UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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EDWARDS LIFESCIENCES CORPORATION, EDWARDS LIFESCIENCES LLC,
AND EDWARDS LIFESCIENCES AG
Petitioners

v.

BOSTON SCIENTIFIC SCIMED, INC.
Patent Owner

_____

Case IPR2016-_____
Patent 8,992,608

_____

DECLARATION OF NIGEL P. BULLER, M.D.
SUBMITTED ON BEHALF OF PETITIONERS EDWARDS LIFESCIENCES CORPORATION, EDWARDS LIFESCIENCES LLC, AND EDWARDS LIFESCIENCES AG

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I, Dr. Nigel P. Buller, declare as follows:

I. INTRODUCTION

1. I am over the age of eighteen (18) and otherwise competent to make this Declaration.

A. Engagement

2. I have been retained on behalf of Edwards Lifesciences Corporation, Edwards Lifesciences LLC, and Edwards Lifesciences AG (collectively, "Edwards") to provide my opinion on the state of endovascular prosthetic technology and the scope and content of certain "prior art" patents and printed publications predating June 16, 2004, which is the priority date on which U.S. Patent No. 8,992,608 (the "'608 patent") relies. I also provide my opinion regarding the subject matter described and claimed in the '608 patent. In particular, I have reviewed and analyzed claims 1-4 of the '608 patent and concluded, for the reasons set forth below, that each of these claims are invalid as anticipated and obvious in view of the prior art.

3. I understand that this Declaration supports Edwards' Petition for the above-captioned *inter partes* review ("IPR") of the '608 patent.

4. I reserve the right to supplement, change, clarify, or modify my opinions should additional information and/or documentation become available to me. I also reserve the right to submit a rebuttal declaration in response to any expert declaration(s) submitted on behalf of the owner of the '608 patent, Boston Scientific Scimed, Inc.

B. Background and Qualifications

5. A copy of my curriculum vitae including a list of my publications is attached hereto as Exhibit A.

6. I am a retired Consultant Cardiologist. Until January of 2008, I was Head of Interventional Cardiology at the Queen Elizabeth Hospital, Birmingham and the Lead Clinician for the Cardiac Catheterization Laboratories. The Cardiology Department at the Queen Elizabeth is one of the leading cardiology departments in the UK and one of only five centers in the UK that provides fully comprehensive adult cardiological services including interventional cardiology, electrophysiology, grown-up congenital heart disease and heart transplantation. I have conducted or directly supervised more than 8000 diagnostic and therapeutic non-surgical catheterization procedures since I was first appointed to a National Health Service consultant post in 1990.

7. During my medical training, I was awarded The John Mellanby Scholarship to fund an Intercalated Bachelor of Science degree. In 1977, I received a BSc (First Class Honours) in Physiology from the University of London. Modules included muscle physiology and biophysics at University College London (UCL), for which my tutor was the late Professor Andrew Huxley FRS, and neurophysiology at the Sherrington School of Physiology, for which my tutor was Professor John Stephens.

8. Following my degree, I was awarded an MRC Training Fellowship to continue my research at UCL and submit a PhD thesis. However, I declined the offer and continued my clinical medical training. Nevertheless, during the three years of undergraduate clinical training I continued my research work in my spare time and, before qualifying in medicine, I had published some of the results of my research in both Nature and The Journal of Physiology. In 1980, I was awarded MB BS by St. Thomas's Hospital Medical School, University of London. In 1983, I became a member and, in 1996, I was elected a Fellow of the Royal College of Physicians in London.

9. I have held a number of positions within highly regarded cardiology departments in the UK.

10. From 1995 to 2010, I was Honoree Senior Lecturer in cardiovascular medicine at the University of Birmingham (UK).

11. From 1995 to 2008, I was employed full time at Queen Elizabeth Hospital, Birmingham.

12. From 1991 to 1995, I was Senior Lecturer in the Department of Interventional Cardiology and Cardiac Medicine at the National Heart and Lung Institute in London, and Honorary Consultant Cardiologist at the Royal Brompton National Heart and Lung Hospital.

13. Before that, I was a Senior Registrar in Cardiology at Harefield Hospital, Middlesex, and the Royal Free Hospital, London and prior to that a Registrar at the National Heart Hospital, London.

14. From 1984 to 1986, I worked for Smith Kline & French Research Ltd, Philadelphia, USA, as a Research Physician and then as a project Chairman in Cardiovascular Drug Development.

15. My first formal postgraduate training in cardiology was at St. Thomas's Hospital and The Middlesex Hospital in 1981 and 1982, respectively.

16. During my years as a junior doctor I trained in all aspects of cardiology but my interest developed in cardiac catheterization and non-surgical interventional cardiology. My mentor was the late Dr. Anthony Rickards who had performed the first successful coronary artery angioplasty in the UK in 1980. By 1990, I was considered fully trained in catheterization techniques and interventional cardiology including angioplasty and valvuloplasty.

17. In 1990, I was appointed to and, in March 1991, I took up the position of Senior Lecturer in Interventional Cardiology at the National Heart and Lung Institute in London and was the third consultant interventional cardiologist to join Dr. Anthony Rickards and Dr. Ulrich Sigwart at the Royal Brompton National Heart and Lung Hospital, London.

18. I have routinely assessed and investigated patients suffering from valvular heart disease. Such investigations typically include electrocardiogram (ECG),

chest X-ray (CXR) and echocardiography (a sonar examination to obtain detailed anatomical images and functional assessment of the heart and heart valves). These three tests are non-invasive and typically provide confirmation of the clinical diagnosis and allow selection of those patients that require further invasive investigation by means of diagnostic catheterization of the heart (passing flexible tubes through the veins and/or arteries and into the chambers of the heart) for hemodynamic (pressure and flow) measurements and angiography (injection of a radiopaque contrast media into the chambers and blood vessels of the heart so as further to document detailed anatomical and functional information on X-ray imaging). With this information it is then usually possible to determine the cause, the severity and the options for treatment of a patients' heart valve disease.

19. My research interests have included the prevention, diagnosis and treatment of heart disease and the development and clinical application of stents and especially coronary artery stents. I have been an investigator for many national and international scientific clinical trials.

20. My earliest "hands on" clinical involvement with stent implantation was in 1987 when working with the late Dr. Anthony Rickards when I assisted him with the first insertions of stents into human coronary arteries in the UK. Stents were difficult to obtain at the time and initially were only for use in situations of acute or threatened closure after balloon angioplasty. This early work was experimental in nature. I have since conducted large numbers of stenting implantation procedures with

stents made by many different manufacturers. During 1991 to 1993, I was an investigator for the Benestent Trial (the major international multicenter "proof of concept" trial designed to demonstrate the benefit of elective stent placement over simple balloon angioplasty in the treatment of coronary artery disease), the results of which were subsequently published in the New England Journal of Medicine in 1994.

21. In 1993, Ulrich Sigwart and I were the co-investigators for the "First-in-Man" study of Guidant Corporation's "Multilink Stent" that subsequently became the long standing market leader for bare metal stents.

22. In 1994, I implanted the first drug coated stent in a patient in the UK. In the same year I was approved by the U.S. Food and Drug Administration (FDA) to act as a proctor to supervise and oversee the first elective implantations of coronary artery stents in the U.S. (an FDA requirement) following the FDA approval of the Johnson & Johnson Palmaz-Schatz coronary artery stent. In this latter role I worked at more than fifty of the leading U.S. cardiology departments.

23. I have also been involved in research and development work directed at stent graft technology. For example, in the late 1980s, I worked with Medinvent in Switzerland on the concept of a covered Wallstent. In the early 1990s, my work with Johnson and Johnson also included input into the Palmaz Stent Graft technology. Between 1992 and 1998, I was a paid member of the SCIMED Advisory Board that discussed and debated concepts and development ideas directly with

SCIMED engineers. During my tenure on the Advisory Board, SCIMED was acquired by Boston Scientific.

24. Between 1987 and 1993 I only implanted bare metal stents. By 1994, I had implanted one of the first fully polymer coated stents (Palmaz Hepacoat). Several years later, I implanted a very early coronary artery stent graft named JoStent. In the late 1990s and early 2000s, together with surgical colleagues and interventional radiologists, I implanted stent grafts, primarily in the aorta but also in iliac arteries. In the aorta, my main interest was the thoracic aorta and the treatment of aneurysms and dissections in this blood vessel.

25. In 2013, I received hands-on training on the use and implantation of transcatheter heart valve ("THV") technology at the New York Presbyterian Hospital.

26. Throughout my career I have had a close working relationship with the research and development departments in the medical device and pharmaceutical industries. I have served on the advisory boards for many of the major medical device manufacturers, including SCIMED, Boston Scientific, Medtronic, Cordis and Guidant/Abbott.

II. LEGAL STANDARDS

A. Anticipation

27. I am informed that a patent claim is anticipated if a single prior art reference discloses every element of the claim.

B. Obviousness

28. I am informed that an obviousness analysis involves a number of considerations. I am informed that the scope and content of the prior art must be determined, as well as the level of ordinary skill in the art. I am further informed that a patent claim was obvious at the time of the invention if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a person having ordinary skill in the art. I am further informed that the focus when making a determination of obviousness should be on what a hypothetical person of ordinary skill in the pertinent art would have known at the time of the invention, and on what such a person would have reasonably expected to have been able to do in view of that knowledge. I am further informed that the following rationales may be considered when determining whether a claimed invention is obvious:

(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 known techniques to improve similar devices (methods, or products) in the same way;

(d) Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;

(e) "Obvious to try" – choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;

(f) Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art; and

(g) 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.

29. I am informed that when determining whether there is an apparent reason to combine known elements in the way a patent claims, it will often be necessary to look to interrelated teachings of multiple patents, to the effects of demands known to the design community or present in the marketplace, and to the background knowledge possessed by a person having ordinary skill in the art.

30. I am informed that when considering obviousness of a combination of known elements, the operative question is whether the improvement is more than the predictable use of prior art elements according to their established functions.

31. The "teaching, suggestion, or motivation" test is a useful guide in establishing a rationale for combining elements of the prior art. This test poses the question as to whether there is an explicit teaching, suggestion, or motivation in the prior art to combine prior art elements in a way that realizes the claimed invention.

Though useful to the obviousness inquiry, I understand that this test should not be treated as a rigid rule. It is not necessary to seek out precise teachings; it is permissible to consider the inferences and creative steps that a person of ordinary skill in the art would employ.

32. I am also informed that obviousness may be determined by looking at historical, objective evidence. Therefore, I am informed that certain historical evidence, such as commercial success of the patented invention, a long felt but unsolved need for the patented invention, failure of others to make the patented invention, skepticism about the claimed invention by experts, praise of the invention by others, and/or copying by others, may show that an invention was not obvious at the time the invention was made. I am informed that these categories of objective indicia are referred to as "secondary considerations."

33. I am also informed that an obviousness determination must be based on what was known at the time of the invention, that it is impermissible to use hindsight, and that it is improper to focus on just a part or element of the invention, as opposed to the invention as a whole.

III. ORDINARY SKILL IN THE ART

34. I am informed that the priority date for the '608 patent is June 16, 2004. The '608 patent, which was filed on June 26, 2009, is a divisional of U.S. patent application 12/269,213, filed on November 12, 2008, which is a continuation of U.S. patent application 10/870,340, filed on June 16, 2004.

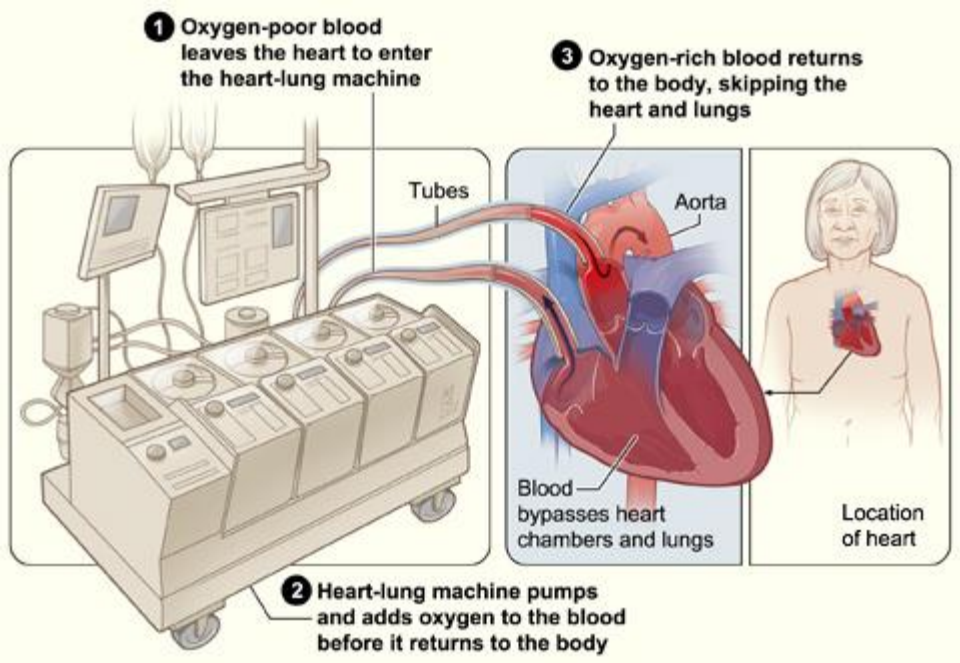
35. I am informed that the person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention. This is a person of ordinary creativity, not an automaton.

36. It is my opinion that a person of ordinary skill in the art as of the priority date of the '608 patent would have been an interventional cardiologist with a working knowledge of heart valve designs and endovascular prostheses, including expandable stents and stent-grafts. This person of ordinary skill in the art would, where necessary, work as a team in combination with a medical device engineer to experiment with or manufacture a device as claimed in the '608 patent.

IV. BACKGROUND OF THE RELEVANT TECHNOLOGY

A. Surgical Prosthetic Heart Valves

37. Petitioner Edwards was founded by Miles "Lowell" Edwards in 1958. Edwards' earliest work related to prosthetic heart valves that could be implanted surgically. Implantation of these devices involved an invasive procedure that required use of a heart-lung machine. In order to surgically implant a prosthetic heart valve, a surgeon opens a patient's chest and the patient is connected to a heart-lung bypass machine, after which the heart can be arrested. The surgeon then surgically removes the diseased native valve and sutures the prosthetic valve in place. A diagram detailing the operation of a heart-lung machine is pictured below:

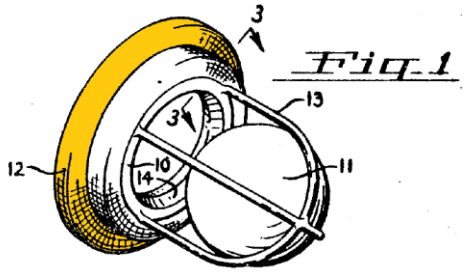


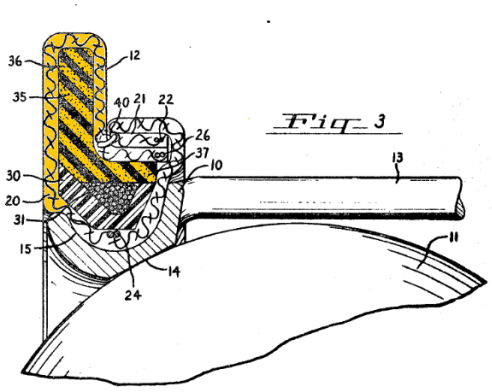
Available at http://www.daviddarling.info/encyclopedia/H/heart_surgery.html. This same procedure is used today for patients receiving a surgically implantable prosthetic heart valve.

38. One of Edwards' first commercially available surgical valves was a ball and cage valve called the Starr-Edwards valve. U.S. Patent No. 3,365,728 (the "'728 patent"), which issued on January 30, 1968, details the features of this valve. *See* Ex. 1011, '728 patent. Notably, even this early valve prosthesis included a circumferentially oriented sewing ring that was adapted to extend into spaces in the tissue surrounding the implanted prosthesis to prevent leakage between the prosthetic valve and the surrounding tissue (*i.e.*, "paravalvular leak"):

> Connected to the periphery of the valve ring is a suturable sewing ring [12] by which the valve may be connected by sutures with living tissue around

the natural orifice in which the valve is implanted. The sewing ring is upholstered with a ring of compressible cushion material which will conform to irregularities in the bed in which the valve is placed whereby a good seal is established and leakage between the valve and the tissue is prevented.

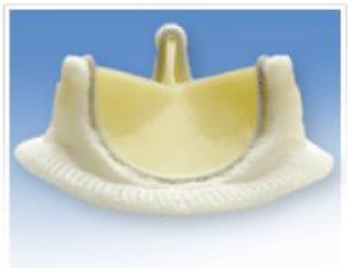




Id. at 1:38-46 and 3:12-20 ("The rubber cushion ring 35 conforms to any irregularities of tissue contour which may exist because of disease or other causes and forms an effective seal against the tissue. The layer of cloth 20 overlying the flange 36 provides an effective medium for the ingrowth of tissue over the whole surface of the sewing ring . . . ."), Figs. 1, 3 (highlighting added). Thus, paravalvular leak was a well-recognized complication of surgical valve replacement as early as the 1960s.

39. In addition to ball and cage valves, Edwards also developed surgically implantable valves with biological valve leaflets. The biological valve structure could be made with a whole excised valve or formed with pericardial tissue, primarily of bovine or porcine origin. Edwards' Perimount valve, for example, was

first introduced in 1980 and included a tri-leaflet bovine pericardial valve and a frame having a fabric sewing ring akin to the Starr-Edwards valve:



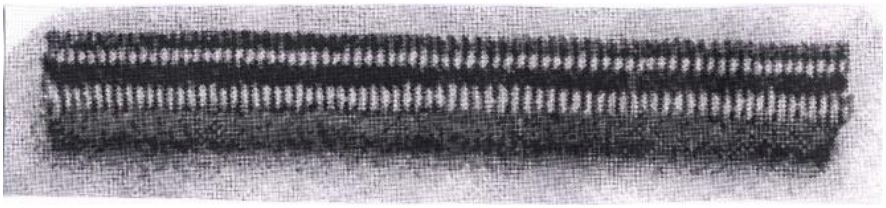
Carpentier-Edwards PERIMOUNT aortic valve

Available at http://www.yourheartvalve.com/productinformation/pages/aorticvalvepericardial.aspx.

B. Evolution of Stent Technology

40. The term "stent" was originally used in the nineteenth century in reference to a medical resin used in dentistry (named after the dentist, Dr. Charles Stent). In the 20th century its meaning broadened to include devices used as scaffolding during conventional surgery.

41. The concept of vascular stenting is attributed to Charles Dotter. In 1969, he published his work concerning the implantation of stainless steel coils into the peripheral arteries of dogs.

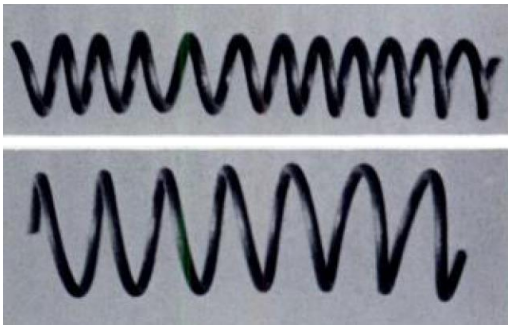


Dotter 1969 Stent

See Ex. 1012, Charles T. Dotter, "Transluminally-Placed Coilspring Endarterial Tube Grafts," *Investigative Radiology*, pp. 329-332 (1969).

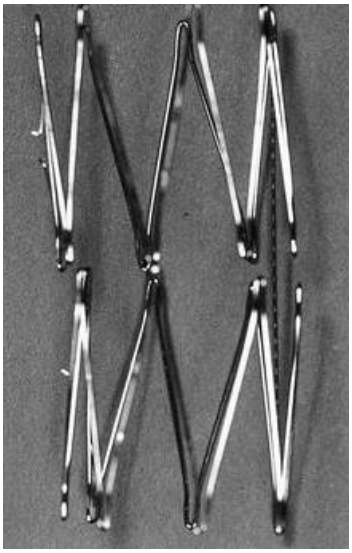
42. In the same publication, Dotter also described a design for a self-expanding stent using spring force to provide expansion along the entire length of the stent thereby allowing the size of the remote arterial access to be significantly smaller than the diameter of the treated segment of artery. Subsequently many designs of self-expanding stents were developed. Notable among these were the Dotter thermal stent, the Z stent, and the Wallstent.

43. The Charles Dotter thermal stent, disclosed in a 1983 article but never commercialized, is a thermal-memory metal self-expanding stent made of Nitinol alloy.



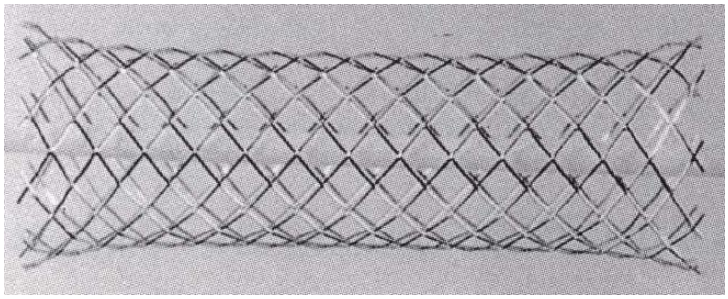
Dotter Thermal Stent

44. The Cesare Gianturco "Z" stent, which was first used in patients in the mid-1980s, is a self-expanding spring zig-zag structure.



Double 'Z' Stent with Connecting Wire

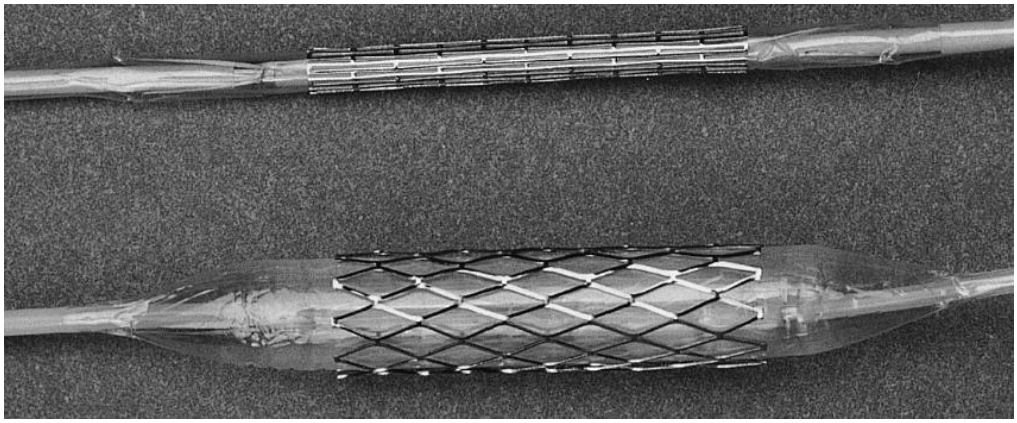
45. The Hans Wallsten stent was commercialized in 1988 by the Swiss company Medinvent. The device, known as the "Wallstent," was the first self-expanding stent to be implanted by a non-surgical catheterization technique in a human coronary artery. That first implant was performed by Jacques Puel working in Toulouse in March 1986. It was this stent that was implanted in patients in London the following year by Dr. Rickards and myself. Like the anchor structure disclosed in the '608 patent (see Ex. 1001 at 5:45-50, Figs. 32-33), the Wallstent is made with a collapsible and expandable braided-wire structure:



Wallstent

Self-expanding stents are implanted such that their deployed diameter is less than their fully expanded, unconstrained diameter. This enables the stent to exert a radial force onto the vessel wall to ensure adequate anchoring.

46. In the field of non-surgical stents for use by interventional cardiologists in the treatment of coronary artery disease, the seminal invention was by Julio Palmaz, that of the plastically deformable, "balloon expandable stent." Developed in the early 1980s, and commercialized in the late 1980s, the commercial Palmaz stent was a continuous stainless steel tube, which had a rectangular slot configuration when manufactured and a diamond cell structure upon expansion. Plastically deformable stents are known to recoil in diameter upon balloon deflation, and are thus expanded to a diameter that allows the stent to remain anchored in place even after recoil.



Palmaz Stent

C. Stent Foreshortening

47. Foreshortening is a known property for both self-expanding and balloon-expandable stents. Foreshortening means that the length of the stent decreases

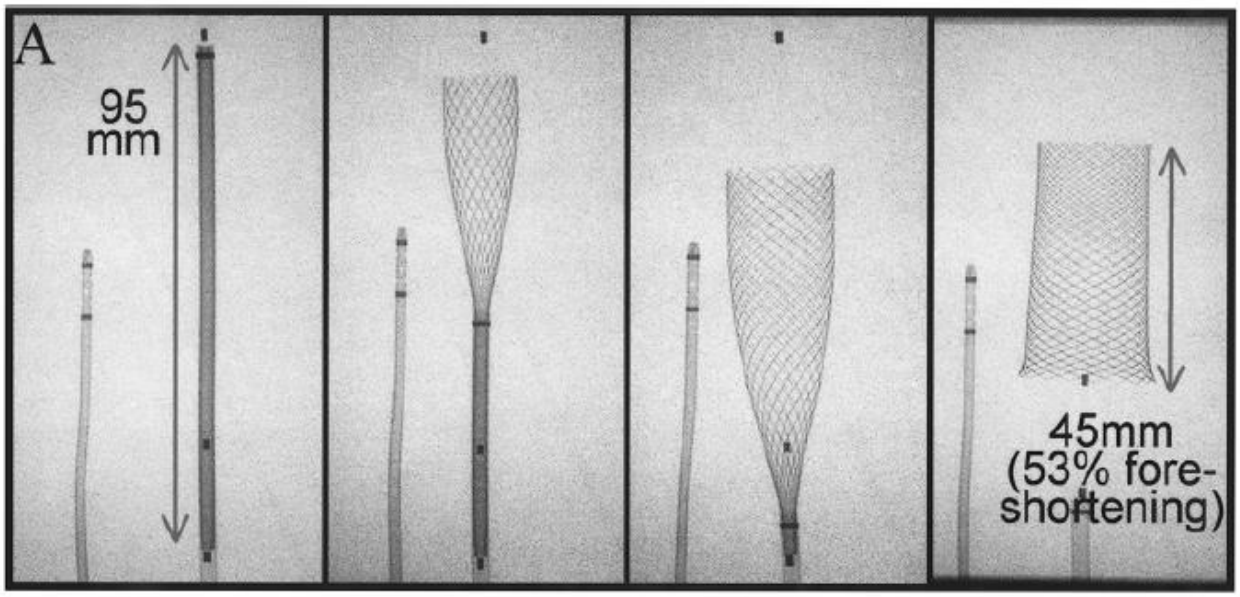
when expanding the stent from its collapsed, delivery configuration to its expanded, implanted configuration. The degree of foreshortening is dependent on the stent design.

48. Foreshortening is a measure of the percentage decrease in the length of the stent from its collapsed, delivery configuration to its expanded, implanted configuration. Thus, foreshortening is calculated as follows:

Foreshortening % = (change in length / length of collapsed stent) x 100

49. Before June 16, 2004, it was well known that stents could be designed to foreshorten, not foreshorten at all, or lengthen upon radial expansion.

50. For example, a design of a commercial Wallstent has been shown to foreshorten by 53%:



Ex. 1013, Frank Ing, "Stents: What's Available to the Pediatric Interventional Cardiologist?" Catheterization and Cardiovascular Interventions 57:274-386 (2002).

51. THVs, discussed *infra*, have also used stent designs that foreshorten. *See, e.g.*, WO 98/29057 to Cribier et al. ("Cribier", Ex. 1003) at 16:11-16 (disclosing a stent with an expanded length of 10mm and a collapsed length of 20 mm (i.e., 50% foreshortening)).

D. Stent Grafts and Use of Fabric Covering to Prevent Endoleaks

52. In the 1980s, it was generally recognized that stents could be used to carry, implant, and anchor other materials. For example, stents were developed with a covering (now called stent grafts). By virtue of the covering, stent grafts can be used to isolate the wall of a blood vessel from the lumen of that vessel, as for instance to reinforce a weakened blood vessel, to prevent leakage between the stent and vessel, or to prevent exposure of a metallic stent to the surrounding tissue.

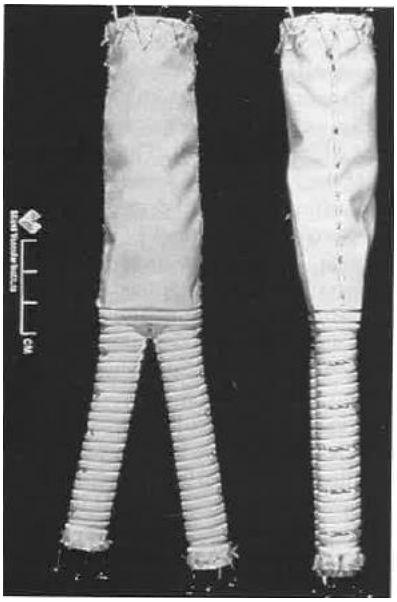
53. Soon after the pioneering stent work of Charles Dotter, Anatoly Kononov, a Russian vascular surgeon, contemplated treating aortic aneurysm and atherosclerotic stenosis using intravascular techniques. In 1973, Kononov performed a series of canine studies in which he implanted stent grafts in the aorta. These stent grafts had a pleated covering, as pictured below:

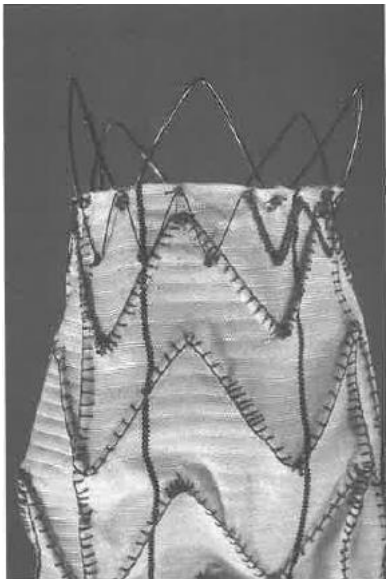
See Ex. 1015, excerpts from Vossoughi *et al.*, *Stent Graft Update* (2000).

54. In 1985, a Ukranian surgeon named Nicholas Volodos from the same institution as Kononov, modified the stent graft to include a self-expanding stent structure covered with a Dacron fabric. Volodos became the first to place an endovascular graft transluminally to treat a patient with iliac artery occlusive disease. *Id.*

55. In 1990, Huan Parodi and Julio Palmaz implanted a plastically deformable stent graft to treat an abdominal aortic aneurysm. *Id.* Following this work, stent graft technology began to attract widespread interest in the field. *Id.*

56. Two commercial embodiments of stent grafts that were available in the 1990s are pictured below:





Ex. 1016, excerpts from Dolmatch *et al.*, *Stent Grafts: Current Clinical Practice* (1999) (EVT Endograft pictured on left; Talent Endoprosthesis pictured on right). As

shown in each of these examples, the fabric covers have excess material with wrinkles in the graft's expanded state.

57. Also shown on the lower end of the EVT Endograft pictured above (left) is the well-known use of pre-formed circumferentially oriented pleats in the graft material. This pre-formed, corrugated structure permits the endograft to extend and increase its length in the longitudinal direction, akin to an accordion. As discussed *infra*, Section VII, these well-known circumferentially oriented pleats in the graft material were recognized by the Patent Office as "flaps" and "pockets" as claimed by the '608 patent, which the patent applicants did not dispute. I agree with the Patent Office's assessment.

58. Specifically, during examination of the '608 patent the examiner concluded that "[a]n implantable fabric having pleats and pockets is well known in the art, as taught by De Paulis in Figure 2" and that it would have been obvious to modify a sealing structure "to include pleats as an obvious alternative design choice." Ex. 1002 ('608 patent File History), 4/10/14 Non-Final Rejection at 2-3. Figure 2 of U.S. Patent No. 6,352,554 to De Paulis ("De Paulis," Ex. 1021) appears below:

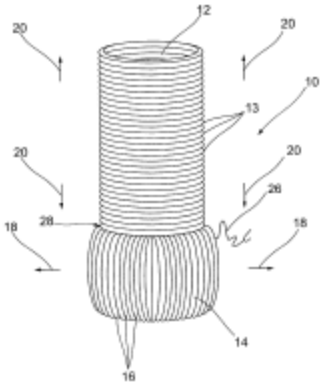
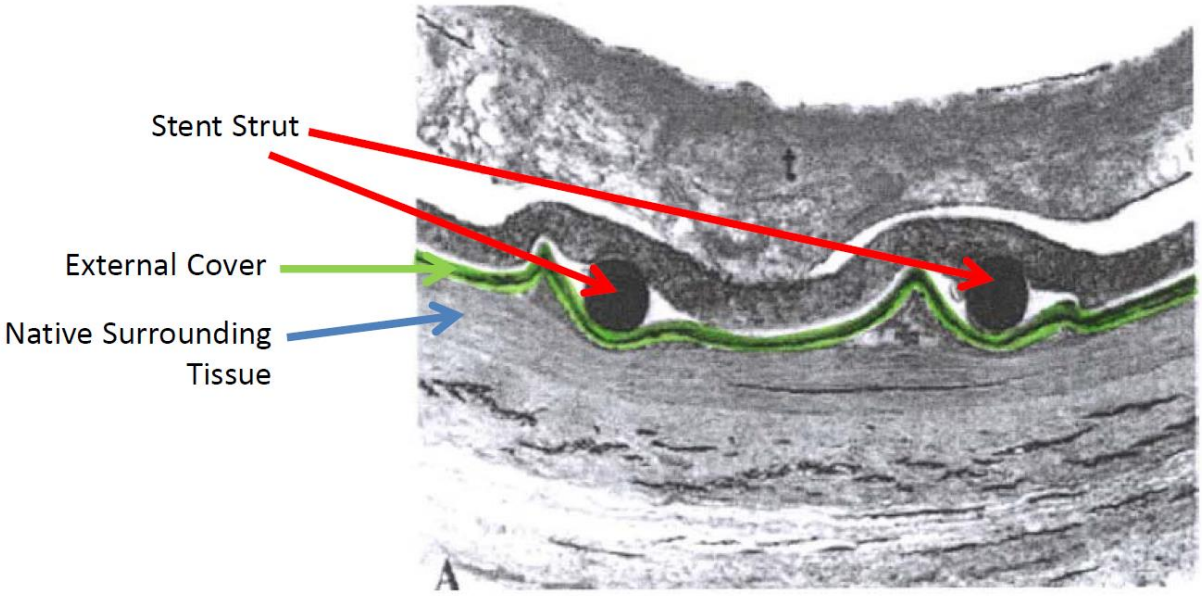


Fig. 2

Ex. 1021, Fig. 2. The aortic grafts detailed by De Paulis are preferably made with Dacron, and include "circumferentially extending pleats" or "corrugations" that surround the conduit and "provide a degree of expansion in the longitudinal direction," thereby allowing the graft to "significantly increase its length." *See* Ex. 1021 at 4:52-5:8; Figs. 1-2. The grafts may also include "longitudinally extending pleats or corrugations," which allow the conduit to "expand in a lateral direction." *Id.* at 5:1-33. Moreover, "[t]he conduit … may be further provided with a prosthetic valve." *Id.* at 3:51-52.

59. Similar to the risk of paravalvular leaks identified by surgical heart valve designers, stent designers and physicians also recognized the risk of blood leaking between the stent graft prosthesis and the surrounding tissue (i.e., "endoleaks") when a stent graft is used to treat an aneurysm. Aiding in the prevention of such endoleaks is the selection of fabric that can conform to the surrounding tissue, as pictured below:



Ex. 1015, excerpts from Vossoughi *et al.*, *Stent Graft Update* (2000) (highlighting and annotations added). The uneven surface in the surrounding tissue pictured above extends in the longitudinal direction, but non-uniformities in the anatomy can occur in any direction.

60. The graft material's ability to conform to the surrounding tissue is furthered because the target location typically is irregular and smaller in diameter than the stent graft's maximum diameter. Stent grafts are designed to be deployed in a range of vessel sizes, meaning that, unless the covering is completely elastic, a stent graft made, for example, with Dacron fabric will have excess graft material that surrounds the stent at least when the stent graft is expanded short of its maximum diameter. Put another way, the diameter of the graft material will be larger than the diameter of the stent that is expanded short of its maximum diameter as well as the

diameter of the target orifice. In addition, as explained above, plastically deformable stents recoil upon balloon deflation and self-expanding stents are deployed with a diameter less than their fully expanded, unconstrained diameter, further highlighting that excess graft material will surround the stent *in situ*.

61. Excess graft material will typically form longitudinally oriented pleats. The formation of longitudinally oriented pleats was well known even in the early years of stent graft development. As described by Lawrence *et al.*, longitudinally oriented pleats were formed in a series of animal experiments performed in 1986 using a stent graft made with a Gianturco stents and Dacron fabric:

> The Dacron grafts, most of which were larger in diameter than the native lumen, were longitudinally "pleated" inside the vessel lumen. This created spaces between the Dacron graft and the native vessel wall that were filled with proliferative tissue response similar to that seen inside the lumen of the graft. With pleating of the Dacron graft, neo-intimal growth response resulted in production of a smooth lumen, with the covering thicker in the crevices.

Lawrence *et al.*, "Percutaneous Endovascular Graft: Experimental Evaluation," Radiology, 162(2): 357-60, 358 (May 1987) (Ex. 1029).

62. Prior to the June 2004 priority date of the '608 patent, multiple graft designs were contemplated to further enhance the external seal to prevent blood from flowing between the seal and surrounding tissue.

63. For example, U.S. Patent No. 6,015,431 to Thornton ("Thornton," Ex. 1019) discloses a "tubular member-seal member combination . . . [that] has utility in the prevention of leakage flow around the outer surfaces of implantable endolumenal medical devices." Ex. 1019 at 7:5-9.[1] "The seal member is secured to the outer surface and is adapted to occlude leakage flow externally around the tubular wall between the outer surface and the endolumenal wall when the tubular member is deployed within the endolumenal body space. In one mode of this variation, the seal member is an occlusive cuff that forms a flange as a one-way valve over the conduit tubing member's outer surface." *Id.* at 4:6-13. Thus, the seal member will conform to the irregular surface of the surrounding tissue. The device can include one or more sealing members and these sealing members can be formed with Dacron fabric, among other materials. *Id.* at 7:20-30, 8:31-54, 8:65-67. An exemplary embodiment of sealing members 20 and 30 is shown in Figure 1:

[1] Although Thornton is discussed herein as an exemplary stent graft device, Thornton's broad teachings of a "tubular member-seal member combination" for "the outer surfaces of implantable endolumenal medical devices" apply to a range of devices, including THVs.

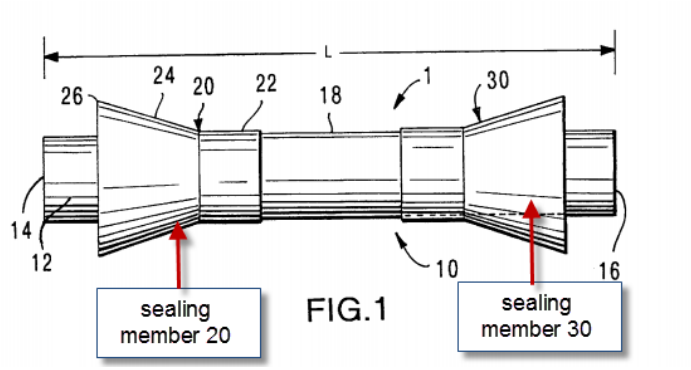
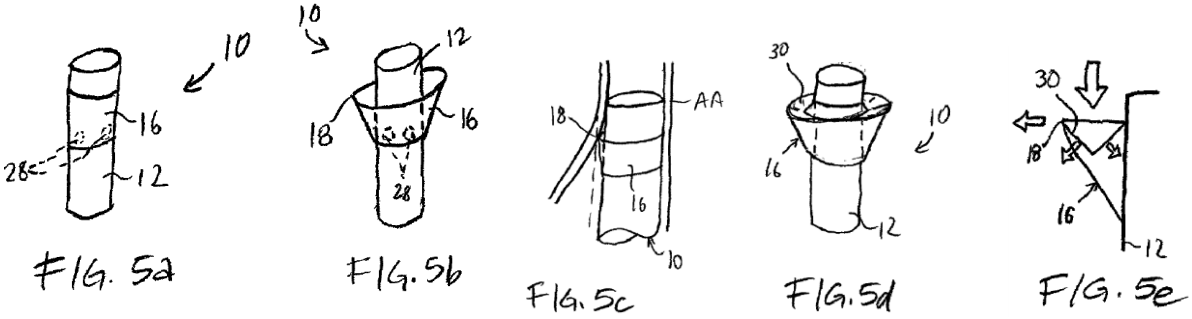


FIG.1

Id. at Fig. 1. The flared construction of the sealing members can be imparted by the flow of blood in a particular direction. *Id.* at 7:31-42 ("[F]lange (26) is shown in a flared condition, which condition may be its relaxed geometry or may be a geometry imparted thereto by flow in the occluded direction."). Thornton further discloses that multiple sealing members may be used, for example in series to provide a sufficient seal. *Id.* at 8:65-9:3. Finally, consistent with the teachings of Lawrence, discussed *supra* ¶ 61, Thornton also recognizes the formation of longitudinally oriented "wrinkles" when the prosthesis is expanded short of its maximum diameter. Ex. 1019 at 10:13-30, Fig. 3.

64. The Thornton prosthesis was commercialized by W.L. Gore & Associates, Inc. and sold as the Gore Excluder stent graft. *See* Ex. 1025, Charles S. Thompson et al., "Endoluminal stent grafting of the thoracic aorta: Initial experience with the Gore Excluder," Journal of Vascular Surgery, 1163-70 (June 2002); Ex. 1026, Gore Excluder Instructions for Use (2002). These devices were successfully implanted in patients with a low rate of reported endoleaks. *See* Ex. 1025 at p. 1163. I was personally familiar with the Excluder device by the late 1990s.

65. U.S. Patent Application Publication No. 2003/0236567 to Elliot ("Elliot," Ex. 1005) similarly discloses a tubular prosthesis having a stent and one or more fabric "skirts" to seal against endoleaks:



Ex. 1005 at Figs. 5a-5e.[2] The "skirt 16 terminates in a peripheral edge 18 that is spaced from a juncture between the skirt 16 and the tubular body 12. . . . [P]ortion(s) of the peripheral edge 18 can be displaced to contact, and form a seal with a surrounding wall. Irregularities and/or wall displacement . . . can be responded to by the skirt 16 in minimizing endoleaks about the prosthesis 10." *Id.* at ¶¶ [0024], [0036] – [0038]. Like Thorton, Elliot also discloses the use of multiple sealing members and

[2] The tubular prosthesis of Elliot "include[s], but [is] not limited to, endovascular grafts and stent-grafts," and broadly encompasses "tubular conduits for maintaining patency in other bodily passageways." Ex. 1005 at ¶ [0001]. Thus, although Elliot is discussed herein as an exemplary stent graft device, Elliot's broad teachings of a "tubular prosthesis" for "tubular conduits" in "bodily passageways" apply to a range of devices, including THVs.

that the flared construction of the sealing members can be imparted by the flow of blood in a particular direction. *Id.* at ¶¶ [0026], [0038], [0040].

66. U.S. Patent Application Publication No. 2004/0082989 to Cook *et al.* ("Cook," Ex. 1006) also recognized the potential for endoleaks. Ex. 1006 at ¶ [0004]. To address this problem, Cook discloses a stent graft having a "cuff portion [15] compris[ing] an external sealing zone that extends around the main body portion to help prevent leakage":

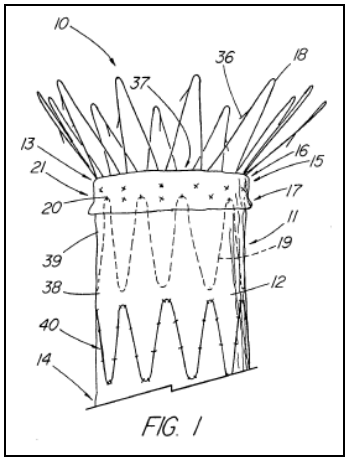


FIG. 1

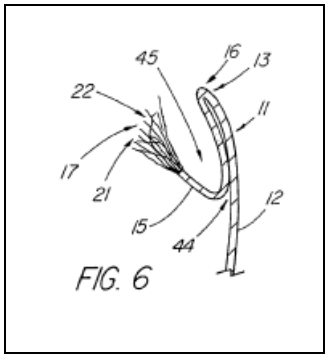


FIG. 6

Ex. 1006 at Abstract, Figs. 1, 6.[3] Cook explains that the cuff portion can by formed with at least one "free edge 17" that is "unattached to the main body 12 so that it is allowed to extend or flair outward to comprise a lip that serves as an external sealing

[3] Although Cook is characterized herein as an exemplary stent graft device, Cook's disclosure is not limited to stent grafts and instead applies to a range of devices, including THVs. See Ex. 1006 at ¶ [0006] ("an illustrative intraluminal prosthesis, such as a stent graft").

zone 21." *Id.* at ¶ [0026]. This cuff portion can be formed by either "folding [ ] excess material over upon itself," or it can be formed with a separate piece of graft material "such that the proximal edges of the main body and cuff portions 13, 16 each comprise 'cut' or free edges rather than a single folded edge." *Id.* Cook also discloses that the cuff portion could be folded over "to produce a fold 44 that creates gutter-like pocket 45 that is able to collect any blood passing around the leading edge 16 of the graft 11 to prevent an endoleak and promote thrombus formation." *Id.* at [0036].

67. As with bare stents, foreshortening was a known property of stent grafts. *See* U.S. Patent No. 6,206,911 to Milo ("Milo", Ex. 1014) at 1:7-11, 1:33-38; U.S. Patent Application Publication No. 2004/0033364 to Spiridigliozzi *et al.* ("Spiridigliozzi", Ex. 1010) at ¶¶ [0014], [0089]. It was also known that a degree of stent graft foreshortening can form wrinkles in the graft material, and, separately, that pleats can be created in the graft material to compensate for axial elongation and longitudinal foreshortening of the stent graft. For example, Milo recognizes that when stents have external coverings, "wrinkling" of the cover may occur upon a certain degree of foreshortening. *See* Ex. 1014 at 1:33-38.[4] Spiridigliozzi further recognizes

[4] Milo suggests that wrinkling of the graft structure may be undesirable when the cover is made with biological material. *See, e.g.*, Ex. 1014 at 1:33-38, 2:43-48. A reason why Milo highlighted the wrinkling of biological material as undesirable is because, as of Milo's December 1996 priority date, there remained a concern that

that a number of circumferentially oriented pleats can be incorporated into the expanded graft structure,[5] whereby the pleats can unfold to compensate for axial elongation during delivery and generally return to pleated form due to longitudinal foreshortening of the stent when deployed:

> In accordance with the present invention, pleats are provided along the length of the implantable material and structure. The number and length of the pleated sections can vary to control the resultant axial elongation, plastic deformation, longitudinal foreshortening and radial shrinkage of

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folding or wrinkling of biological material could damage the integrity of that material. Another reason is the very small size of coronary arteries (i.e., less than 5 mm in diameter), which are a particular area of focus for treatment using the Milo device. *Id.* at 1:21-27. Given the small size of coronary arteries, it would be preferable to avoid any wrinkling that could add to the overall diameter of the device. In any event, Milo recognizes that regardless of the desired end properties, a cover secured to the outer surface of a stent may wrinkle upon a certain degree of foreshortening.

[5] Although Spiridigliozzi is characterized herein as an exemplary stent graft device, Spiridigliozzi's broad teachings of a device for "various applications, especially vascular applications" apply to a range of devices, including THVs. *See* Ex. 1010 at ¶ [0013].

the graft material due to the stresses applied to the graft material by the support structure during the contraction and expansion of the support structure.

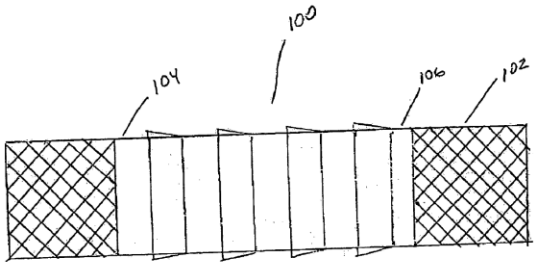


FIG. 10

Ex. 1010 at ¶¶ [0014], [0019] ("The layered sheets may be pleated after being formed into a tubular structure."), [0089], [0095] – [0098], and Figs. 9-10.

68. Depending on the desired properties of the stent graft, the foreshortening could be maintained or instead minimized through stent design. *See, e.g.*, Ex. 1014 at 1:16-55. For those stent grafts designed to foreshorten, a non-uniform surface may form along the length of the graft material upon foreshortening. The degree and dimension of these non-uniformities (if any) formed along the length of the graft are related to the degree of stent foreshortening, physical properties and dimensions of the graft material, and the attachment between the graft and stent. For example, as discussed *infra*, Section V, when a Dacron graft is secured at a series of locations along its length to a stent, extensive stent foreshortening (*e.g.*, 50% or more) will create circumferential "flaps" and "pockets" as claimed in the '608 patent.

69. Graft structures of the type taught by Thornton, Elliot, Cook, and De Paulis also detail the use of "flaps" and "pockets" regardless of whether the stent foreshortens. And, under Boston Scientific's broad interpretation of "flaps" and "pockets," discussed *infra* Section VIII., each of these references disclose extra "excess material so that the seal can at least partially be distanced from the outer surface of the [stent]" and thus further prevent blood from flowing between the seal and surrounding tissue. *See, e.g.*, Ex. 1031 (Boston Scientific's August 24, 2016 Response in Opposition Proceedings of EP 2 749 254 B1).

E. Transcatheter Heart Valve Technology

70. THV technology, the subject of the '608 patent, is aimed at providing a patient with a permanently implanted prosthetic heart valve that can be delivered via a catheter.

71. In 1989, Danish doctor Henning Rud Andersen conceived of the seminal invention of a permanently implanted transcatheter bioprosthetic heart valve. That year, Dr. Andersen and his colleagues, Drs. Michael Hasenkam and Lars Knudsen, built the first prototype by hand. The Danish team successfully implanted its prototype in pigs using a catheterization procedure.

72. The Danish team published their results in 1992. Ex. 1017, Andersen et al., "Transluminal implantation of artificial heart valves. Description of a new expandable aortic valve and initial results with implantation by catheter technique in closed chest pigs," European Heart Journal, 13:704-08 (1992). There, Drs.

Andersen, Hasenkam, and Knudsen described their hand-made THV, which included "a foldable biological cardiac valve inside a balloon expandable metallic stent." *Id.*

73. The Danish team's work also led to several patents, including U.S. Patent No. 5,411,552. ("Andersen," Ex. 1018). The Andersen patent describes multiple THV embodiments that expand upon the inventors' early prototypes, including embodiments having additional tubular graft material that can be used along the external and internal surface of the THV. Ex. 1018 at 2:56-60, 4:3-17, 7:17-29, Figs. 11-12 ("[T]he stent may be made with a relatively great height and with a cylinder surface which is closed by a suitable material. Thus, a vascular prosthesis known per se is formed wherein the valve is mounted."). It is noteworthy that even the seminal designs of THVs pulled from both the stent and stent graft arts.

74. As with the coverings in stent grafts, the covers proposed to be used with THVs were designed to conform to the surface of the surrounding tissue. These covers could be made with low-porosity woven fabric materials. An early THV detailed in U.S. Patent No. 5,957,949 to Leonhardt *et al.* ("Leonhardt," Ex. 1027), which issued on September 28, 1999, details graft material to be used as an external cover on a THV:

> Graft material 24 is a thin-walled biocompatible, flexible and expandable, low-porosity woven fabric, such as polyester or PTFE. It is capable of substantially conforming to the surface of the living tissue to which stent 26 coerces it.

Ex. 1027 at 5:53-59.

75. In France, Drs. Alain Cribier and Brice Letac conceived of several further THV designs in the mid-1990s. These designs provided the basis for a December 1996 patent application. A family of patents and patent applications stems from this 1996 application, including WO 98/29057 ("Cribier," Ex. 1003).

76. The Cribier publication aims to improve upon the THV technology described in the Andersen '552 Patent.

77. The Cribier publication notes that an "aim of the present invention is to provide an efficient prosthesis valve which can be implanted by a catheterization technique, in particular in a stenosed aortic orifice, taking advantage of the strong structure made of the distorted stenosed valve and the large opening area produced by preliminary balloon inflation, performed as an initial step of the procedure." Ex. 1003 at 5:11-16.

78. An exemplary embodiment of Cribier is pictured below:

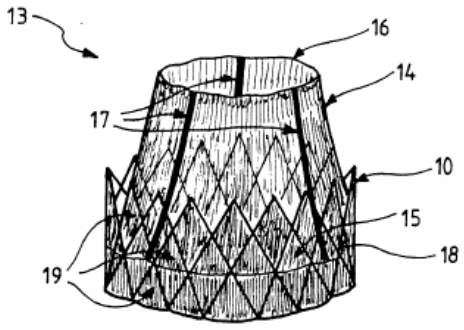
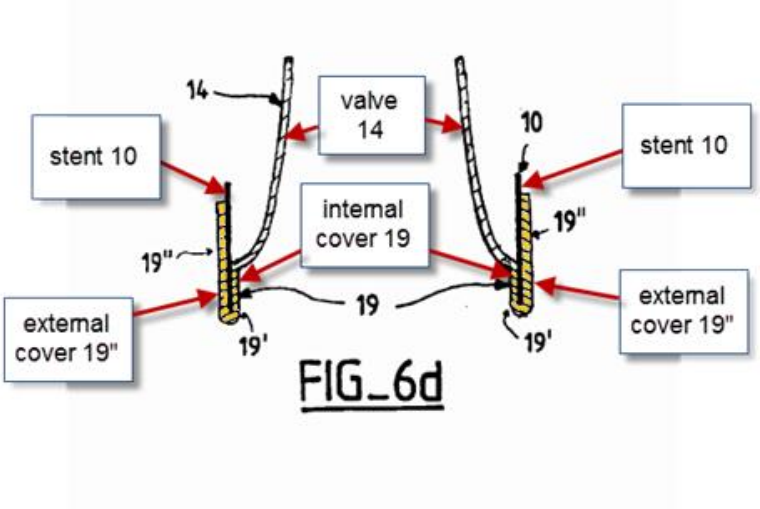


FIG_4b

Id. at Fig. 4b.

79. Further aims of the Cribier patent include providing a THV frame structure capable of withstanding the recoil forces of the native aortic valve in treating aortic stenosis and providing a THV with a frame covering that "prevent[s] any passage of the body fluid through said frame." *Id.* at 5:6-10, 8:28-9:6; *see also id.* at 5:17-18, 20:26-21:3, 22:11-20.

80. Cribier's Figure 6d embodiment illustrates an internal cover [19'] that extends from the base of the valve (*i.e.*, the distal end of the valve) to the lower end of the stent [10], which is then "rolled up to be applied to the external wall of the stent" to form an external cover [19"]:



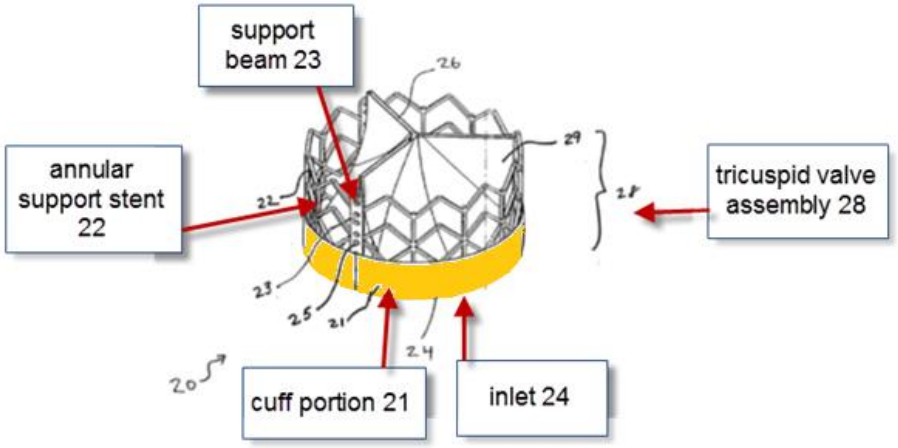
Id. at 22:23-26, Fig. 6d (annotations and highlighting added). The single-piece cover is a tubular structure that can be made with any of the materials disclosed for making the valve structure, which include fabric (*e.g.*, Dacron), biological material (*e.g.*, pericardium), or other synthetic materials (*e.g.*, polyethylene). *Id*. at 8:16-23, 22:11-20. Cribier broadly discloses multiple ways of securing the cover to the frame.

Specifically, the cover can be secured to the frame "at various points of attachment on various parts of the internal [and external] surface" by suturing, molding, gluing, or soldering the cover to the bars of the frame and, in its expanded state, would prevent blood from flowing between the cover and heart tissue. *Id.* at 22:23-26, 23:15-16, 24:24-27, Fig. 6d; *see also id.* at 23:12-24:23, Figs. 7, 8a-b.

81. The frame disclosed by Cribier can foreshorten across a range of percentages, including by 50%. *Id.* at 16:11-16 (disclosing a stent with an expanded length of 10 mm and a collapsed length of 20 mm).

82. The valve structures disclosed by Cribier broadly include "any type of valvular structure," including, for example, biological valves made with "pericardium, porcine leaflets and the like." *Id.* at 8:16-23, 24:7-13, and 26:13-16. A person of ordinary skill in the art would appreciate that "any type of valvular structure" made with biological material would include well-known biological valve structures such as bi- and tri-leaflet valves wherein commissures are formed between adjacent leaflets. In preferred embodiments, the valve structure of Cribier includes commissural supports secured to the surrounding frame in the form of "guiding means" that can extend "from the base to the upper extremity of the valvular structure." *Id.* at 6:1-8:15. The guiding means can be made, for example, with pleats or grooves formed within the tissue, or can be made with strengthening struts incorporated in the tissue. *Id.* at 8:5-11.

83. In 2001, a company named Percutaneous Valve Technologies ("PVT"), which was co-founded by Dr. Cribier and three others (Stan Rowe, Stan Rabinovich, and Dr. Martin Leon), filed a patent application on another THV design that included an external cover:



See WO 03/047468 to Spenser *et al.* ("Spenser," Ex. 1004) at Fig. 1 (annotations and highlighting added). Spenser discloses a THV having a tricuspid valve, a support stent including support beams for securing the commissures of the valve, and a cuff portion wrapped around the support stent at its inlet. *Id*. at p. 22 and Fig. 1. The support beams (25) for the valve commissures described by Spenser are designed such that their length remains constant, thereby providing a stable attachment region for the commissures of the valve while the remaining portions of the THV undergo a degree of foreshortening. *Id.* at pp. 34-35. Spenser further discloses that the cuff portion can be rolled up over the edge of the frame to provide a "sleeve-like" portion at the inlet. *Id*. at p. 21. This helps prevent leakage. *Id*. ("To prevent leakage from the inlet it is optionally possible to roll up some slack wall of the inlet over the edge of the frame so

as to present rolled-up sleeve-like portion at the inlet.”). The cuff portion can be formed with PET (Dacron) fabric. *See id.* at pp. 25, 33.

84. In April 2002, using a THV developed by PVT, Dr. Cribier performed the first-in-man implantation of a THV in the aortic valve position. This is the device referenced in the background of Boston Scientific’s European Patent 2 749 254 B1 (Ex. 1022, “EP ’254”). EP ’254 has a similar but, in some respects, more detailed specification than the ’608 patent. According to EP ’254, the PVT device suffered from two drawbacks: its deployment was not reversible and the stent was therefore not retrievable, and the device had a relatively large cross-sectional delivery profile. Ex. 1022 at ¶¶ [0006] – [0008].

85. In 2001, the transcatheter heart valve work of Dusan Pavcnik and his colleagues was described in U.S. Patent Application Publication 2001/0039450 (“Pavcnik,” Ex. 1009). Pavcnik disclosed an implantable valve that is deployed “within a bodily passage, such as a blood vessel or the heart.” Ex. 1009 at ¶ [0006]. “[T]he device 10 comprises an implantable valve having multiple leaflets 25 that act together to regulate and augment the flow of fluid through a duct or vessel 33, or within the heart to treat patients with damaged or diseased heart valves”:

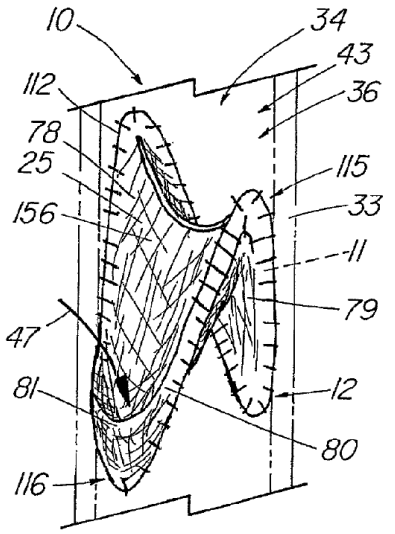


FIG. 27

Id. at ¶ [0067], Fig. 27. The stent can be either self-expanding or balloon expandable, and is covered in part by a biomaterial or a synthetic material such as Dacron. *Id.* at ¶¶ [0067]-[0068].

86. Pavcnik also discloses the formation of an enhanced sealing structure. The enhanced sealing structure of Pavcnik is in the form of "corner flap[s] 81 or pocket[s]" secured to the stent at the edges of each "flap" or "pocket" and positioned at discrete locations around the prosthesis. *Id.* at ¶ [0074]. "This corner flap 81 can serve to catch retrograde blood flow 47 to provide a better seal between the [prosthetic valve] device 10 and the vessel wall 70 as well as providing an improved substrate for ingrowth of native intimal tissue from the vessel 33 . . . ." *Id.* Boston Scientific's commonly owned European Patent 2 926 766 B1 ("EP '766") acknowledges the teachings of Pavcnik as prior art, and notes that "US 2001/0039450

describes a venous valve device having a generally serpentine shape and a corner flap." *See* Ex. 1030 at 3:44-46.

87. Depending on the desired end use, the device described by Pavcnik could be used as either a stent graft or a THV. *See id.* at ¶ [0012] ("The artificial valve traps retrograde blood flow and seals the lumen, while normal blood flow is permitted to travel through the device. In related embodiments, the device can be used to form a stent graft for repairing damaged or diseased vessels." (Emphasis added)). As such, Pavcnik, like De Paulis and Andersen, discloses the interchangeability of stent graft and prosthetic heart valve technology, and confirms that sealing structures with loose material used on stent grafts like those taught by Elliot, Thornton, Cook, and Spiridigliozzi, discussed *supra* Section IV.D., also are applicable to transcatheter heart valves like those taught by Cribier and Spenser, discussed *supra* Section IV.E.[6]

[6] Stent graft patent and publications typically are cited in THV patents, including in the '608 Patent, which further confirms the relatedness of certain aspects of stent graft technology and THV technology. For example, the '608 Patent cites U.S. Patent No. 5,476,506 to Lunn (Ex. 1034, "Lunn"), which describes a stent graft with circumferentially oriented and longitudinally oriented pleats. *See, e.g.*, Ex. 1034 at 1:47-2:46, 3:10-18, 4:7-15, 5:59-66, Figs. 1-3 and 6b.

V. SUMMARY OF THE '608 PATENT

88. The '608 patent issued from application no. 12/492,512 (the "'512 application"), which was filed on June 26, 2009, and claims priority to a series of earlier applications originating in application no. 10/870,340, which was filed on June 16, 2004.

89. The named inventors on the '608 patent are Ulrich Haug, Hans Valencia, Robert Geshlider, Tom Saul, Amr Salahieh, Dwight Morejohn, and Kenneth Michlitsch.[7] The '608 patent was originally assigned to Sadra Medical, Inc., but I am informed that the patent was subsequently assigned to Boston Scientific Scimed, Inc.

90. Citing the work of Drs. Andersen, Hasenkam, and Knudsen, the '608 patent acknowledges that "advancements in minimally invasive surgery and interventional cardiology have encouraged some investigators to pursue percutaneous replacement of the aortic heart valve." Ex. 1001, '608 patent at 1:53-56.

91. Focusing on a modified self-expanding THV technology, the inventors of the '608 patent contend that "[s]tandard self-expanding systems have very poor accuracy in deployment" and a "lack of radial strength." *Id.* at 1:63-64, 2:10-11.

92. To address these problems, the '608 patent generally discloses a retrievable THV "for endovascularly replacing a patient's heart valve" that includes a

[7] Boston Scientific's commonly owned EP '254 claims a similar invention but discloses five additional inventors.

collapsible and expandable anchor, commissural supports attached to the anchor, a replacement valve with commissures attached to the commissural supports, and a fabric seal to minimize paravalvular leaking. *Id.* at 2:42-49, 3:5-12, 5:60-63, 16:63-65, 14:21-29, and 21:19-24. The commissure support elements are described as separate elements that suspend the valve within the anchor such that the valve commissures are not impacted by the foreshortening of the anchor. *Id.*; *see, e.g.*, Figs. 2A, 2B, 3B.

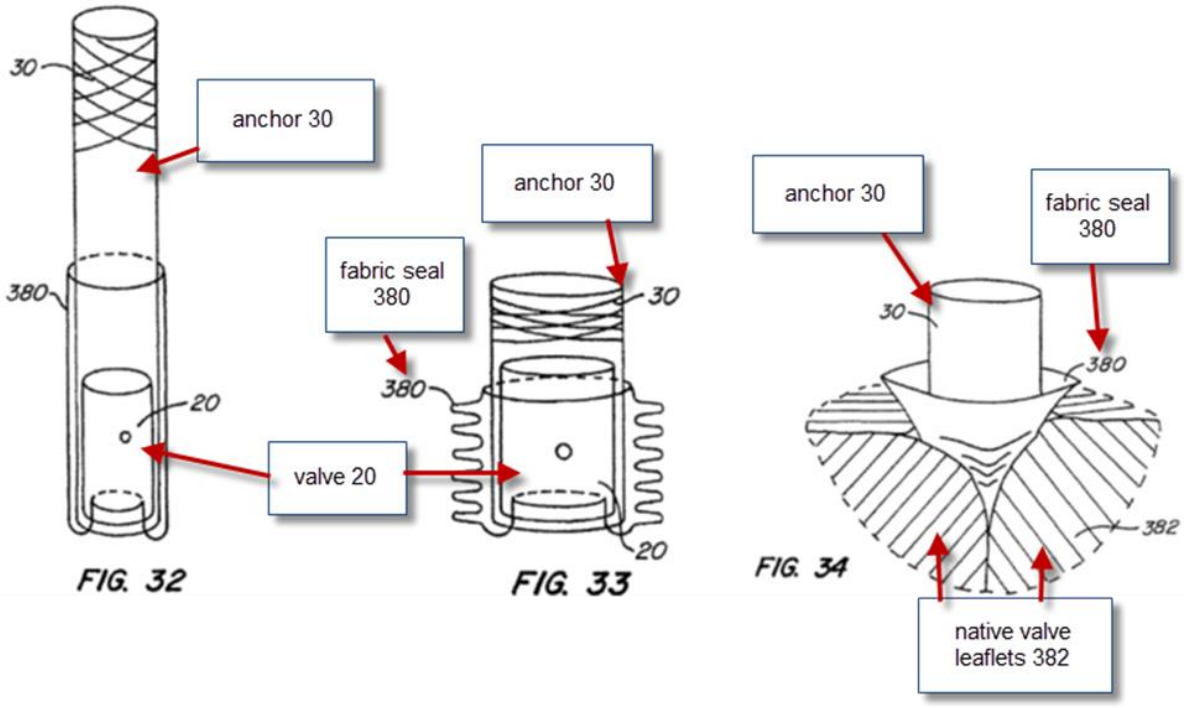
93. The '608 patent discloses that the anchor "preferably is fabricated by using self-expanding patterns . . . , braids and materials, such as a stainless steel, nickel-titanium ('Nitinol') or cobalt chromium . . . ." *Id.* at 5:45-50. "In order to avoid delivery of [the] anchor [ ] on a balloon for balloon expansion," the THV utilizes an anchor actuator that uses external non-hydraulic or non-pneumatic force via control wires and rods to actively foreshorten the anchor and expand the THV to its deployed state. *See, e.g.*, *id.* at 5:64-6:19, 7:30-54. The "[i]mposed foreshortening will enhance radial force applied . . . to surrounding tissue over at least a portion of [the] anchor . . . ." *Id.* at 5:29-6:12, 6:56-66. The anchor also includes a locking mechanism that locks the anchor in its fully deployed state. *See, e.g.*, *id.* at 6:13-31, 7:55-8:3. Up until the anchor is locked, the THV is both repositionable and retrievable. *See, e.g.*, *id.*

94. Although balloon-expandable patterns are referenced in the specification, *see id.* at 5:45-50 ("[the anchor] alternatively may be fabricated using balloon-expandable patterns where the anchor is designed to plastically deform to its final shape by means of balloon expansion"), it is not possible, in my opinion, that a

plastically deformable anchor could be repositionable, retrievable, or use the locking mechanism described by the ’608 patent.

95. The valve disclosed in the ’608 patent is “preferably made from biologic tissues, e.g. porcine valve leaflets or bovine or equine pericardium tissues or human cadaver tissue.” *Id.* at 5:51-53. The ’608 patent does not explicitly describe the structure of the valve. The specification notes only that in a preferred embodiment, “at least a portion of the replacement valve is wrapped about an end of the anchor in a deployed configuration.” *Id.* at 3:5-12. This can be achieved, for example, by configuring the valve to “evert about the anchor during endovascular deployment.” *Id.* at 2:42-49.

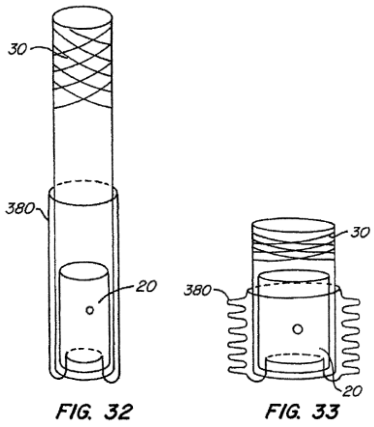
96. The THV described by the ’608 patent also includes a structure intended to prevent blood from flowing between the THV and surrounding heart tissue. As claimed, this structure is in the form of a fabric seal having “flaps” and “pockets,” which are purportedly shown (but not explicitly identified) in Figures 33 and 34:



Id. at Figs. 32-34 (annotations added).

97. Figure 33 shows, in part, an anchor 30 and a replacement valve 20 inside the anchor. A fabric seal overlaps the inlet of the replacement valve, extends across the bottom of the anchor, and then extends up along the outside of the anchor with circumferentially oriented corrugations. *Id.* at 14:21-29, Fig. 33.

98. In Figure 32, the anchor is in its collapsed state. In the collapsed state, the anchor is elongated and the fabric seal lies in a smooth cylinder surrounding the anchor. In Figure 33, the anchor is radially expanded.



According to the ’608 patent, as the anchor expands radially, it shortens in the longitudinal direction (*i.e.*, the anchor foreshortens). As depicted, this foreshortening is extensive, which is expected given that the anchor is formed with a braided-wire structure akin to a Wallstent and is also actively foreshortened. *See supra* Section IV.C. (confirming that a braided-wire stent structure can foreshorten at least 53%). As a result of the foreshortening, the fabric seal of the THV shown in Figure 33 “bunches up to create fabric flaps and pockets.” *Id.* at 14:21-29, Figs. 33-34.

99. The “flaps” and “pockets” purportedly “extend into spaces formed by the native valve leaflets.” *Id.* at 14:21-29. Some of these “spaces” are illustrated in Figure 13, where “interface I between leaflets L and anchor 30 may comprise gaps where blood B may seep through”:

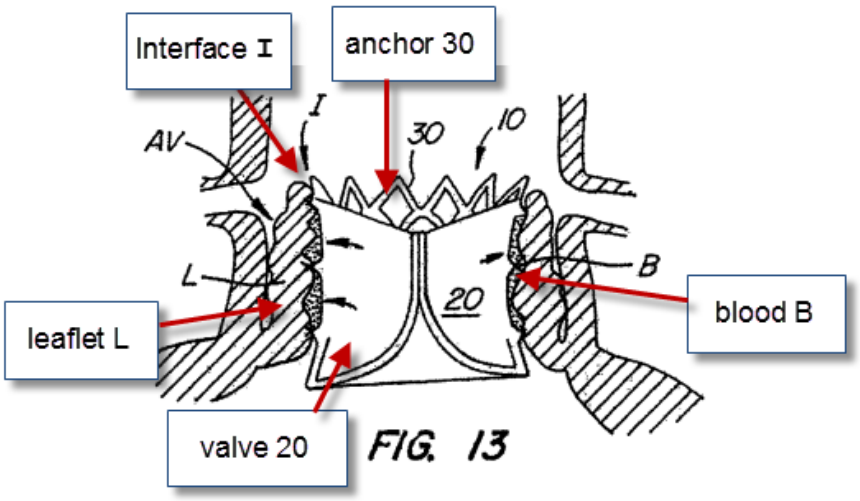


FIG. 13

Id. at 12:19-27, Fig. 13 (annotations added); *see also* Fig. 34.

100. I understand that where, as here, the specification does not disclose that the drawings are to scale and is silent as to dimensions, arguments based on measurement of the drawing features are given little, if any, weight. As such, Figures 33 and 34 of the '608 patent, which are the only figures detailing "flaps" and "pockets," cannot be relied upon by those of ordinary skill in the art to determine the dimensional requirements of "flaps" and "pockets." Beyond these figures and the limited description in the specification associated with these figures (col. 14, ll. 21-29), however, the '608 patent does not provide any guidance as to the scope or meaning of "flaps" and "pockets." There are no parameters imposed on "flaps" and "pockets." For example, there is no disclosure of a specific degree of discontinuity along the fabric seal necessary to form "flaps" and "pockets." There is also no disclosure as to any required dimensions of "flaps" and "pockets"

necessary to actually improve the THV's ability to seal against paravalvular leaks, which is purportedly the aim of these claimed features.

101. Moreover, the specification is silent as to how the fabric seal is capable of radially expanding or whether any unfolding occurs during expansion. The specification only generically discloses that the seal is "fabric." The only other guidance provided by the '608 patent is Figure 32, which suggests to a person of skill in the art that the "fabric" may be elastic because no longitudinally oriented pleats are depicted in the THV's collapsed state. *See supra* ¶¶ 60-61.

102. Also missing from the disclosure is a description or illustration of the prosthesis before it is first collapsed into its delivery configuration. In my opinion, a potential starting point is a fabric seal akin to the types taught by De Paulis (Ex. 1021) and Spiridigliozzi (Ex. 1010). For example, the circumferentially oriented "flaps" and "pockets" structures of De Paulis and Spiridigliozzi would unfold as the anchor extends axially into its collapsed delivery configuration, and would generally return to form once the anchor is expanded into its deployed state. While the specification accounts for the use of foreshortening to "create fabric flaps and pockets," it fails to address the starting point prior to compression, which may be this very same (or a substantially similar) structure. Ex. 1001 at 14:24-27. Another possibility is a fabric that is elastic that bunches together to form circumferentially oriented pleats when compressed longitudinally.

103. While the issues set forth in Paragraphs 100-102 above are not addressed in the '608 patent,[8] I have applied to my invalidity analysis the broadest reasonable interpretation standard to the meaning of "flaps" and "pockets" that a person of ordinary skill in the art would understand in light of the '608 patent's specification. *See* Section VIII, *infra*. Thus, in my opinion, the skilled person would appreciate that circumferentially oriented "flaps" and "pockets" could be achieved by extensive anchor foreshortening (*e.g.*, 50% or more) when the fabric seal, made, for example, of Dacron, is secured at points along its length to the anchor.

104. Boston Scientific's EP '254 confirms my opinion. Figures identical to Figures 32-34 of the '608 patent as well as an identical supporting description of those Figures appear in EP '254. *See* Ex. 1022 at Figs. 22-24 and ¶ [0062]. EP '254 provides additional disclosures missing from the '608 patent that concern the magnitude of foreshortening embodied by the invention, which is consistent with the known foreshortening capabilities of braided-wire stent structures. *See supra* Section IV.C. (depicting the 53% foreshortening of the Wallstent). In sum, EP '254 discloses that in the collapsed configuration, the anchor preferably has a length between 5 and 170 mm, and in the expanded configuration, the anchor

[8] To be clear, the shortcomings of the '608 patent set forth above are exemplary, and not intended to be an exhaustive list.

preferably has a length between 1 and 50 mm. *Id.* at ¶¶ [0071] – [0072]. EP '254 further discloses that "the ratio of deployed to collapsed/sheathed lengths is preferably between about 0.05 and 0.5, more preferably about 0.1 to 0.35, or more preferably about 0.15 to 0.25." *Id.* at ¶ [0073]. These correspond to a total foreshortening range of 50-95%. Thus, consistent with known braided-wire stent structures, EP '254 confirms that the anchor described by the '608 patent extensively foreshortens (*e.g.*, 50% or more), which in turn forms "flaps" and "pockets" in the fabric seal.[9]

105. To be clear, the '608 patent's deficiencies aside, it is my opinion that a person of ordinary skill in the art would appreciate that circumferentially oriented "flaps" and "pockets" in a fabric seal could be formed by extensive anchor foreshortening (*e.g.*, 50% or more) when the fabric seal, made for example with a smooth tubular Dacron fabric, has intermediate attachment points along its length to the anchor. These intermediate attachment points will cause the formation of multiple "flaps" and "pockets" upon the extensive foreshortening. As recognized by the Examiner during prosecution of the '608 patent, discussed *infra* Section VII., circumferentially oriented "flaps" and "pockets" may also be pre-formed. For example, a fabric cover with pre-formed "flaps" and "pockets" akin to those disclosed by De Paulis (Ex. 1021) could be secured to the anchor to allow the

[9] In addition, EP '254 states that a preferred fabric of the seal is a "thin elastic polymer." Ex. 1022 at ¶ [0097].

"flaps" and "pockets" to smooth out (or reduce in size) when the THV is longitudinally extended and to re-form when the THV foreshortens.

106. Separately, Boston Scientific has recently taken the position that "pleats" are present in an expanded THV where a THV is compressed to its delivery diameter by crimping, a well-known practice used to prepare a THV for delivery.[10] These longitudinally oriented pleats that Boston Scientific asserts must be present as a result of crimping would be no different to those of an expanded graft structure of the type described by Lawrence, *supra* Section IV.D. Pleats of this type are also shown in compressed form in, for example, U.S. Patent No. 5,855,601 to Bessler *et al.* ("Bessler", Ex. 1033), which details a compressed, self-expanding THV with a pleated seal at least partially disposed around an exterior portion of the frame:

[10] Specifically, in characterizing petitioner's own SAPIEN 3 product, Boston Scientific stated that "the outer part of the seal of the SAPIEN 3 has a pleated structure after re-expansion, because the outer part of the seal is compressed to a very small diameter on the balloon catheter. Thereby, pleats are formed by applying external pressure [via crimping]." Ex. 1032 at 46-48.

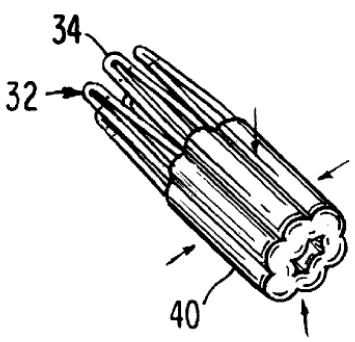


FIG. 5

Ex. 1033 at Fig. 5.

VI. CLAIMS 1-4 OF THE '608 PATENT

107. I understand that Edwards' Petition for *Inter Partes* Review is based on Claims 1-4 of the '608 patent. I reproduce these claims below on an element-by-element basis:

Claim No.	'608 Patent Claim Element
1.	A system for replacing a heart valve, comprising:
1.1	an expandable anchor having a collapsed delivery configuration and an expanded configuration, the expandable anchor comprising a distal end;
1.2	a replacement valve commissure support element attached to the expandable anchor;
1.3	a commissure portion of a replacement valve leaflet attached to the commissure support element; and

Claim No.	'608 Patent Claim Element
1.4	a fabric seal at least partially disposed around an exterior portion of the expandable anchor when the anchor is in the expanded configuration,
1.5	the fabric seal having an undeployed state and a deployed state,
1.6	wherein in the deployed state the fabric seal comprises flaps that extend into spaces formed by native valve leaflets;
1.7	wherein a distal end of the replacement valve leaflet is attached to the fabric seal
1.8	and when the expandable anchor is in the collapsed delivery configuration, the fabric seal extends from the distal end of the replacement valve and back proximally over the expandable anchor,
1.9	the fabric seal being adapted to prevent blood from flowing between the fabric seal and heart tissue.
2.	The system of claim 1, wherein, in the deployed state, the fabric seal defines a plurality of pockets.
3.	The system of claim 2, wherein the pockets are adapted to fill with blood in response to backflow blood pressure.
4.	The system of claim 1, wherein the expandable anchor is formed from stainless steel or nickel-titanium alloy.

VII. PROSECUTION HISTORY OF THE '608 PATENT

108. The '512 application as filed was titled "Everting Heart Valve." The specification and originally filed claim 1, the sole independent claim, were in turn aimed primarily at an everting heart valve structure:

> 1. A system for replacing a heart valve, comprising:
>
> an expandable anchor having a collapsed delivery configuration and an expanded configuration;
>
> a replacement valve commissure support element attached to the expandable anchor;
>
> a commissure portion of a replacement valve leaflet attached to the commissure support element; and
>
> a seal at least partially disposed around an exterior portion of the expandable anchor when the anchor is in the expanded configuration, wherein the seal is adapted to prevent blood from flowing between the seal and heart tissue,
>
> wherein a distal end of the replacement valve leaflet is attached to the seal.

See Ex. 1002, Prosecution History at Claims filed on 6/26/09.

109. On December 17, 2010, the Patent Office issued a Non-Final Office Action rejecting all pending claims as anticipated under 35 U.S.C. § 102(b) in view of U.S. Patent Application Publication No. 2001/0021872 to Bailey *et al.*: ("Bailey," Ex. 1020):

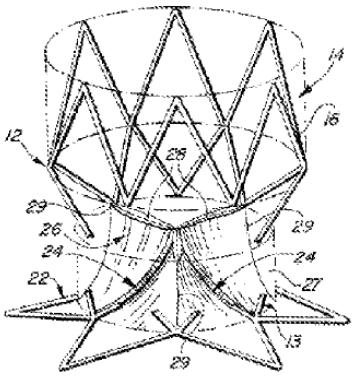


Figure 2 of Bailey

Ex. 1020, Bailey at Fig. 2.

110. Applicants responded on March 7, 2011. They did not dispute that Bailey discloses an expandable anchor, a replacement valve commissure support element, and a commissure portion of a replacement valve leaflet as claimed. Ex. 1002, 3/7/11 Remarks at 3-4. Applicants disputed only that Bailey did not disclose a seal as claimed. *Id.* The applicants argued that "[i]t is clear from the figures and disclosure (Figures 15A-E, paragraphs [0102] and [0103]) that the recited 'seal' is a structurally distinguishable component." *Id.* at 4.

111. The Patent Office disagreed with applicants' argument and issued a Final Rejection on April 8, 2011, again relying on the same disclosures of Bailey as a basis for the Rejection. The examiner responded to the applicants' arguments as follows:

> The Applicant contends that Bailey et al. does not disclose a seal at least partially disclosed [sic] around the exterior of the anchor. The examiner respectfully disagrees. Bailey et al. describes in paragraph 0049 that the

> device may have an outer graft member that is disposed around an exterior portion of the anchor. Examiner maintains that the graft member may be broadly construed as providing a sealing function i.e. will act as a seal when the device is expanded to be flush against vessel walls (paragraphs 0021-0022). When the device is expanded it will force the blood to flow through the valve, and will not allow the blood to leak past the sides of the device between the outer graft member and the vessel walls.

Id., 4/8/11 Final Rejection at 3-4.

112. On May 2, 2011, applicants filed an Amendment After Final Rejection and Request for Reconsideration. There, the applicants amended claim 1 and presented new independent claim 9 and 10, along with six new dependent claims. Each of independent claims 1, 9, and 10 was now aimed at claiming a distinct embodiment of the external seal. Specifically, claim 1 required a seal comprising "an expandable foam disposed around a circumference of a wire," claim 9 required a "fabric" seal "wherein the fabric seal has an undeployed state and a deployed state, wherein in the deployed state the fabric seal comprises flaps that extend into spaces formed by native valve leaflets," and claim 10 required a seal comprising "at least one sac disposed about the exterior of the anchor." *See id.*, 5/2/11 Amendment After Final at 2-4. Other than the limitations related to the specific structure of the seal, all other limitations in claims 1, 9, and 10 were identical. Applicants argued that support for the claim 1 embodiment could be found at paragraph [0111] of the specification and

Figures 27-31, support for the claim 9 embodiment could be found at paragraph [0112] and Figures 32-34, and support for the claim 10 embodiment could be found at paragraphs [0102]-[0104] and Figures 14-16C. *Id.* at 6-7. According to the applicants, Bailey failed to disclose an external seal as claimed in claims 1, 9, and 10. *Id.*

113. On May 19, 2011, the Patent Office issued an Advisory Action. It declined to review the applicants' amended claims, prompting a June 10, 2011 Request for Continued Examination. In response, the Patent Office issued a Requirement for Retriction/Election on December 30, 2013, noting that the seal structures claimed in claims 1, 9, and 10 are patentably distinct species. Applicants elected to pursue claim 9 directed at the "fabric" seal with "flaps," and filed new dependent claims 16-24. *Id.*, 2/28/14 Response to Election/Restriction. According to the applicants, support for claims 16-24 is found in the specification at paragraphs [0068], [0069], [00112], and [00113], and in Figures 1A, 1B, and 32-34. *Id.* at 4.

114. The Patent Office issued a Non-Final Rejection of all pending claims on April 10, 2014. With respect to claims 9 and 16-21, the examiner rejected the claims as obvious based on the teachings of Leonhardt (Ex. 1027) in view of U.S. Patent No. 6,352,554 to De Paulis (Ex. 1021). The examiner found that Leonhardt discloses all of the elements of claims 9 and 16-21 with the exception of a fabric seal comprising flaps and pockets. The examiner concluded, however, that a fabric seal comprising flaps and pockets was an obvious feature to add to Leonhardt in view of De Paulis:

> Leonhardt et al. does not teach the fabric seal comprising flaps and pockets. An implantable fabric having pleats and pockets is well known in the art, as taught by De Paulis in Figure 2, and would have been obvious to one of ordinary skill in the art to modify the seal of Leonhardt *et al.* to include pleats as an obvious alternative design choice. At least a portion of Leonhardt *et al.'s* seal is adapted to be filled with blood, and captured between the leaflets (14) and a wall of the patient's heart (18) when the anchor and replacement valve are fully deployed.

Id., 4/10/14 Non-Final Rejection at 2-3 (emphasis added).

115. The applicants responded on July 9, 2014. Claim 9 was amended to include a requirement that "a distal end of the replacement valve leaflet is attached to the fabric seal and when the expandable anchor is in the collapsed delivery configuration, the fabric seal extends from the distal end of the replacement valve and back proximally over the expandable anchor, the fabric seal being adapted to prevent blood from flowing between the fabric seal and heart tissue."[11] *See id.*, 7/9/14

[11] The distal end is defined in the '608 patent as the end of the THV farthest along the catheter from the surgeon (i.e., the inflow end of the valve). *See, e.g.*, Ex. 1001 at 12:51-67. The end of the THV closest along the catheter to the surgeon (i.e., the outflow end of the valve) is defined by the '608 patent as the proximal end. *Id.*

Amendment at 2 (underlining in original to reflect added claim language). Applicants argued that support for the amendment can be found at paragraph [00112] and Figure 32 of the specification. *Id.* at 4. Applicant's further argued that:

> As shown for example in FIG. 32 of the immediate Application . . . the fabric seal doubles over the distal end of the expandable anchor. Further, paragraph [00112] states, in-part, "a fabric seal 380 extends from the distal end of valve 20 and back proximally over anchor 30 during delivery." . . . In contrast, neither Leonhardt nor De Paulis, whether considered independently or in combination, teaches, suggests, or otherwise renders obvious a "<u>when the expandable anchor is in the collapsed delivery configuration, the fabric seal extends from the distal end of the replacement valve and back proximally over the expandable anchor</u>, the fabric seal being adapted to prevent blood from flowing between the fabric seal and heart tissue," as is claimed.

Id. at 4-5 (emphasis added).

116. The examiner issued a Notice of Allowance on October 6, 2014. Claims 9 and 17-24 were allowed, which correspond to claims 1 and 2-9, respectively, in the '608 patent. A second notice of allowance was issued on February 12, 2015

These definitions are consistent with a THV that is implanted through the femoral artery of a patient against the flow of blood (i.e., transfemoral delivery).

after the examiner considered additional references submitted by the applicants in a series of Information Disclosure Statements. On March 31, 2015, the '512 application issued as U.S. Patent No. 8,992,608. Despite the altered scope of the issued claims from the originally filed claims, the title of the '608 patent remained "Everting Heart Valve."

117. Based on my review of the Prosecution History of the '608 patent, it is my opinion that, with respect to claim 1, the Patent Office considered all of the claimed limitations obvious – including external fabric seals with "flaps" and "pockets" – except for the requirement that "in the collapsed delivery configuration, the fabric seal extends from the distal end of the replacement valve and back proximally over the expandable anchor, the fabric seal being adapted to prevent blood from flowing between the fabric seal and heart tissue." Put another way, as argued by the applicants, the prior art relied upon by the examiner did not teach a fabric seal that "doubles over the distal end of the expandable anchor." In my opinion, as discussed *supra* Section IV.E., this is not a sufficient basis for patentability as THVs having fabric seals that "double over the distal end of the expandable anchor" were well known. *See, e.g.*, Ex. 1003, Cribier at Fig. 6d; Ex. 1004, Spenser at Fig. 1.

VIII. PROPOSED CONSTRUCTIONS OF CLAIM TERMS

118. I am informed that a claim subject to *inter partes* review receives the "broadest reasonable construction in light of the specification of the patent in which it appears."

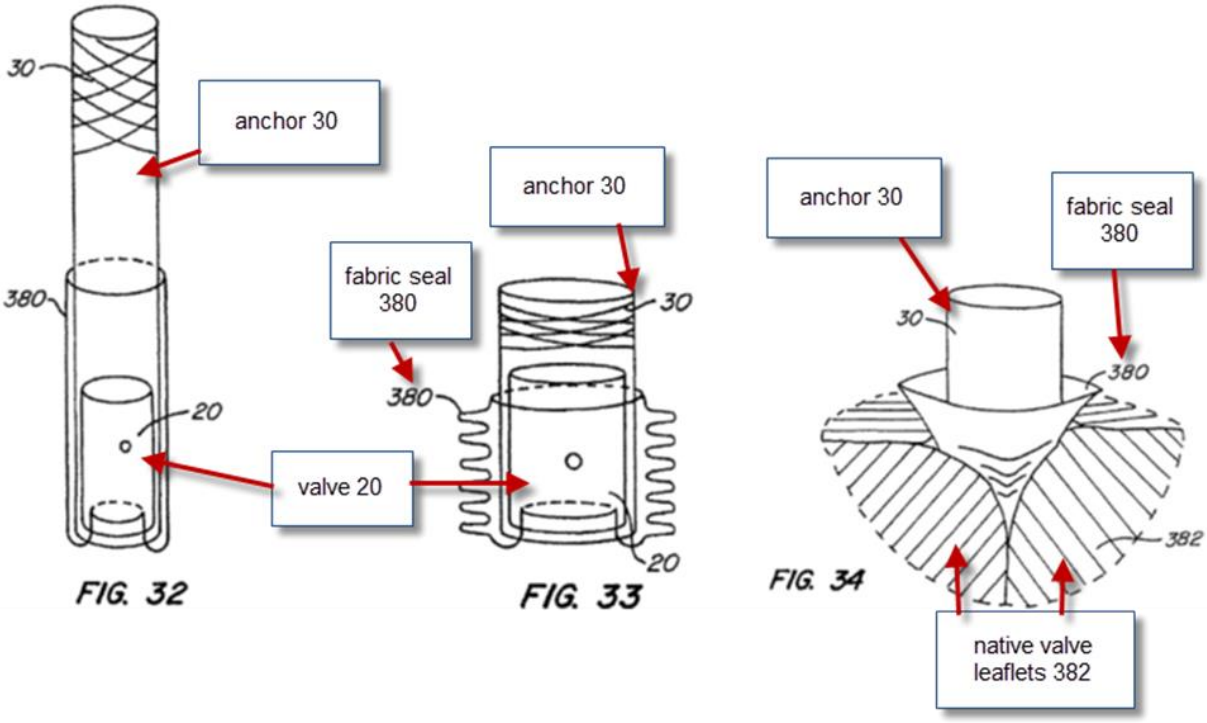
119. I understand that Edwards' Petition proposes constructions for two claim terms in the '608 patent: "flaps" and "pockets." Specifically, Edwards has proposed that "flaps" and "pockets" are not terms of art, that "flaps" are "circumferentially oriented folds or unattached ends," and that "pockets" are "open spaces or cavities formed by flaps of the fabric seal." As confirmed by the specification and additional claim language, the "flaps" "extend into spaces formed by native valve leaflets," which are shown, for example, in Figure 13 and 34 of the '608 patent. *See* Ex. 1001 at 12:19-27, Fig. 13. I agree that "flaps" and "pockets" are not terms of art. I also agree that a person of ordinary skill in the art having read the specification and applying the broadest reasonable interpretation would give these terms each of the proposed constructions set forth above.

120. The only support for "flaps" and "pockets" in the '608 patent specification identified by the applicants during prosecution is in the description of Figures 32-34:

> FIGS. 32-34 show another way to seal the replacement valve against leakage. A fabric seal 380 extends from the distal end of valve 20 and back proximally over anchor 30 during delivery. When deployed, as shown in FIGS. 33 and 34, fabric seal 380 bunches up to create fabric **flaps** and **pockets** that extend into spaces formed by the native valve leaflets 382, particularly when the **pockets** are filled with blood in response to backflow

blood pressure. This arrangement creates a seal around the replacement valve.

Ex. 1001, col. 14:21-28 (emphasis added); *see also* Ex. 1002, 5/2/11 Amendment After Final at 2-4. As purportedly illustrated in Figures 32-34, the "flaps" and "pockets" are formed when the anchor shortens as it transitions from its undeployed (collapsed) state to its deployed (expanded) state, causing the fabric seal to foreshorten along with the anchor and, in turn, form circumferentially oriented "flaps" and "pockets":



Ex. 1001, Figs. 32-34 (annotations added).

121. In Figures 33 and 34, only "fabric seal 380" is identified; no identification is made in these Figures as to what portions of the fabric seal constitute "flaps" and what portions constitute "pockets."

122. Nonetheless, in my opinion, Figures 33-34 appear to depict a fabric seal 380 having circumferentially oriented folds and a circumferentially oriented unattached end.

123. Moreover, during prosecution of the ’608 patent, the examiner used “flaps” and “pleats” interchangeably:

> Leonhardt et al. does not teach the fabric seal comprising flaps and pockets. An implantable fabric having pleats and pockets is well known in the art, as taught by De Paulis [U.S. Patent No. 6,352,554] in Figure 2, and it would have been obvious to one of ordinary skill in the art to modify [the] seal of Leonhardt et al. to include pleats as an obvious alternate design choice.

Ex. 1002, 04/24/14 Office Action at 3 (emphasis added). Figure 2 of De Paulis, which the examiner relied upon as teaching “pleats” and “pockets” as claimed by the ’608 patent, is pictured below:

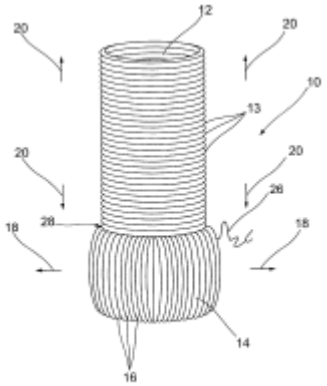


Fig. 2

Ex. 1021, De Paulis at Fig. 2. The "flaps" taught by De Paulis are described as "circumferentially extending pleats" and "circumferentially extending corrugations." *Id.* at 4:52-5:1.

124. In Boston Scientific's commonly owned EP '254, which contains figures identical to Figures 32-34 of the '608 patent and related descriptions missing from the '608 patent, "flaps" and "pleats" are also used interchangeably to describe the sealing structures purportedly shown in Figures 32-34. *See* EP '254 at ¶ [0103] ("Figures 22-24 [identical to Figures 32-34 in the '608 Patent] illustrate the process of forming a pleated seal around a replacement valve to prevent leakage. . . . The bunched up fabric or pleats occur, in particular, when the pockets are filled with blood in response to backflow blood pressure."); *see also id.* at ¶ [0017] ("The fabric seal can bunch up to create fabric flaps and pockets. The seal can bunch up and creates pleats. The seal can comprise a pleated seal.").

125. Separate from the disclosures in the '608 patent, the file history, and the commonly owned EP '254, the dictionary definition of "flap" is "something that is broad, limber, or flat and usu[ally] thin and that hangs loose or projects freely: as a: a piece on a garment that hangs free b: a part of a book jacket that folds under the book's cover c: a piece of tissue partly severed from its place of origin for use in surgical grafting d: an extended part forming the closure (as of an envelope or carton)." Ex. 1024 (definition of "flap" set forth in Merriam-Webster's Collegiate Dictionary, 10th

ed. (2001)); *see also* Ex. 1023, American Heritage College Dictionary, 4th Ed. (2002) (defining "flap" as "a flat, usually thin piece attached on one side; a projection or hanging piece usually intended to double over and protect or cover."). The dictionary definition of "pleats" is "a fold in cloth made by doubling material over on itself." Ex. 1024 (definition of "pleats" set forth in Merriam-Webster's Collegiate Dictionary, 10th ed. (2001)).

126. In light of the overall intrinsic and extrinsic support, a person of ordinary skill in the art would understand that when applying the broadest reasonable interpretation standard, "flaps" are "circumferentially oriented folds or unattached ends." These "flaps" "extend into spaces formed by native valve leaflets."

127. That said, I understand that patent owner Boston Scientific, in both the Opposition proceeding of EP '254 and German infringement proceeding involving EP '254, has defined "flaps" more broadly. Specifically, Boston Scientific argues "the wording 'circumferential and horizontal' is neither mentioned in the PCT application WO '980 [i.e., the parent application to EP '254] on page 34, lines 26 to 31, nor on page 86, lines 22 to 32. Figure 33 shows a schematic drawing to illustrate an example of a bunched-up fabric seal. Therefore, that the Proprietor cannot be forced to introduce this wording in granted claim 1." Ex. 1031 at 11; *see also* Ex. 1032 at 15-16 ("[F]rom a functional perspective, it is only necessary for the seal to rest loosely on the outer surface of the expandable anchor so that the seal can fill spaces between the anchor and the natural heart valve."). Thus, according to Boston Scientific, no

directional limitations on "flaps" should be imposed. As such, under Boston Scientific's broad interpretation, longitudinally oriented "flaps" such as those formed when the graft is expanded short of its maximum diameter and those formed as Boston alleges when a THV is compressed by crimping, would also fall within the scope of Claims 1-4. Where appropriate, I have endeavored to account for this broader interpretation of "flaps" in my below analysis.

128. As to "pockets," the '608 patent describes that the "flaps" and "pockets" necessarily result from "bunching up" of the fabric seal. As such, "pockets" cannot be formed without "flaps." This also is shown in Figures 33-34 and consistent with the claim language in that Claim 1 requires "flaps" and Claim 2 depends from claim 1 and further requires "pockets." Applying the broadest reasonable interpretation standard and accounting for the intrinsic and extrinsic evidence set forth above, a person of ordinary skill in the art would define "pockets" as "open spaces or cavities formed by flaps of the fabric seal."

129. I understand that for the remaining terms in claims 1-4 of the '608 patent, Edwards' Petition applies the ordinary and customary meaning of those terms, as they would be understood by persons of ordinary skill in the art in light of the '608 Patent specification. I agree that the remaining terms are well known terms in the art, and I have adopted their plain and ordinary meaning as those terms would be understood by a person of ordinary skill in the art in light of the '608 Patent specification.

IX. INVALIDITY OF CLAIMS 1-4 OF THE '608 PATENT

130. There are eleven separate grounds of invalidity set forth in Edwards' Petition: (1) Claims 1-4 are invalid under 35 U.S.C. § 102(b) as anticipated by Cribier; (2) Claims 1-4 are invalid under 35 U.S.C. § 103(a) as being obvious over Cribier in view of Spiridigliozzi; (3) Claims 1-4 are invalid under 35 U.S.C. § 103(a) as being obvious over Cribier in view of Elliot; (4) Claims 1-4 are invalid under 35 U.S.C. § 103(a) as being obvious over Cribier in view of Thornton; (5) Claims 1-4 are invalid under 35 U.S.C. § 103(a) as being obvious over Cribier in view of Cook; (6) Claims 1-4 are invalid under 35 U.S.C. § 103(a) as being obvious over Cribier in view of De Paulis; (7) Claims 1-4 are invalid under 35 U.S.C. § 103(a) as being obvious over Spenser in view of Elliot; (8) Claims 1-4 are invalid under 35 U.S.C. § 103(a) as being obvious over Spenser in view of Thornton; (9) Claims 1-4 are invalid under 35 U.S.C. § 103(a) as being obvious over Spenser in view of Cook; (10) Claims 1-4 are invalid under 35 U.S.C. § 103(a) as being obvious over Spenser in view of De Paulis; and (11) Claims 1-4 are invalid under 35 U.S.C. § 102(b) as anticipated by Spenser. For the reasons set forth below, I agree with each of these grounds.

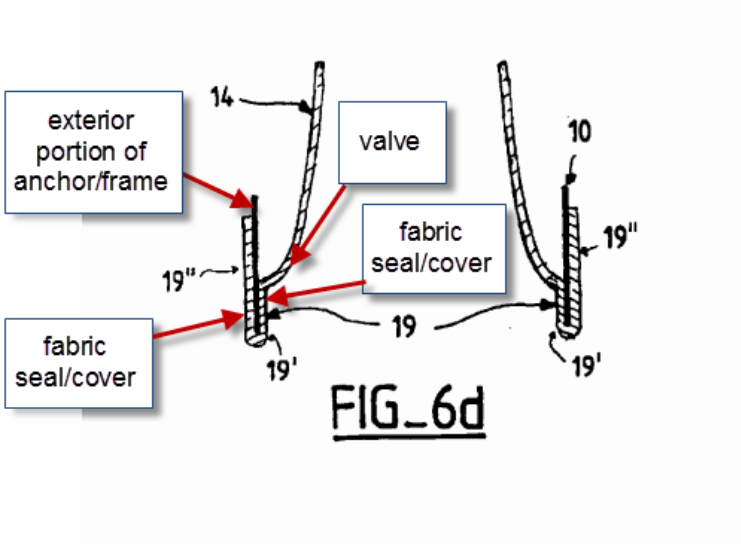
131. With respect to Grounds 3-4 and 7-8, I agree that the teachings of Elliot (Grounds 3 and 7) and Thornton (Grounds 4 and 8) are largely duplicative.

132. As an initial matter, I note the examiner's conclusion that almost all features claimed by the '608 patent, including a "fabric seal" with "flaps" and "pockets," were obvious in view of the prior art. *See, e.g.*, Ex. 1002, Prosecution

History, 04/24/14 Office Action at 3 ("[a]n implantable fabric having pleats and pockets is well known in the art"). I agree with this conclusion.

133. The limitations added during prosecution of the '608 patent that purportedly rendered the claims patentable were: "a distal end of the replacement valve leaflet is attached to the fabric seal and when the expandable anchor is in the collapsed delivery configuration, the fabric seal extends from the distal end of the replacement valve and back proximally over the expandable anchor, the fabric seal being adapted to prevent blood from flowing between the fabric seal and heart tissue." *See id.*, 7/9/14 Amendment at 2 (underlining in original to reflect added claim language). In my opinion, the examiner erroneously concluded that this added limitation rendered the claims patentable.

134. THVs having seals extending from the distal end of a replacement valve and back proximally over the expandable anchor were well known in the art, as evidenced, for example, by Figure 6d of Cribier:



See Ex. 1003, Cribier at Fig. 6d. Spenser likewise disclosed this same feature. *See also* Ex. 1004, Spenser at Fig. 1.

135. Thus, the sole feature of the claimed invention purportedly missing from the prior art relied upon by the examiner during prosecution is in fact explicitly taught by Cribier and Spenser. Claims 1-4 of the '608 patent should therefore be rendered invalid upon review of the prior art. [12]

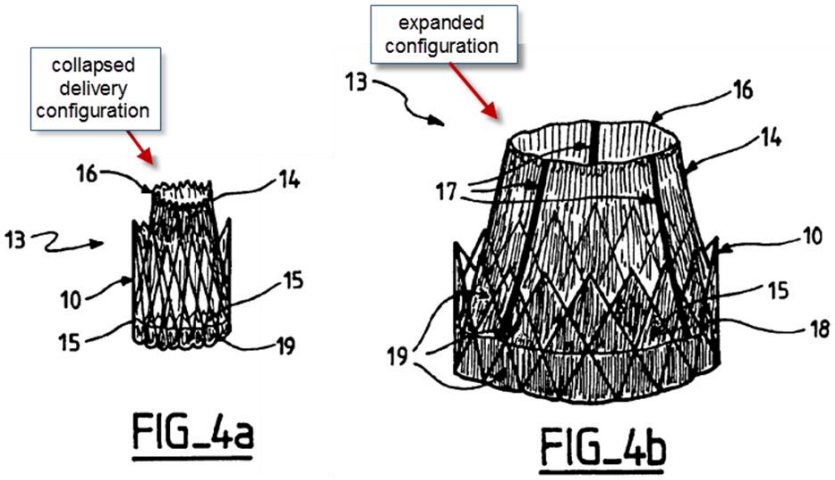
A. Ground 1: Cribier Anticipates Claims 1-4 of the '608 Patent

136. Not only does Cribier disclose the purported "inventive" feature of the claimed invention, Cribier anticipates each and every limitation of Claims 1-4 of the '608 patent.

137. With respect to Claim 1 of the '608 patent, Cribier discloses a transcatheter heart valve, which is a system for replacing a heart valve. Ex. 1003, Cribier at 1:4-6.

138. One of the preferred embodiments of Cribier is depicted in Figures 4a and 4b:

[12] Boston Scientific has since admitted in the European Opposition proceedings of EP '254 that Cribier is "the closest prior art" to the subject matter of that patent, which substantially overlaps with the subject matter of the '608 patent. Ex. 1031 at p. 29.



As shown, Cribier discloses an expandable anchor ("frame 10") having a collapsed delivery configuration (Fig. 4a: "compressed position") and an expanded configuration (Fig. 4b: "expanded and opened (systole) position"), the expandable anchor comprising a distal end (i.e., an inlet end). *See id.* at 8:24-27, 11:12-14, 18:1-6.

139. The Cribier THV includes a commissure support element attached to the expandable anchor ("guiding means," depicted above as "rectilinear struts 17") and a commissure portion of a replacement valve leaflet (Fig. 4b: "valvular structure 14") attached to the commissure support element. *See id.* at Fig. 4b, 18:22-28 ("The tissue has rectilinear struts 17 incorporated in it in plane including the central axis X'X, in order to strengthen it, in particular, in its closed state with a minimal occupation of the space, and to induce a patterned movement between its open and closed state. . . . They are formed from thicker zones of the tissue or from strips of stiffening material incorporated in the tissue; they can also be glued or soldered on the valvular tissue"). The structure of the valve commissures disclosed by Cribier can vary as Cribier

discloses the use of "any type of valvular structure," including valvular structures "made with biological tissues such as the pericardium, or with porcine leaflets." *See id.* at 24:9-10, 26:13-16. Thus, Cribier contemplates various commissure and commissure support elements beyond those shown, for example, in Figure 4b.

140. As shown in Fig. 6d, *supra* ¶ 133, Cribier discloses a fabric seal (e.g., "Dacron") at least partially disposed around an exterior portion of the expandable anchor when the anchor is in the expanded configuration. *See id.* at Fig. 6d, 20:26-21:3 ("The valvular structure . . . includes advantageously a third part, i.e., the internal cover 19 to be fixed on the internal wall of the frame 10"), 24:7-13 ("The internal cover constitutes therefore a surface on which any type of valvular structure [can] be more easily sewed, molded, or glued"), 22:23-26 ("At FIG. 6d, the internal cover 19 is extended at its lower end 19' to an external cover 19" which is rolled up to be applied on the external wall of the stent 10"), 8:16-23 and 22:11-20 (the cover can be made with any of the materials disclosed for making the valve structure, which include fabric (*e.g.*, Dacron), biological material (*e.g.*, pericardium), or other synthetic materials (*e.g.*, polyethylene)). Because the THV disclosed by Cribier has an undeployed state and a deployed state, the fabric seal has an undeployed state and a deployed state. *Id.* at Figs. 4a and 4b, 18:1-12.

141. Also shown in Figure 6d, Cribier discloses that a distal end of the replacement valve leaflet is attached to the fabric seal such that when the expandable anchor is in the collapsed delivery configuration, the fabric seal extends from the distal

end of the replacement valve and back proximally over the expandable anchor. *Id.* at Fig. 6d, 20:26-21:3 ("The valvular structure . . . includes advantageously a third part, i.e., the internal cover 19 to be fixed on the internal wall of the frame 10"), 24:7-13 ("The valvular structure can also be fastened on the internal cover previously fixed at the total length of the internal surface of the metallic frame. The internal cover constitutes therefore a surface on which any type of valvular structure [can] be more easily sewed, molded, or glued"), 22:23-26 ("At FIG. 6d, the internal cover 19 is extended at its lower end 19' to an external cover 19" which is rolled up to be applied on the external wall of the stent 10"). The fabric seal can be secured to the frame at various points along its length and adapted to prevent blood from flowing between the fabric seal and heart tissue. *Id.* at Fig. 6d, 22:23-26 ("The internal and external cover are molded, glued or soldered to the bars of the stent 10."), 23:15-16 ("The fastening of the valvular structure to the frame can be made by sewing the internal and/or the external cover to the bars."), 24:24-27 ("The fastening of the internal cover 19 on the extremities can be reinforced by various points of attachment on various parts of the internal surface of the frame 10. The internal cover 27 can be fastened by sewing, molding or gluing the bars 11 onto the frame."); *see also id.* at 23:12-24:23, Figs. 7, 8a-b. As is clear from Cribier's disclosure, the methods for attaching the cover to the frame are applicable to both the internal and external portions of the cover.

142. Finally, Cribier discloses that, in the deployed state, the fabric seal will comprise circumferentially oriented "flaps" and "pockets" that extend into spaces

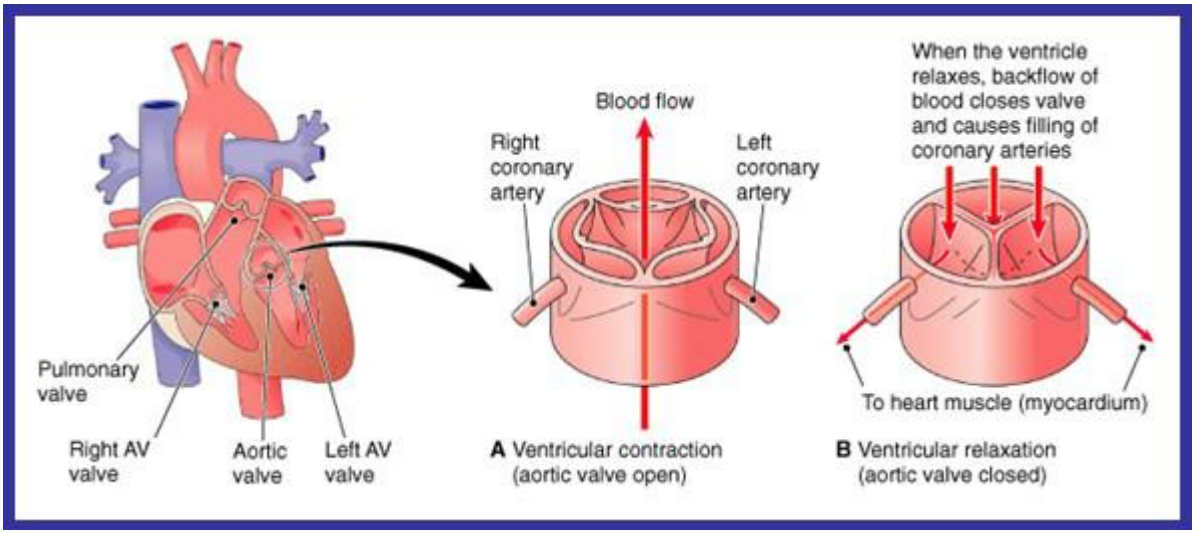
formed by native valve leaflets. As disclosed in the '608 patent, circumferentially oriented "flaps" and "pockets" are formed as a result of extensive stent foreshortening. *See* Ex. 1001, '608 patent at Figs. 32-34. And, as disclosed in the commonly owned EP '254 with Figures identical to Figure 32-34 in the '608 patent, the anchor foreshortens from 50-95%. *See also* Section IV.C. (confirming that a braided-wire stent structure can foreshorten at least 53%). This same amount of foreshortening is disclosed by Cribier. The anchor in Cribier can be 20 mm in length in the collapsed configuration and 10 mm in length in the expanded configuration, and thus foreshortens by 50%.[13] Ex. 1003, Cribier at 16:11-16. When the Dacron fabric seal of Cribier is secured at various points along its length to the anchor and the anchor extensively foreshortens by 50%, the external seal disclosed by Cribier will form multiple "flaps" and "pockets" that will extend into spaces formed by native valve leaflets.

143. Separately, when applying Boston Scientific's broad interpretation of "flaps" (i.e., no "circumferential" directional requirement), Cribier also discloses

[13] The lengths of the Cribier anchor in both the collapsed (20 mm) and expanded state (10 mm) also fall within the ranges disclosed by Boston Scientific's EP '254. EP '254 details that the anchor can have a length between 5 and 170 mm in the collapsed configuration and a length between 1 and 50 mm in the expanded configuration. Ex. 1022, EP '254 at ¶¶ [0071] – [0073].

"flaps" and "pockets" that are longitudinally oriented. Cribier details that the anchor is "expandable from a size of about 4 to 5 millimeters to a size of about 20 to 25 mm in diameter . . . ." Ex. 1003 at 14:12-15. Any fabric seal used would necessarily have to accommodate this range of expansion. Thus, to the extent that the prosthesis described by Cribier is used to treat an annulus diameter smaller than the prosthesis' maximum diameter, excess fabric would surround the prosthesis, thereby forming longitudinally oriented pleats of the type described by Lawrence (in addition to the circumferential pleats described above). *See supra* Section IV.D. Moreover, Cribier is compressed or crimped as illustrated in Figure 4a, which, according to Boston Scientific, will form pleats in the cover that will remain upon expansion. Ex. 1003 at Fig. 4a; Ex. 1032 at 46-48; *see also supra* Section V (describing longitudinally oriented pleats of Bessler).

144. As to claims 2-3 of the '608 patent, these claims require the fabric seal, in a deployed state, to define "a plurality of pockets" that "are adapted to fill with blood in response to backflow blood pressure." The figure on the right in the below diagram details the backflow of blood when the aortic valve is in its closed state:



See presentation titled "The Circulatory System: The Heart" *available at* http://slideplayer.com/slide/6295168/, Slide 23. This blood will fill any spaces or cavities surrounding the valve leaflets. Thus, the "pockets" formed in the fabric seal of Cribier as a result of extensive foreshortening will necessarily fill with blood in response to backflow blood pressure. *See, e.g.*, Ex. 1003, Cribier at Fig. 6d. "Pockets" are likewise formed when longitudinally oriented "flaps" are formed as described above. *See supra* ¶ 142.

145. With respect to claim 4 of the '608 patent, the expandable anchor in Cribier is formed, for example, with stainless steel. *Id.* at 15:19-22.

146. Each of Claims 1-4 of the '608 are therefore anticipated by Cribier.

B. Obviousness

(a) Ground 2: Cribier in View of Spiridigliozzi (Claims 1-4)

147. I incorporate by reference each of the Cribier disclosures detailed above, *supra* Sections IV.E. and IX.A.

148. As demonstrated above in Section IX.A (Ground 1), Cribier discloses each element of claims 1-4. To the extent Cribier is interpreted as not disclosing or rendering obvious Element 1.6 of Claim 1 ("flaps") or the elements of Claims 2-3 ("pockets"), these were well-known features adopted in the seal of similar prostheses that foreshorten. *See supra,* Section IV.D.

149. For example, Spiridigliozzi, which I am informed was not disclosed to the Patent Office during prosecution of the '608 patent, teaches a stent graft structure that elongates when compressed and foreshortens when radially expanded. *See* Ex. 1010 at ¶ [0014] (describing a "support structure" of a stent graft that foreshortens). To accommodate stent foreshortening, Spiridigliozzi teaches that a number of circumferentially oriented pleats can be incorporated into the graft structure, which unfold to compensate for axial elongation during delivery and generally return to form upon longitudinal foreshortening of the stent when deployed:

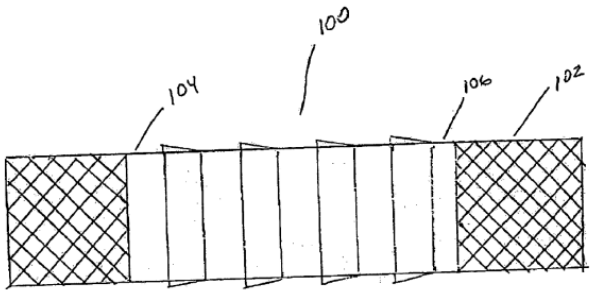


FIG. 10

Id. ("The number and length of the pleated sections can vary to control the resultant axial elongation, plastic deformation, longitudinal foreshortening and radial shrinkage of the graft material"); *see also id.* at ¶ [0019] ("Resultant axial elongation, plastic deformation, longitudinal foreshortening and radial shrinkage of the graft material can thus be limited by the application of longer pleats or a greater number of pleats along the length of the graft."), ¶ [0088] ("The pleated regions are formed by folding the ePTFE material into a flap . . ."). If the graft structure comprises more than one layer of material, the pleats can be formed in discrete layers of the multi-layered graft structure, or the entire graft structure can be pleated. *Id.* at ¶ [0019] ("The layered sheets may be pleated after being formed into a tubular structure."), [0089], [0095] – [0098], and Figs. 9-10. Once deployed, it would be obvious to a person of ordinary skill in the art that the structure of the pleats form "flaps" that extend into spaces in the surrounding tissue, and form a plurality of "pockets" that are adapted to fill with blood in response to backflow blood pressure. *See, e.g.*, Ex. 1010 at Figs. 9-10.

150. Given that the THV disclosed by Cribier foreshortens up to 50% (Ex. 1003 at 16:11-16), it would have been obvious, in my opinion, to incorporate "flaps" and "pockets" in the fabric seal of Cribier in view of Spiridigliozzi's teaching that "pleated sections can vary to control the resultant axial elongation, plastic deformation, longitudinal foreshortening and radial shrinkage of the graft material." Ex. 1010 at ¶ [0014]. There is a clear motivation to combine the teachings of Cribier and Spiridigliozzi as the Cribier THV extensively foreshortens, and the "flaps" and

"pockets" taught by Spiridigliozzi are designed to accommodate such axial elongation and longitudinal foreshortening in a stent-based structure. *Id.* at ¶ [0089]. "The length and number of pleats can be varied along the length of the graft in accordance with the expected stress on the graft material from the support structure." *Id.*

(b) Grounds 3-4: Cribier in View of Elliot (Ground 3) or Thornton (Ground 4) (Claims 1-4)

151. I incorporate by reference each of the Cribier disclosures detailed above, *supra* Sections IV.E. and IX.A.

152. Separate from the formation of flaps and pockets formed by Cribier as described above and the flaps and pockets of Spiridigliozzi, it would have been obvious to one of ordinary skill in the art to modify the fabric seal in Cribier to include an enhanced sealing structure having flaps and pockets as taught by Elliot.

153. I am informed that Elliot, which later issued as U.S. Patent No. 7,044,962, was owned by Boston Scientific until December 2012 but was never disclosed to the Patent Office during prosecution of the '608 patent. *See* Ex. 1028, Assignment record for U.S. Patent App. Pub. No. 2003/0236567 to Elliot.

154. Elliot discloses tubular prostheses for maintaining patency in body passageways, including, but not limited to, stent grafts:

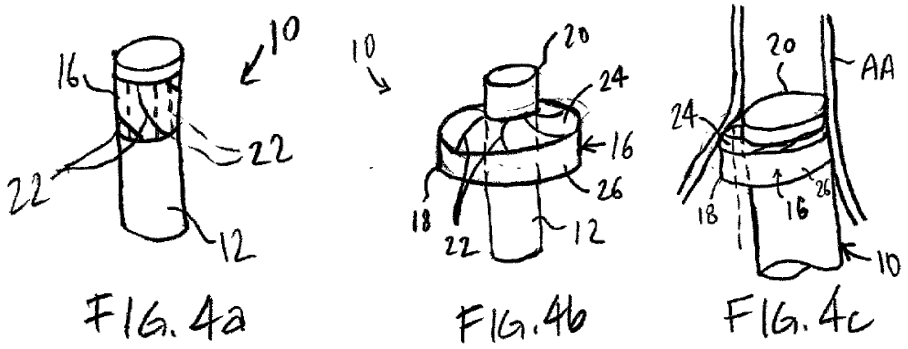


FIG. 4a FIG. 4b FIG. 4c

Ex. 1005, Elliot at ¶ [0001], Figs. 4a-4c; *see also supra* Section IV.D. (excerpting Figs. 5a-5e of Elliot). As noted, *supra* n.1, Elliot's broad teachings of a "tubular prosthesis" apply to a range of devices, including THVs.

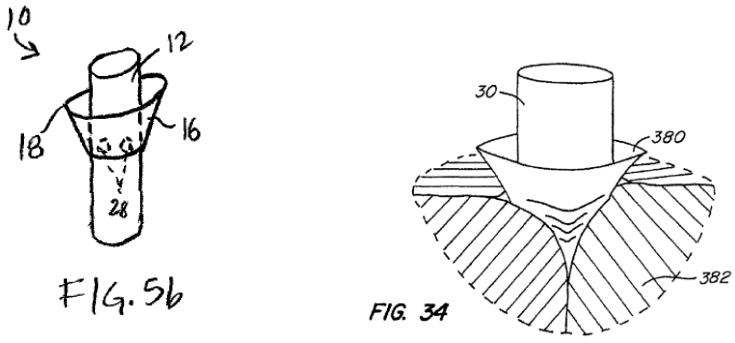
155. Elliot discloses that:

> [T]o limit Type I endoleaks [i.e., leaks between the vascular prosthesis and the vessel wall], an implantable prosthesis is provided having a radially-expandable tubular body and at least one skirt extending therefrom. The skirt terminates in a peripheral edge, wherein at least portions of the peripheral edge are free and displaceable to a greater diameter than the tubular body. . . . The skirt may actively inhibit Type I endoleaks by forming a physical barrier against flow between the tubular body and the aortic wall. In addition, the skirt may passively inhibit endoleak formation by sufficiently restricting blood flow to allow coagulation and clot formation, which would act as a barrier against endoleakage. Endothelial cell ingrowth into the skirt may also occur providing a cellular barrier against endoleakage.

Id. at ¶ [0009].

156. Elliot continues by detailing that the peripheral edge of the skirt "can be displaced to contact, and form a seal with a surrounding wall. Irregularities and/or wall displacement . . . can be responded to by the skirt . . . in minimizing endoleaks about the prosthesis . . . ." *Id.* at ¶ [0024]. This displacement of the peripheral edge of the skirt can result from backflow pressure of blood. *Id.* at ¶¶ [0035], [0037]. [0038]. Elliot also makes clear that one or more skirt structures can be used. *Id.* at ¶¶ [0026], [0040]. Thus, the fabric skirt of Elliot forms flaps and pockets that prevent blood from flowing between the fabric seal and the heart tissue. Indeed, as highlighted in Edwards' Petition, embodiments disclosed by Elliot are depicted as very similar to the "flaps" and "pockets" embodiment of the'608 patent:

Elliot **'608 patent**



Compare Elliot Fig. 5b (sealing skirt 16) *with* '608 Patent Fig. 34 (fabric seal 380).

157. Elliot discloses that the skirt can be formed of any material used in preparing the tubular body, which includes fabric ("polyethylene terephthalate (PET),"

known commercially as Dacron), polymeric material, natural tissue, or combinations thereof. *Id.* at ¶¶ [0021]-[0022].

158. It would have been obvious to one of ordinary skill in the art to combine the teachings of Cribier and Elliot to further improve the sealing function of the fabric seal in Cribier and further minimize the risk of paravalvular leaks. In fact, Cribier published results of his first six THV procedures and, based on these results, recognized the need for improved sealing function against paravalvular leaks. *See* Ex. 1008, Alain Cribier *et al.*, "Early experience with percutaneous transcatheter implantation of heart valve prosthesis for the treatment of end-stage inoperable patients with calcific aortic stenosis," J. Am. Coll. Cardiol., 43(4): 698-703 (Feb. 18, 2004) ("[S]evere paravalvular aortic regurgitation might impair long-term clinical outcomes after [THV] [ ] implantation. Larger maximal stent diameters and other improvements in stent design might decrease the incidence and severity of paravalvular aortic regurgitation in the future.").

159. In my opinion, the teachings of Elliot (Ground 3) and Thornton (Ground 4) are substantially similar. This can be seen, for example, in a comparison between Elliot's Figure 7 and Thornton's Figure 1:

Elliot Figure 7

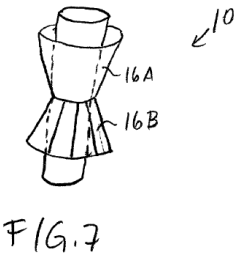


FIG.7

Thornton Figure 1

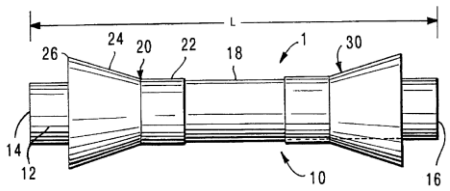


FIG.1

160. I am informed that Thornton, like Elliot, was not disclosed to the Patent Office during prosecution of the ’608 patent.

161. For the same reasons set forth above with respect to Elliot, it would have also been obvious to combine the teachings of Cribier and Thornton, rendering Claims 1-4 of the ’608 patent invalid.

162. Specifically, Thornton broadly discloses a sealing member for preventing leakage around implantable endoluminal devices. Ex. 1019 at 7:5-9. “The seal member is secured to the outer surface and is adapted to occlude leakage flow externally around the tubular wall between the outer surface and the endolumenal wall when the tubular member is deployed within the endolumenal body space.” *Id.* at 4:6-13. The device can include one or more sealing members and these sealing members can be formed with Dacron fabric, among other materials. *Id.* at 7:20-30, 8:31-54, 8:65-67. The flared construction of the sealing members can be imparted by the flow of blood. *Id.* at 7:31-42 (“[F]lange (26) is shown in a flared condition, which condition may be its relaxed geometry or may be a geometry imparted thereto by flow in the occluded direction.”).

163. As detailed with respect to Elliot, it likewise would have been obvious to one of ordinary skill in the art to combine the teachings of Cribier and Thornton to further improve the sealing function of the fabric seal in Cribier and further minimize the risk of paravalvular leaks. As with Elliot, the teachings of Thornton are not limited to stent grafts, and broadly apply to any "implantable endoluminal medical devices." *Id.* at 5:7-9. That said, even if Thornton or Elliot were limited to stent graft technology, from the earliest disclosures of transcatheter heart valves (*i.e.*, Andersen and his colleagues), it was well known to look to stent graft technology in forming external covers on THVs. *See supra* Section IV.E.; *see also* Ex. 1027 (Leonhardt) at 5:53-59 (discussing graft material for THVs); Ex. 1009 (Pavcnik) at ¶ [0012] (drawing equivalence between stent graft and THV fabric covers); Ex. 1002, 4/10/14 Non-Final Rejection at 2-3 (examiner's reliance on De Paulis stent graft). Moreover, the fact that seals described in Thornton were successfully commercialized as the Gore Excluder stent graft further supports the combination of Cribier with the sealing structures of the type disclosed by Elliot and Thornton as there would have been a strong likelihood of success that the sealing structures described by Elliot and Thornton would further improve the sealing function of Cribier. *See* Exs. 1025, 1026.

(c) Ground 5: Cribier in View of Cook (Claims 1-4)

164. I incorporate by reference each of the Cribier disclosures detailed above, *supra* Sections IV.E. and IX.A.

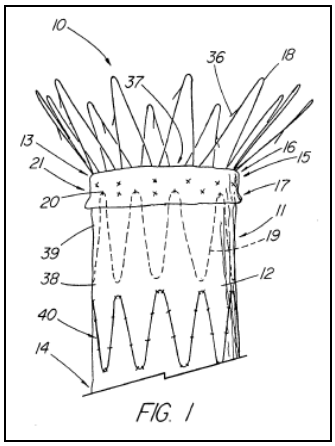
165. Separate from the formation of flaps and pockets formed by Cribier as described above and the flaps and pockets described by Spiridigliozzi, Elliot, and Thornton, it would have also been obvious to one of ordinary skill in the art to modify the fabric seal in Cribier to include an enhanced sealing structure having flaps and pockets as taught by Cook.

166. I am informed that the Cook prior art reference was not disclosed to the Patent Office during prosecution of the ’608 patent.

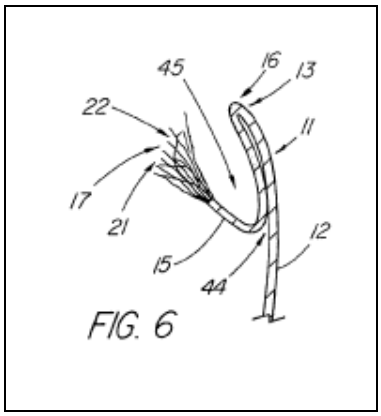
167. Cook discloses a stent graft having a fabric seal formed with Dacron polyester fiber. Ex. 1006, Cook at ¶ [0026]. As shown in Figure 1, the vascular prosthesis further includes:

> [A] cuff portion 15 comprising material of the main body 12 that is folded over the outside thereof to form a double layer of material. The cuff portion 15 includes a first edge 16 or leading edge, which is typically a folded edge, that also comprises the first end 13 of the graft portion 11, and extends distally to a second edge 17, which is the free edge of the cuff. In the illustrative cuff portion 15, the free edge 17 is unattached to the main body 12 so that it is allowed to extend or flair outward to comprise a lip that serves as an external sealing zone 21 to help provide a better seal graft portion 11 and walls of the vessel in which the device is placed. It should be noted that while it may be preferable to form the cuff portion 15 by folding the excess material over upon itself, it is also within the scope of the

invention for the cuff portion 15 to be a separate piece that is secured to the main body 12 of the graft portion, such that the proximal edges of the main body and cuff portion 13, 16 each comprise 'cut' or free edges rather than a single folded edge.



Id. at ¶ [0026], Fig. 1. Cook also discloses, as shown in Figure 6, the use of a seal that includes both a fold and an unattached end: "[the cuff portion could be folded over] to produce a fold 44 that creates gutter-like pocket 45 that is able to collect any blood passing around the leading edge 16 of the graft 11 to prevent an endoleak and promote thrombus formation":



Id. at ¶ [0036], Fig. 6.

168. Thus, Cook discloses various structures of "flaps" that can be adopted to seal the device to the surrounding tissue and "pockets" that will fill with the backflow of blood to prevent endoleaks.

169. It would have been obvious to one of ordinary skill in the art to combine the teachings of Cribier and Cook to further improve the sealing function of the fabric seal in Cribier and further minimize the risk of paravalvular leaks. As noted above, from the earliest disclosures of transcatheter heart valves (i.e., Andersen and his colleagues), it was well known to look to stent graft technology in forming external covers on THVs. *See supra* Section IV.E.; *see also* Ex. 1027 (Leonhardt) at 5:53-59 (discussing graft material for THVs); Ex. 1009 (Pavcnik) at ¶ [0012] (drawing equivalence between stent graft and THV fabric covers).

(d) Ground 6: Cribier in view of De Paulis (Claims 1-4)

170. I incorporate by reference each of the Cribier disclosures detailed above, *supra* Sections IV.E. and IX.A.

171. Separate from the formation of flaps and pockets formed by Cribier as described above and the flaps and pockets of Spiridigliozzi, Elliot, Thornton, and Cook, it would have also been obvious to one of ordinary skill in the art to modify the fabric seal in Cribier to include the circumferentially oriented "flaps" and "pockets" described by De Paulis.

172. In particular, the Patent Office has already concluded – and the applicants conceded the point – that "[a]n implantable fabric having pleats and pockets

is well known in the art, as taught by De Paulis in Figure 2" and it would have been obvious to modify a sealing structure "to include pleats as an obvious alternative design choice." Ex. 1002 ('608 patent File History), 4/10/14 Non-Final Rejection at 2-3.[14]

173. The aortic graft detailed by De Paulis (which can also include a prosthetic valve (*see id.* at 3:51-52)) is preferably made with Dacron, and includes, in part, "circumferentially extending pleats" or "corrugations" that "provide a degree of expansion in the longitudinal direction," thereby allowing the graft to "significantly increase its length" when the stent graft is elongated during delivery:

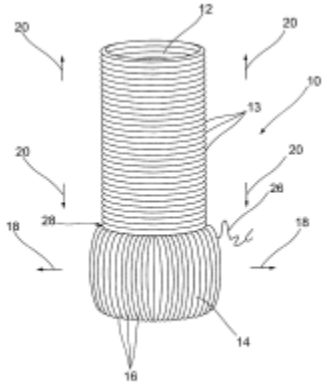


Fig. 2

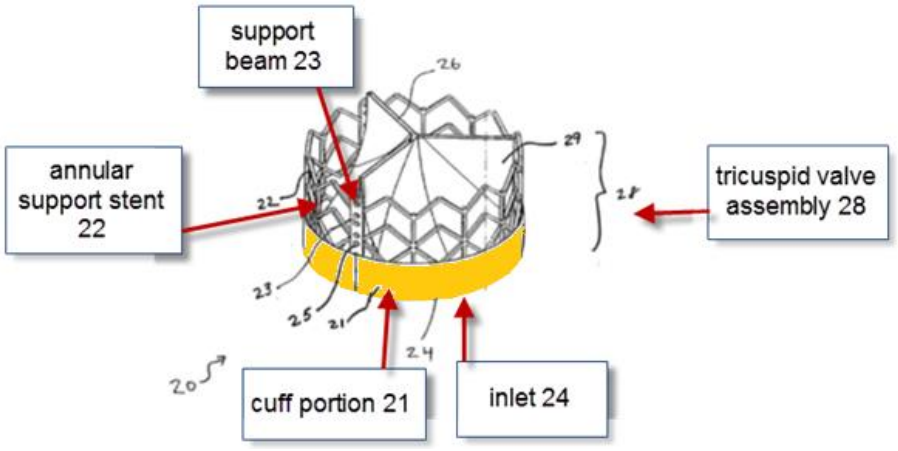
Ex. 1021 at 4:52-5:8, Fig. 2; *see also id.* at Fig. 1.

[14] Further confirming the well-known use of fabric seals having flaps and pockets are the stent grafts described in Section IV.D.-E., *supra*, including the transluminally deliverable Kononov, EVT, Talent, and Lunn stent grafts.

174. Accordingly, not only would the "flaps" and "pockets" structure disclosed by De Paulis have been an obvious design choice to adopt with the THV disclosed by Cribier, it also would have been obvious to combine the teachings of Cribier and De Paulis as the pleated structure of De Paulis permits the seal to significantly increase in length, which would be a desirable feature in light of the extensive foreshortening of the anchor in Cribier.

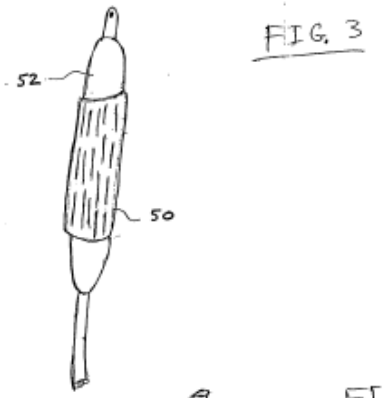
(e) Grounds 7-8: Spenser in view of Elliot (Ground 7) or Thornton (Ground 8) (Claims 1-4)

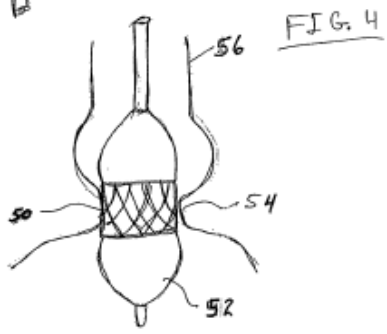
175. Spenser discloses a THV system for replacing a heart valve:



See, *e.g.*, Ex. 1004, Spenser at 1 ("The present invention relates to implantable devices. More particularly, it relates to a valve prosthesis for cardiac implantation or for implantation in other body ducts.") and Fig. 1 (annotations and highlighting added).

176. The THV disclosed by Spenser comprises an expandable anchor having a collapsed delivery configuration and an expanded configuration, the expandable anchor comprising a distal end:

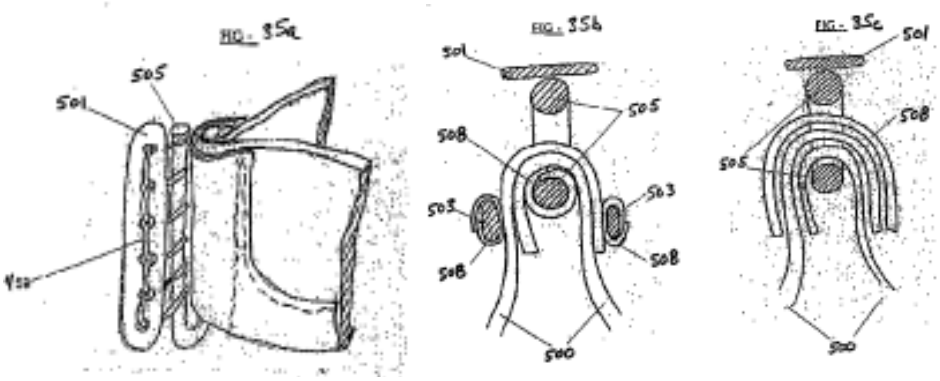




Id. at Figs. 3-4, pp. 14-15, 24 ("Figure 3 illustrates an implantable valve according to the present invention mounted over a stent with an inflatable balloon, in a crimped position"; "Figure 4 depicts implantable valve deployment in a natural aortic valve position in accordance with the present invention."). The anchor in Spenser is identified in the Figures above as "stent 50" wherein the distal end is the inflow end of the anchor. The anchor can be made with stainless steel or nickel-titanium alloy. *Id.* at p. 21.

177. The THV disclosed by Spenser also comprises both a replacement valve commissure support element attached to the expandable anchor and a commissure portion of a replacement valve leaflet attached to the commissure support element. There are multiple embodiments of the THV's commissure support element

and means of attachment of the valve to the commissure support element, one of which is depicted in Figures 35a-35c:

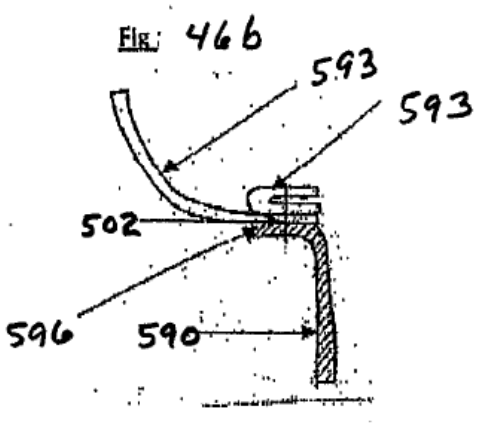


"Figures 35b and 35c depict different techniques of commissural attachments: in Figure 35b two pieces of pericardial leaflets 500 are wrapped around a metallic member 505 that is connected to a frame 501. Rigid members 503 are positioned from both sides of metallic member 505 that is connected to a frame 501. Rigid members 503 are positioned from both sides of metallic member 595 and then tightened together and connected by a suture 502. . . . Figure 35c depicts a similar structure, however, there is no use of rigid sidebars." *Id.* at p. 40 and Figs. 35a-35c; *see also id.* at Figs. 24a-c.

178. Spenser also discloses a fabric seal at least partially disposed around an exterior portion of the expandable anchor when the anchor is in the expanded configuration. As shown in Figure 1, *supra* ¶ 173, "a cuff portion 21 of the valve assembly 28 is wrapped around support stent 22 at inlet 24 to enhance the stability. Preferably cuff portion 21 of valve material 28 is attached to support beams 23." *Id.* at p. 22. The cuff portion can be formed with PET fabric (Dacron). *See, e.g.*,

id. at pp. 25, 33. Just as the THV as a whole has an undeployed and deployed state, the fabric seal of Spenser likewise has an undeployed and deployed state. *See, e.g.*, *id.* at Figs. 3-4. The distal end of the replacement valve leaflet is attached to the fabric seal, wherein the fabric seal, when the expandable anchor is in the collapsed configuration, extends from the distal end of the replacement valve and back proximally over the expandable anchor, the fabric seal being adapted to prevent blood from flowing between the fabric seal and heart tissue. *See id.* at p. 24 ("A portion of the valve assembly 34 at an inlet zone 45 is optionally rolled over support stent 32 at the inlet, making up a rolled sleeve, which enhances the sealing of the device at the valve inlet.").

179. Spenser discloses various means of attaching the valve to the frame and fabric seal, including embodiments where the distal end of the replacement valve leaflet is attached to the fabric seal with sutures:



See id. at 45-46 ("A pre-shaped PET tube 590 is cut to have substantially sinusoidal shape 596 and then bent in order to provide a suturing area. The pericardium leaflet

593 is pre-cut and assembled to PET tube 590 by means of suturing 502."), Figs. 46a-46b.

180. Spenser discloses that the THV is "deployed within the aorta thus anchoring the deployable annular stent and the coupled valve device in position." *Id.* at p. 10. This means that the stent is embedded into the surrounding tissue. Given that the THV would be anchored into place upon expansion, the fabric seal necessarily would conform to the surrounding tissue. *See supra* Section IV.D. (discussing the Hemobahn graft). This is further evidenced by the fact that the fabric seal in Spenser can be made with Dacron, which was well known to conform to the surrounding tissue. *See* Ex. 1027 (Leonhardt) at 5:53-56 ("biocompatible, flexible and expandable, low-porosity woven fabric[s], such as polyester or PTFE," are "capable of substantially conforming to the surface of the living tissue to which stent [ ] coerces it").

181. Spenser does not explicitly disclose whether the fabric seal, in the deployed state, comprises circumferential flaps that extend into spaces formed by the native valve leaflets and/or pockets adapted to fill with blood in response to backflow blood pressure.

182. It nonetheless would have been obvious to one of ordinary skill in the art to combine the teachings of Spenser with Elliot or Thornton to incorporate an enhanced sealing structure with circumferentially oriented "flaps" and "pockets" to further improve the sealing function of the fabric seal in Spenser and further minimize the risk of paravalvular leaks.

183. I incorporate by reference each of the Elliot (Ground 3) and Thornton (Ground 4) disclosures detailed above, *supra* Sections IV.D. and IX.B.(b). As noted above, from the earliest disclosures of transcatheter heart valves (i.e., Andersen and his colleagues), it was well known to look to stent graft technology in forming external covers on THVs. *See supra* Section IV.E.; *see also* Ex. 1027 (Leonhardt) at 5:53-59 (discussing graft material for THVs); Ex. 1009 (Pavcnik) at ¶ [0012] (drawing equivalence between stent graft and THV fabric covers). The fact that seals described in Thornton were successfully commercialized as the Gore Excluder stent graft further supports the combination of Spenser with Elliot or Thornton, as there would have been a strong likelihood of success that the sealing structures described by Elliot and Thornton would further improve the sealing function of Spenser. *See* Exs. 1025, 1026.

(f) Ground 9: Spenser in view of Cook (Claims 1-4)

184. I incorporate by reference each of the Spenser disclosures detailed above, *supra* Sections IV.E. and IX.B.

185. Separate from the formation of flaps and pockets described by Elliot and Thornton, it would have also been obvious to one of ordinary skill in the art to modify the fabric seal in Spenser to include an enhanced sealing structure having flaps and pockets as taught by Cook.

186. I incorporate by reference each of the Cook disclosures detailed above, supra Sections IV.D. and IX.B.(c).

187. It would have been obvious to one of ordinary skill in the art to combine the teachings of Spenser and Cook to further improve the sealing function of the fabric seal in Spenser and further minimize the risk of paravalvular leaks. As noted above, from the earliest disclosures of transcatheter heart valves (*i.e.*, Andersen and his colleagues), it was well known to look to stent graft technology in forming external covers on THVs. *See supra* Section IV.E.; *see also* Ex. 1027 (Leonhardt) at 5:53-59 (discussing graft material for THVs); Ex. 1009 (Pavcnik) at ¶ [0012] (drawing equivalence between stent graft and THV fabric covers).

(g) Ground 10: Spenser in view of De Paulis (Claims 1-4)

188. I incorporate by reference each of the Spenser disclosures detailed above, *supra* Sections IV.E. and IX.B.(e).

189. Separate from the formation of flaps and pockets described by Elliot, Thornton, and Cook, it would have also been obvious to one of ordinary skill in the art to modify the fabric seal in Spenser to include an enhanced sealing structure having flaps and pockets as taught by De Paulis.

190. I incorporate by reference each of the De Paulis disclosures detailed above, *supra* Sections IV.D. and IX.(B).(d).

191. Not only would the "flaps" and "pockets" structure disclosed by De Paulis have been an obvious design choice to adopt with the THV disclosed by Spenser, it also would have been obvious to combine the teachings of Spenser and De Paulis as the pleated structure of De Paulis permits the seal to significantly increase in

length, which would be a desirable feature in light of the anchor design in Spenser. Even with a smaller degree of anchor foreshortening, it remains desirable to select a seal design that can accommodate extension in the axial direction.

C. Ground 11: Spenser Anticipates Claims 1-4 of the '608 Patent

192. I incorporate by reference each of the Spenser disclosures detailed above, *supra* Sections IV.E. and IX.B.(e).

193. As noted above, it is my opinion that Spenser discloses each element of Claims 1-4 of the '608 patent except for circumferentially oriented "flaps" and "pockets" as claimed. But, when applying Boston Scientific's broad interpretation of "flaps" (i.e., no "circumferentially oriented" directional requirement), Spenser discloses "flaps" and "pockets" in the form of pleats that are longitudinally oriented.

194. First, Spenser details that the valve prosthesis "has the ability to change its diameter from about 4 mm to about 25 mm." Ex. 1004 at 47. Any fabric seal used would necessarily have to accommodate this range of expansion. Thus, to the extent that the prosthesis described by Spenser is expanded to treat an annulus size of a patient short of the prosthesis' maximum diameter, excess fabric would surround the prosthesis, thereby forming longitudinally oriented pleats of the type described by Lawrence. *See supra* Section IV.D.

195. Second, Spenser discloses the use of a crimping device that applies external pressure to compress the THV into its delivery state. *See* Ex. 1004 at 32 and Figs. 18a-b. As Boston Scientific asserts, this will form a pleated structure that

remains pleated after re-expansion. *See* Ex. 1032 at 46-48; *see also supra* Section V (describing longitudinally oriented pleats of Bessler). Spenser's fabric seal will therefore form "flaps" (and associated "pockets"), which in the deployed state, extend into spaces formed by native valve leaflets and further prevent the flow of blood between the frame and surrounding tissue.

196. Thus, when applying Boston Scientific's broad interpretation of "flaps", Spenser in combination with the references detailed above not only renders obvious the "flaps" and "pockets" limitations as claimed, Spenser alone also anticipates these requirements.

X. CONCLUSION

197. In connection with the above, I have reviewed, had input into, and endorse as set forth fully herein the invalidity analysis in the accompanying Petition showing that each element of Claims 1-4 is anticipated or rendered obvious by the prior art references set forth therein.

198. For my efforts in connection with the preparation of this Declaration I have been compensated at my standard hourly rate for this type of consulting activity. My compensation is in no way contingent on the results of these or any other proceedings.

199. In signing this Declaration, I understand that the Declaration will be filed as evidence in a review proceeding before the Patent Trial and Appeal Board of the U.S. Patent and Trademark Office. I acknowledge that I may be subject to cross

examination in the case and that cross examination will take place within the United States.

200. I hereby 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 the Title 18 of the United States Code and that such willful false statements may jeopardize the results of these proceedings.

Dated: 10th October __, 2016

Dr. Nigel P. Buller

Exhibit “A”

Curriculum Vitae

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Membership of Societies and Associations:

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1-6-85 to 31-2-86	Project Chairman Cardiovascular Development Smith Kline & French Research Limited, Philadelphia PA. USA.

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