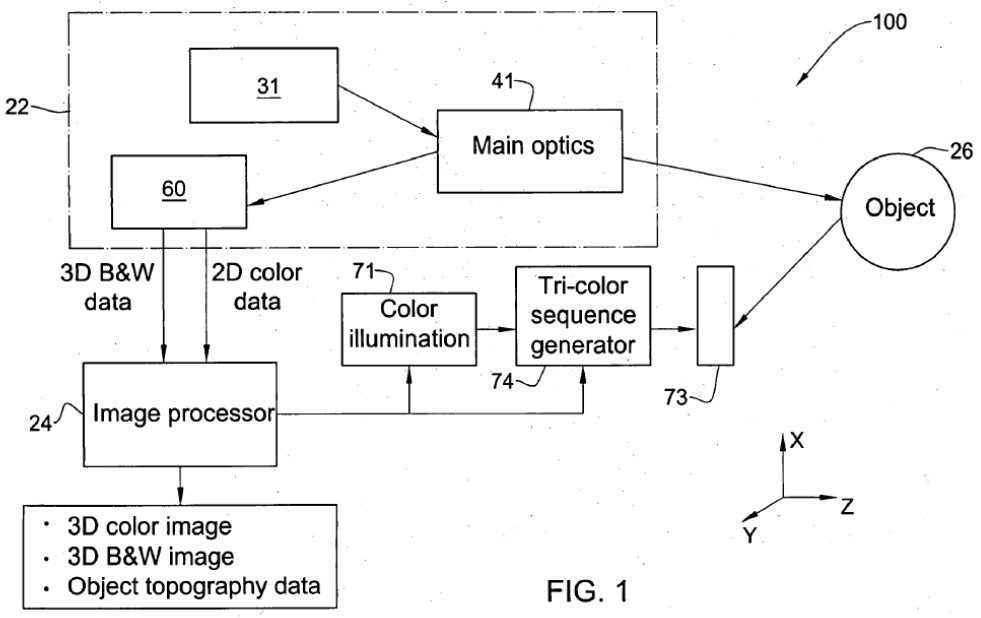


FIG. 1

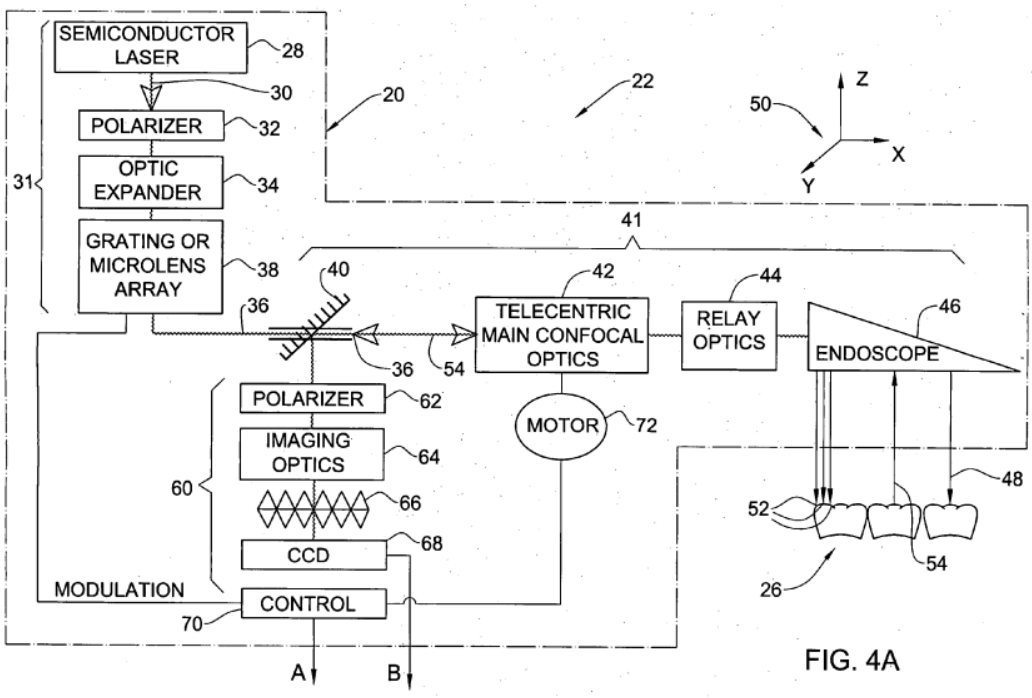


FIG. 4A

Id., Figs. 1, 4A.

183. Babayoff discloses "a probing member with a sensing face" because its hand-held intraoral scanner comprises "probing member 90," which "is made of a light transmissive material." *Id.*, [0124]. The probe member further includes a "[g]lass disk 96 defining a sensing surface 97" (i.e., sensing face). *Id.* (emphasis added).

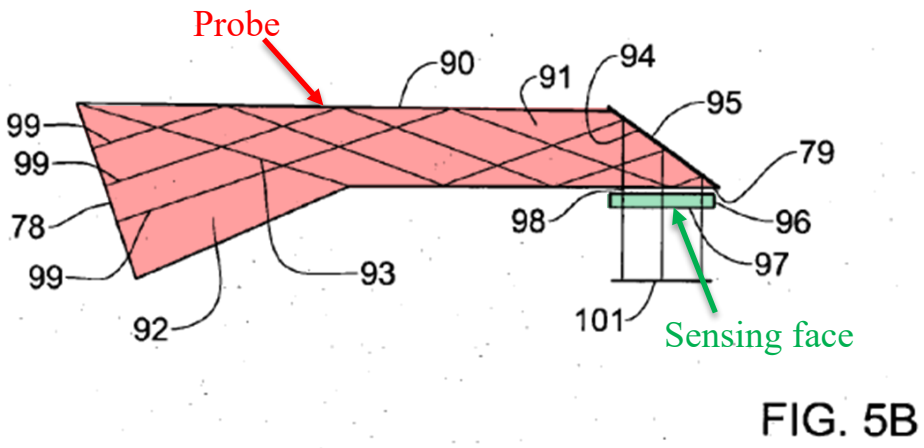


FIG. 5B

Id., Fig. 5B (annotated).

184. Babayoff discloses "an illumination unit" because Babayoff's probe includes "a main illumination source 31 for illuminating the object of interest 26, typically a part of the intraoral cavity." *Id.*, [0107] (emphasis added). Babayoff's probe "further comprises a plurality of tri-color LED's [sic] 77[] for providing the colored illumination to the object 26." *Id.*, [0124] (emphasis added). In addition to the main illumination source, each of the LEDs is an illumination unit as "each [is] capable of providing an illumination radiation" in a desired color. *Id.*, [0126]; *see also id.*, [0108] (teaching color illumination means for illuminating the object

using suitable colors), [0156] (teaching color illumination 71 and tri-color sequence generator 74 included in the hand-held device).

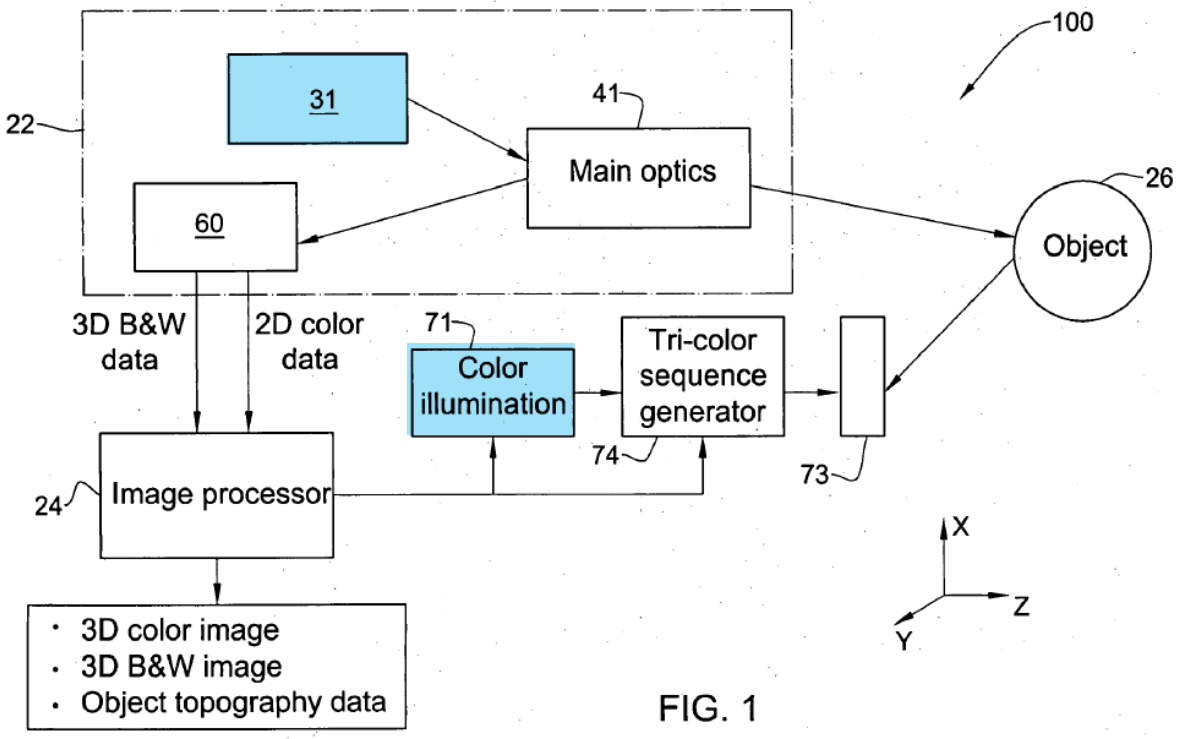


FIG. 1

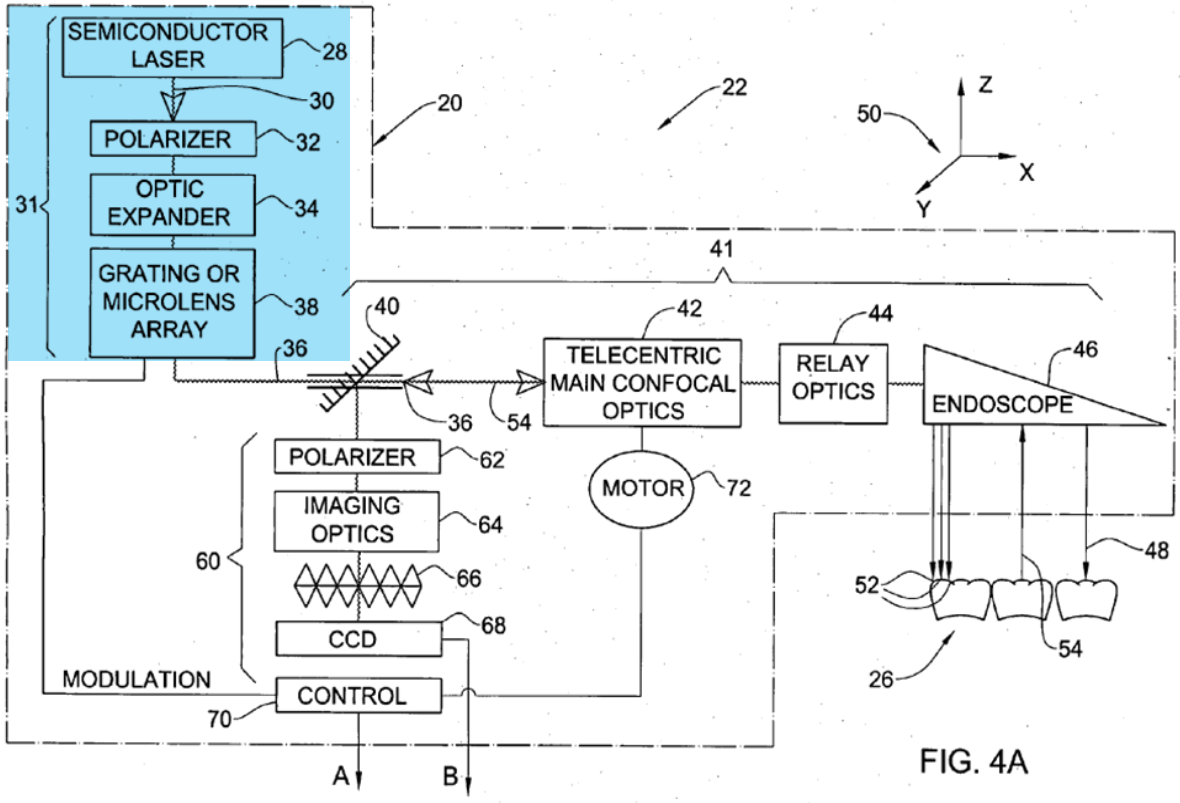

SEMICONDUCTOR LASER
28
30
POLARIZER
32
OPTIC EXPANDER
34
31
GRATING OR MICROLENS ARRAY
38
20
22
50
Z
X
Y
41
40
42
44
36
TELECENTRIC MAIN CONFOCAL OPTICS
RELAY OPTICS
46
ENDOSCOPE
36
54
POLARIZER
62
MOTOR
72
IMAGING OPTICS
64
60
66
48
52
CCD
68
54
MODULATION
CONTROL
26
70
A
B

FIG. 4A

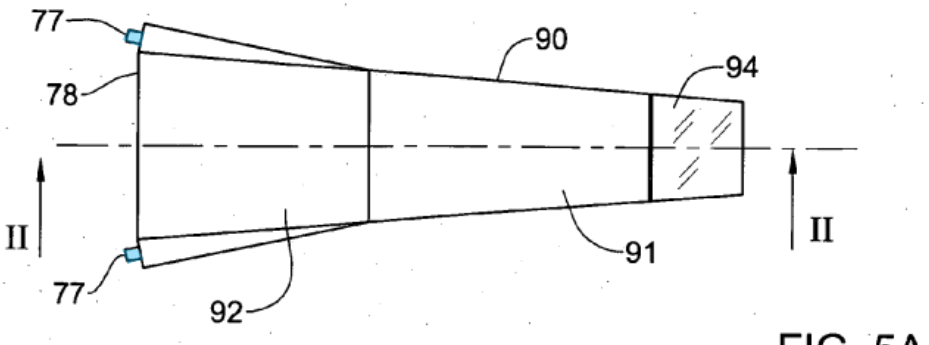


FIG. 5A

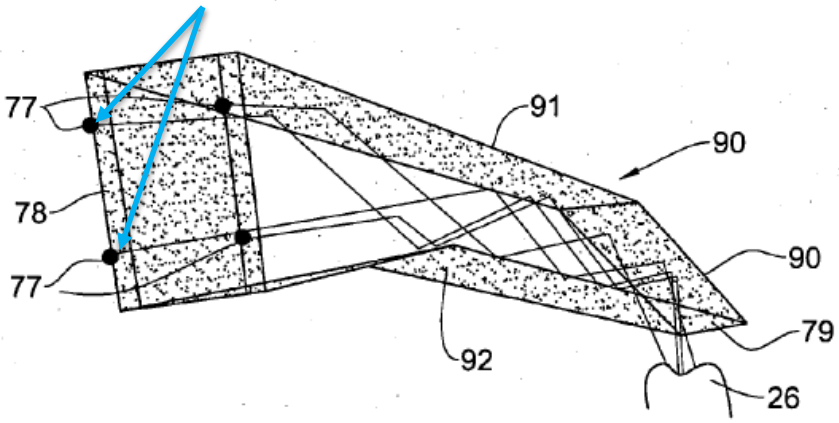


FIG. 5C

Id., Figs. 1, 4A, 5A, 5C (annotated); *see also id.*, [0107]-[0108], [0156].

185. Babayoff discloses that the probe further comprises light-focusing optics defining one or more focal planes forward the sensing face. Babayoff explains that light rays are reflected through sensing face 97 and focus on focusing plane 101, which is positioned forward of sensing face 97, closer to the dental objects 26. *Id.*, [0124].

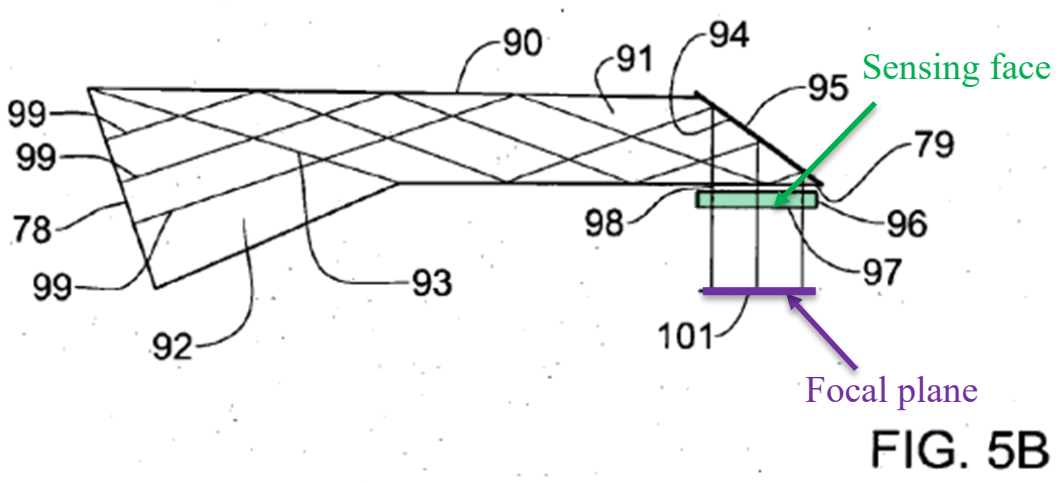


FIG. 5B

Id., Fig. 5B (annotated).

186. By using light "focusing optics (not shown in [the above] figure)," the user can adjust the position of the focal plane 101. *Id.*, [0124] (emphasis added); *see also id.*, [0120], Fig. 4A ("TELECENTRIC MAIN CONFOCAL OPTICS" (emphasis added)).

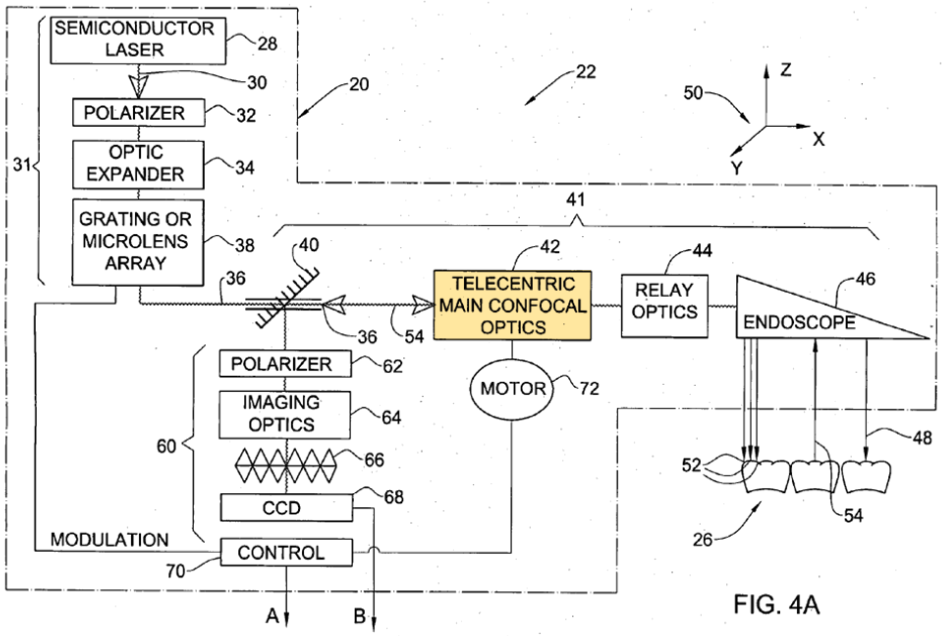


FIG. 4A

Id., Fig. 4A (annotated).

187. Babayoff's scanner further comprises a translation mechanism for displacing the one or more focal planes relative to the sensing face because it describes a motor 72, which "is linked to telecentric confocal optics 42 for changing the relative location of the focal plane of the optics 42 along the Z-axis." *Id.*, [0120]. Babayoff's control unit 70 will cause "motor 72 to displace the optical element 42 to change the focal plane location" along the Z-axis, which would displace optical element 42 relative to the device's sensing face 97. *Id.*

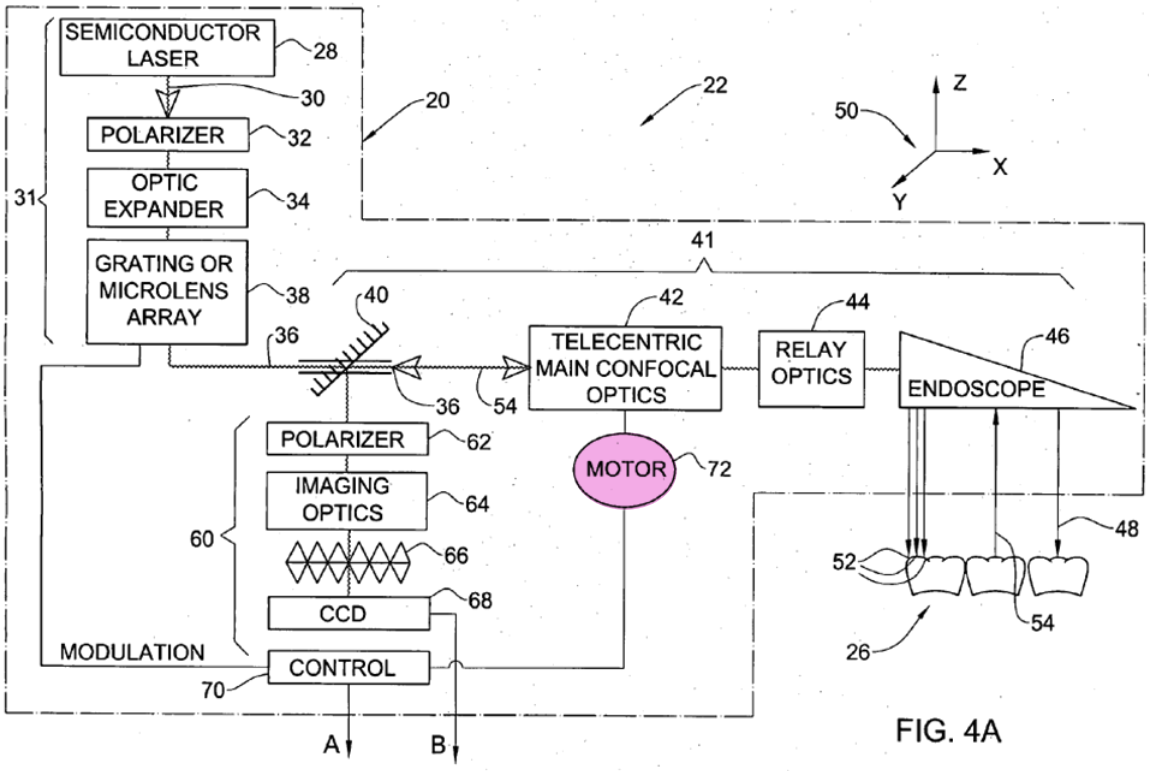


FIG. 4A

Id., Fig. 4A (annotated).

b. A person of ordinary skill in the art would have found it obvious to use Babayoff's intraoral scanner in Boerjes or Boerjes combined with Geng

188. A person of ordinary skill in the art would have been motivated to use Babayoff's intraoral scanner in the system of Boerjes **(Ground 3)** or Boerjes as modified by Geng **(Ground 4)**.

189. As discussed above, Babayoff is analogous art to the '936 patent and to Boerjes and Geng. *See supra* Sections VII.A-VII.C And like Boerjes and Geng, Babayoff also discloses that the system includes a hand-held intraoral scanner and a computer-readable medium storing software that processes scan data to provide a 3D surface representation of the oral cavity and display the 3D representation on the display. Ex-1004, [0010], [0040], [0061], [00130]-[00132]; Ex-1005, 3:47-5:40, 7:12-37; Ex-1006, [0070]-[0072]. *See supra* Sections VII.A-VII.C

190. A person of ordinary skill in the art would have understood that Babayoff's intraoral scanner would be a suitable option for capturing scan data for obtaining an accurate digital dental model for quantitatively evaluating a prepared dental surface, as desired by Boerjes. Ex-1004, [0006], [0020], [0025]; Ex-1006, [0104]. And a person of ordinary skill in the art would have understood that Babayoff's scanner provides advantageous features that improve the system of Boerjes or Boerjes as modified by Geng.

191. A person of ordinary skill in the art would have understood that Babayoff's color scan data or 3D color model would improve the dental restoration procedure of Boerjes or Boerjes as modified by Geng. Babayoff's intraoral scanner provides color data for presenting to the user an accurate 3D color model. Ex-1006, [0001], [0007], [0101]. Babayoff explains that it is important to match the color and texture of the prosthesis with the surrounding teeth to give the prosthesis or restoration a natural appearance. *Id.*, [0007]-[0014]. A person of ordinary skill in the art would have understood that the color scan data or 3D color model would allow the dentist to more accurately match the color and shade of a prosthesis, such as a crown, by performing digital colorimetric measurements in addition to or instead of only visual comparison. *Id.*, [0190]-[0198]. Indeed, Boerjes suggests evaluating color and shade matching. Ex-1004, [00194]. A person of ordinary skill in the art would have understood that Babayoff's intraoral scanner would be suitable for providing the color data for color and shade matching, as suggested by Boerjes.

192. In addition, a person of ordinary skill in the art would have understood that Babayoff's intraoral scanner with color scan data would improve Boerjes's automatic identification of the margin line (i.e., finish line). Babayoff's intraoral scanner provides color data of the surrounding soft tissue, such as gums, cheeks, and tongue. Ex-1006, [0001], [0028]-[0033], [0036], [0064]-[0069],

[0161]. This allows differentiating between hard and soft tissues (*id.*, [0161]-[0171]), and identifying a finish line for a prosthesis (*id.*, [0036], [0172]-[0175], [0182]-[0187]), even when the finish line is below the gum line (*id.*, [0185]).

193. While Boerjes allows for automatic or manual identification of a margin line for a dental restoration, Boerjes does not expressly indicate how to perform automatic identification of the margin line. Ex-1004, [0041]-[0046], [00148], [00196], [00208]. Boerjes notes that manual marking of the margin line may be needed when the margin is not visible on a prepared tooth surface. *Id.*, [00194]. A person of ordinary skill in the art would have understood that using Babayoff's scanner with color data would facilitate the identification of a margin line (finish line), such as when the margin line is below the gum line, in Boerjes or Boerjes as modified by Geng. Ex-1006, [0185]. A person of ordinary skill in the art would have understood that using Babayoff's scanner would improve the efficiency of the dental procedure as desired by Boerjes, such as by omitting the need of manually marking the margin line when the margin is not visible.

194. A person of ordinary skill in the art would have had a reasonable expectation of success in using Babayoff's intraoral scanner in Boerjes's system or Boerjes's system as modified by Geng. Boerjes teaches that its scanner can use any camera system suitable for acquiring three-dimensional data or two-dimensional data from which a 3D model may be derived. Ex-1004, [00133]. Babayoff's

intraoral scanner would be a suitable option for acquiring such scan data in Boerjes or Boerjes as modified by Geng, while providing the benefit of precise color matching and additional ways to identify the margin line. A person of ordinary skill would have understood that using Babayoff's intraoral scanner in the system of Boerjes or Boerjes as modified by Geng would be using a known technique in a known, similar system ready for improvement to yield predictable results. And a person of ordinary skill would have understood that using Babayoff's intraoral scanner in the system of Boerjes or Boerjes as modified by Geng would also have been simply combining known techniques, Boerjes's system (or Boerjes's system modified with Geng's functions) and Babayoff's intraoral scanner, with each performing the same function it had been known to perform, and would have yielded predictable results of obtaining scan data with color image data for obtaining a model of a patient's teeth with color image data in Boerjes.

2. Dependent Claim 3: The system of claim 2, wherein the system further comprises the computer system and the display; wherein the system further comprises a mouse or wherein the display comprises a touch screen display; and wherein the user input defining portion of the model to be removed is received by the mouse or the touch screen display.

195. Boerjes discloses the limitations of claim 3.

196. Boerjes's system includes computer system 108 that includes touchscreen display 110 and mouse 112 for receiving user input for manipulating the model. Ex-1004, [0065], [0076], [00132], [00142], Fig. 1.

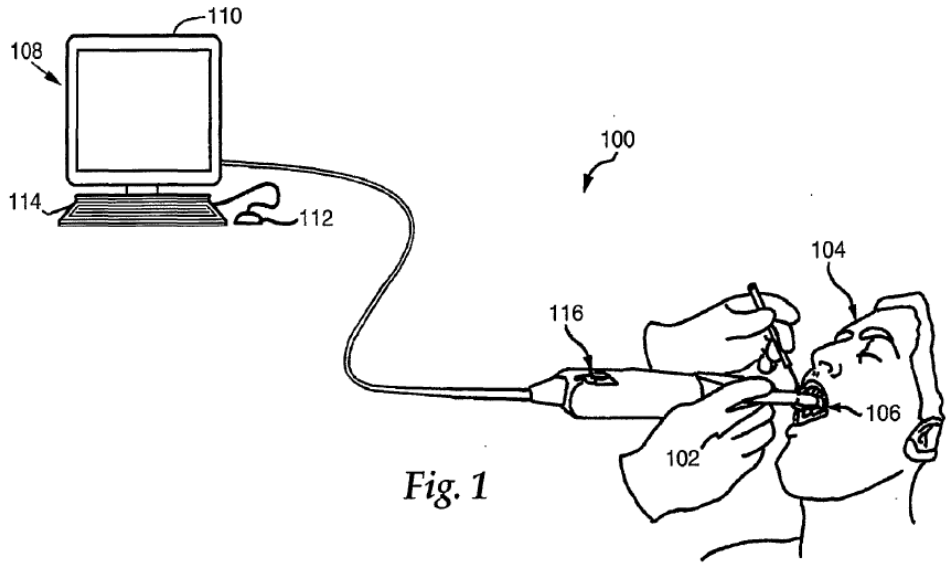


Fig. 1

Id., Fig. 1. A person of ordinary skill in the art would have understood that Boerjes's mouse or touchscreen display would be used to receive the user input identifying a portion of the model to be removed. *See supra* Section IX.A.1.f.i. Using such input devices, such as a mouse or touchscreen display, for interacting with and manipulating a displayed model was conventional and well known. *See supra* Section V.B.

3. Dependent Claim 7: The system of claim 6, wherein the instructions to replace the at least the portion of the removed surface portion of the model using the received second scan data comprise instructions to further discard a remainder of the received second scan data, the remainder including the identifying surface data, after stitching the portion of the received second scan data with the model.

197. Boerjes in view of Babayoff (**Ground 3**) or Boerjes in view of Geng and Babayoff (**Ground 4**) renders obvious discarding a remainder of the received second scan data, the remainder including the identifying surface data, after stitching the portion of the received second scan data with the model.

198. As discussed above for claims 5 and 6, Boerjes alone or Boerjes in view of Geng renders obvious aligning identifying data of the received second scan data with corresponding parts of the model and stitching a portion of the received second scan data with the model. *See supra* Sections IX.A.3, IX.A.4. Boerjes or Geng does not expressly disclose discarding a remainder of the received second scan data, the remainder including the identifying surface data, after the stitching. Babayoff does. Babayoff discloses discarding repeated data of overlapping areas after two or more data sets (digital models) are registered and stitched together. Ex-1006, [0176]-[0177].

199. Babayoff discloses a system "for accurately stitching data sets of overlapping areas scanned within the intra-oral cavity." *Id.*, [0176]. When the system receives data sets of numerical entities (digital models) of an intraoral

cavity to be stitched, the system will identify the overlap zone between the data sets, establish the spatial relationship between the data sets, and stitch together or combine the data sets to form a model "that comprises the full geometry and color representation of the target zone." *Id.*; *see also id.*, [0037]-[0039], [0176]-[0177], [0179]. Babayoff further teaches that it was well known in the prior art to discard the data point that is repeated in the overlap zone. *Id.*, [0176]-[0177].

200. As discussed above in claim 5, a person of ordinary skill in the art also would have understood that in Boerjes or Boerjes combined with Geng, stitching the second scan data to the existing model that has the user-identified portion removed would include identifying and aligning corresponding points or features ("identifying surface data"/"identifying data") of the second scan data to corresponding parts of the retained portion of the model. *See supra* Section IX.A.3. A person of ordinary skill in the art would have understood the portion of the second scan data that includes the corresponding points or features ("identifying surface data"/"identifying data") as "a remainder of the received second scan data," i.e., a left-over portion to be disposed of after the stitching process is completed. This is because the data of that portion contains duplicative points corresponding to similar points in the retained portion of the model and these duplicate points are used for aligning the second scan data with the retained portion of the model.

201. A person of ordinary skill in the art would have been motivated to modify the system of Boerjes or Boerjes as modified by Geng to discard the corresponding points ("identifying surface data"/"identifying data") of the second scan data after registration and stitching, as taught in Babayoff. A person of ordinary skill in the art would have understood that such data, such as corresponding data points, would be repetitive after registration and stitching. Discarding the repeated data after registration and stitching as taught in Babayoff would improve the smoothness in the stitched boundary. For example, discarding the repeated data, or some of the repeated data, can reduce artifacts, ghosting, or blurring that can occur in the stitched model if the repeated data is not removed due to differences between the two scans, such as different light exposure or small misalignment from the registration. A person of ordinary skill in the art also would have understood that discarding the repeated data after registration and stitching would reduce data redundancy, and thus reduce data size and the required memory space and processing power for storing and further manipulating the stitched model.

202. A person of ordinary skill in the art would have had a reasonable expectation of success in modifying the system of Boerjes or Boerjes as modified by Geng to include discarding repeated data in the second scan data after registration and stitching, as taught in Babayoff, because such modification would

merely involve using a known technique to improve similar systems in the same way taught. A person of ordinary skill in the art would have known how to modify Boerjes's software that is stored in the computer-readable medium and executed by Boerjes's processor to discard repeated data after registering and stitching, as taught in Babayoff, using ordinary computer-programming skills. Incorporating Babayoff's discarding step in the system of Boerjes or Boerjes as modified by Geng would be applying a known technique to improve a known, similar system ready for improvement to yield predictable results of an updated model with reduced data redundancy.

203. A person of ordinary skill in the art also would have understood that various known methods would be suitable for stitching two scan data sets. A person of ordinary skill in the art also would have known that Babayoff's discarding of repeated data after image registration and stitching would be a suitable option for obtaining a final stitched model in the system of Boerjes or Boerjes as modified by Geng. A person of ordinary skill in the art would have understood that other suitable options can be also used, such as blending the overlapping areas between the two data sets.

4. Dependent Claim 13: The method of claim 12, wherein replacing the at least the portion of the surface portion of the model to be replaced according to the user input using the at least the portion of the second scan data further comprises discarding a remainder of the second scan data, including the identifying surface data, after stitching the at least the portion of the second scan data with the model.

204. As discussed in claims 6 and 12, Boerjes alone (**Ground 1**) or in view of Geng (**Ground 2**) renders obvious stitching a portion of the received second scan data with the model. *See supra* Sections IX.A.4, IX.A.9. And for the reasons discussed in claim 7, Boerjes in view of Babayoff (**Ground 3**) or Boerjes in view of Geng and Babayoff (**Ground 4**) renders obvious discarding the remainder of the second scan data including the identifying surface data. *See supra* Section IX.B.3; Ex-1006, [0176]-[0177].

5. Independent Claim 17

a. 17[pre]: A system for intraorally scanning a patient's teeth for a dental procedure, the system comprising:

205. Boerjes discloses this limitation for the reasons discussed in limitation 1[pre]. *See supra* Section IX.A.1.a.

b. 17[a]: a hand-held intraoral scanner; and

206. Boerjes discloses this limitation for the reasons discussed in limitation 1[a]. *See supra* Section IX.A.1.b.

c. 17[b]: a computer readable medium including instructions that when executed by a computer system, cause the computer system to:

207. Boerjes discloses this limitation for the reasons discussed in limitation 1[b]. *See supra* Section IX.A.1.c.

d. 17[c]: receive first scan data of the patient's teeth from the hand-held intraoral scanner;

208. Boerjes discloses this limitation for the reasons discussed in limitation 1[c]. *See supra* Section IX.A.1.d

e. 17[d]: display, to a display, a model of the patient's teeth, wherein the model of the patient's teeth is based on the received first scan data of the patient's teeth;

209. Boerjes discloses this limitation for the reasons discussed in limitation 1[d]. *See supra* Section IX.A.1.e.

f. 17[e]: receive user input defining a portion of the model to be removed;

210. Boerjes alone or Boerjes in view of Geng renders obvious this limitation for the reasons discussed in limitation 1[e]. *See supra* Section IX.A.1.f.

g. 17[f]: after receiving the user input, remove, from the displayed model, a removed surface portion of the model to be removed according to the user input;

211. This limitation is encompassed in limitations 1[e] and 1[f]. Boerjes alone or Boerjes in view of Geng renders obvious this limitation for the reasons discussed in limitations 1[e] and 1[f]. *See supra* Section IX.A.1.f. Indeed, as

explained above, a person of ordinary skill in the art would have understood that in Boerjes alone or Boerjes combined with Geng, the removal step would occur "after receiving the user input" because Boerjes's display updates the displayed model according to the user input as it is received. Ex-1004, [00141], [00190]. And as discussed above, a person of ordinary skill in the art would have removed the user-identified surface portion from the model to improve the accuracy and efficiency of replacing the user-identified surface portion. *See supra* Section IX.A.1.f.

h. 17[g]: after removing the portion of the model, receive second scan data of the patient's teeth from the hand-held intraoral scanner;

212. This limitation is encompassed in limitations 1[f] and 1[g] and additionally requires "after removing the portion of the model." Boerjes discloses receiving the new scan data after identifying a portion to be replaced (*id.*, [00199], Fig. 4) as discussed in limitation 1[g]. *See supra* Section IX.A.1.g. And Boerjes alone or Boerjes in view of Geng renders obvious removing the identified portion before replacing the identified portion with the new scan data (second scan data) as discussed in limitations 1[e]-1[g]. *See supra* Sections IX.A.1.f, IX.A.1.g. And as discussed above, a person of ordinary skill in the art would have removed the identified portion to visually aid the user in finding the locations for performing the second scan, which would conserve time for performing the additional scanning and obtaining a final model, and thus reduce the overall time for the dental

procedure and improve patients' comfort. *Id.* Thus, Boerjes alone or Boerjes in view of Geng renders obvious after removing the portion of the model (e.g., in steps 408, 412), receiving second scan data of the patient's teeth from the hand-held intraoral scanner (e.g., in step 414) such that the user-identified portion is replaced with the new scan data (i.e., second scan data) as explained in limitations 1[e]-1[g]. *Id.*

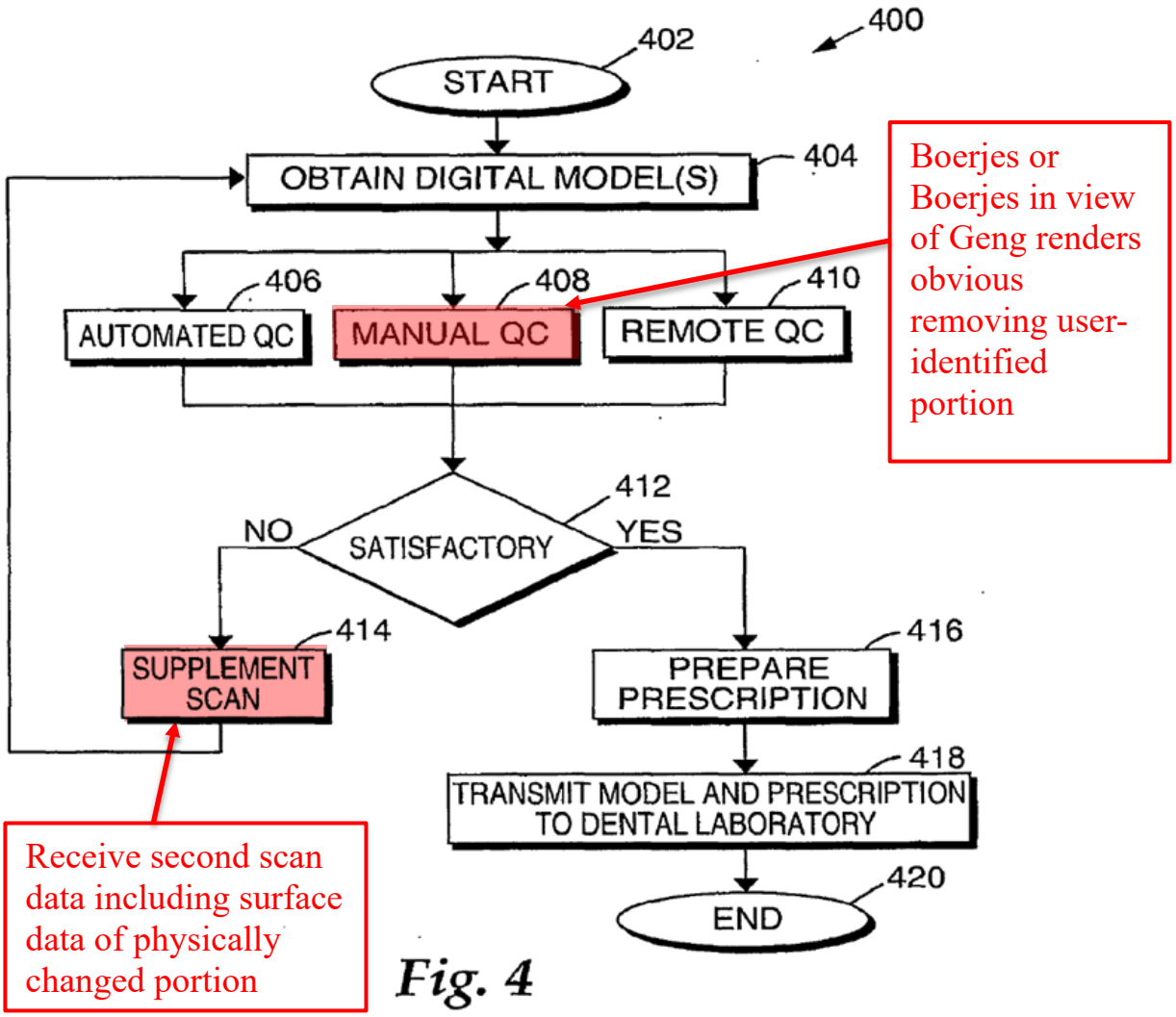


Fig. 4

Id., Fig. 4 (annotated).

i. 17[h]: register the second scan data with the model by aligning identifying data of the second scan data with corresponding parts of the model;

213. Boerjes alone or Boerjes in view of Geng renders obvious this limitation for the reasons discussed in limitation 1[h] and claims 4-5. *See supra* Sections IX.A.1.h, IX.A.2, IX.A.3.

j. 17[i]: replace at least a portion of the removed surface portion of the model using at least a portion of the received second scan data of the patient's teeth;

214. Boerjes alone or Boerjes in view of Geng renders obvious this limitation for the reasons discussed in limitation 1[h] and claims 4-5. *See supra* Sections IX.A.1.h, IX.A.2, IX.A.3.

k. 17[j]: discarding a remainder of the second scan data, including the identifying data, after registering the second scan data with the model; and

215. Boerjes in view of Babayoff (**Ground 3**) or Boerjes in view of Geng and Babayoff (**Ground 4**) renders obvious this limitation for the reasons discussed in claim 7. *See supra* Section IX.B.3.

l. 17[k]: output, to the display, the model of the patient's teeth with the portion of the removed surface portion replaced using the received scan data.

216. Boerjes alone or Boerjes in view of Geng renders obvious this limitation for the reasons discussed in limitation 1[i]. *See supra* Section IX.A.1.i.

6. Dependent Claim 18: The system of claim 17, wherein the hand-held intraoral scanner comprises a probing member with a sensing face, an illumination unit, a light focusing optics defining one or more focal planes forward the sensing face, and a translation mechanism for displacing the one or more focal planes relative to the sensing face.

217. This claim is nearly identical to claim 2. Babayoff discloses these limitations, and Boerjes in view of Babayoff (**Ground 3**) or Boerjes in view of Geng and Babayoff (**Ground 4**) renders obvious this claim for the reasons discussed in claim 2. *See supra* Section IX.B.1.

7. Dependent Claim 19: The system of claim 18, wherein the system further comprises the computer system and the display; wherein the system further comprises a mouse or wherein the display comprises a touch screen display; and wherein the user input defining portion of the model to be removed is received by the mouse or the touch screen display.

218. This claim is nearly identical to claim 3. Thus, Boerjes discloses these limitations for the reasons discussed in claim 3. *See supra* Section IX.B.2.

8. Dependent Claim 20: The system of claim 17, wherein the portion of the removed surface portion of the model is replaced using at least the portion of the received second scan data by registering the second scan data with the model.

219. Boerjes or Boerjes in view of Geng renders obvious these limitations for the reasons discussed in limitation 1[h] and claim 4. *See supra* Sections IX.A.1.h, IX.A.2.

X. Conclusion

220. For the reasons set forth above, in my opinion, a person of ordinary skill in the art as described in paragraph 29 would have considered the Challenged Claims of the ’936 patent to be obvious over the prior art discussed above.

221. In signing this declaration, I understand that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

222. 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 10, 2025 By: 

Lina J. Karam, Ph.D.