Filed on behalf of: RapidPulse, Inc.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

PENUMBRA, INC.,
Petitioner,

v.

RAPIDPULSE, INC.,
Patent Owner.

Case IPR2024-01261
Patent 11,406,402

DECLARATION OF BRAD CULBERT IN SUPPORT OF PATENT OWNER'S PRELIMINARY RESPONSE

RapidPulse, Inc.
Exhibit 2001
Penumbra v. RapidPulse
IPR2024-01261
Ex. 2001

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I. Introduction

1. I have been retained as an expert by RapidPulse, Inc. ("RapidPulse") to provide my analysis and conclusions on certain technical aspects of this dispute. I understand RapidPulse is the Patent Owner and that Penumbra, Inc. ("Penumbra") is the Petitioner in this case. I understand that Petitioner has challenged the patentability of claims 1-20 (the "Challenged Claims") of U.S. Patent No. 11,406,402 (the "'402 patent").

2. I have been asked to provide my opinions as to whether the Challenged Claims are patentable. My opinions and the bases for them are set forth in this Declaration.

II. Qualifications

3. I am a medical device engineer with substantial experience designing and developing thrombectomy systems and devices for removing blood clots from vessels in various parts of the body. In forming the opinions expressed in this Declaration, I have considered and relied upon my education, background, and experience. My experience, qualification, and education are detailed in my *curriculum vitae* ("CV"), a copy of which is attached as Exhibit 2002. My CV also lists my relevant thrombectomy patents and identifies parties on behalf of whom I have previously provided expert testimony.

4. I received a Bachelor of Applied Science degree in Metals and Materials Engineering from the University of British Columbia in 1992. Later, I received a Master's degree in Business Administration from California State University, Fullerton in 2001.

5. In 1994, I accepted a position as a manufacturing engineering at Vas-Cath Inc. and was later promoted to Angioplasty Product Team Leader. Vas-Cath was a privately held company focused on developing and distributing dialysis and angioplasty catheters. I led a team of research and development, manufacturing, and quality engineers in improving and maintaining the company's angioplasty catheter product lines.

6. In 1996, I accepted a position as an R&D Project Manager at CVD. CVD was a cardiovascular company focused on developing new angioplasty balloons and stents with focal technology. While at CVD, I designed and developed new percutaneous transluminal coronary angioplasty ("PTCA") catheters and stent delivery systems and participated in the preparation and filing of regulatory documents.

7. In 1998, I accepted a position as Senior R&D Project Manager at EndiCOR Medical, Inc. EndiCOR Medical was a venture-backed startup company focused on developing percutaneous thrombectomy and atherectomy systems for cardiovascular and neurovascular applications. While at EndiCOR

Medical, I invented a new smaller profile clot cutting mechanism that was optimized for a new neuro thrombectomy system. I designed and developed an aspiration system that cuts larger channels through in-stent restenosis. I also worked on improvements to existing coronary thrombectomy systems, including, but not limited to, new lower profile drive shaft to optimize aspiration, developed a laser cut hypotube catheter shaft that is thinner to optimize aspiration, and made improvements to the cutter to break up the clot more efficiently for easier aspiration, etc.

8. In 2000, I was hired as the first employee at Interventional Spine, Inc. (formerly known as Triage Medical, Inc.). I was initially hired as Director of Engineering but was quickly promoted to Vice President of Research and Development. I was later promoted to Chief Technology Officer. While at Interventional Spine, I oversaw the design and development of a series of orthopedic trauma and spine devices for a variety of surgical procedures.

9. Beginning in 2010, I started my own consulting business focused on medical device companies. I currently advise medical device companies across a range of disciplines, including product development, regulatory approval, manufacturing, intellectual property procurement, and financing. My consulting work involves consulting on aspiration technology. For example, I work with Incuvate to manage the patent portfolio for various medical device companies

incubated by Incuvate. One such company, Walk Vascular, hired me to develop their next generation coronary and peripheral thrombectomy system. My development goal was to take their completely disposable coronary thrombectomy system and develop a reusable saline drive unit to provide high-pressure saline to the disposable catheter. The high pressure saline is used to break up clots at the distal tip of the catheter as the clot is aspirated. The next step was to develop a larger version of the catheter for peripheral use, which involved making the catheter larger and over the wire instead of using rapid exchange delivery. I have also developed a new saline jet hole that provides a more effective way of cutting clot at the tip of the catheter. I also optimized the saline jet pressure and pulse frequency for improved clot maceration and aspiration. I then led all internal efforts to transfer the device to production and then the transition of production to Abbott after the company was acquired by Abbott.

10. Also, during my experience working with Incuvate, I invented and developed a method of monitoring system pressure to detect when catheters are aspirating clots versus aspirating free flowing blood to minimize blood loss to the patient. In addition, I invented a telescoping aspiration catheter, with and without a saline jet, to increase the aspiration force at the tip of the catheter. Several patents have been issued on both of these technologies.

11. I am currently working on a new neuro aspiration catheter for ischemic stroke. The technology is based on the same jet technology as Walk Vascular but with a new method of delivering the pulsating saline jet to the tip of the catheter to break up the clot as it is being aspirated. I am also incorporating a different vacuum system compared to Walk Vascular's vacuum pump to simplify and make the system more user friendly. Further, the catheter is different and optimized for tracking the tortuous neurovasculature.

12. In addition to my professional experience and education, I am listed as an inventor on over 38 U.S. issued and pending patents relating to peripheral, coronary, and neuro thrombectomy systems for removing blood clots from vessels.

13. Based on my work with EndiCOR Medical, Walk Vascular, and Incuvate, I am very familiar with thrombectomy systems and with the functional requirements to safely remove blood clots from various vessels of the body. I am also familiar with and understand the procedures used to treat patients with blood clots in various locations in the body. I am familiar with the effects of how clots are aspirated through a catheter and the importance of breaking up the clot at and/or in the tip of the catheter, so it does not clog the catheter as the clot advances through the lumen of the catheter.

14. Based on my education and professional experience, I believe I am an expert in the relevant field of the '402 patent and have been an expert in this field since before the first provisional patent for the '402 patent was filed with the United States Patent and Trademark Office ("USPTO"). I am familiar with how a person of ordinary skill in the art ("POSA") would have understood and used the terminologies found in the '402 patent as of the date of the invention.

III. Summary Of Analysis And Conclusions

15. In my opinion, Petitioner fails to show that any claim of the '402 patent is unpatentable. In particular, Petitioner fails to demonstrate claim 1 and all dependent claims are rendered obvious by Yang in view of Mullins and the knowledge of a POSA. In addition, Petitioner fails to demonstrate that claim 1, and all claims dependent on it, are rendered obvious by Ofek in view of Mullins and the knowledge of a POSA. This Declaration focuses on the deficiencies in Petitioner's analysis for claim 1. I reserve my right to opine on other claims in this or other proceedings. I explain the bases for my opinion in detail in this Declaration.

IV. Summary Of Materials Reviewed And Considered

16. All of the opinions contained in this Declaration are based on the documents I reviewed and my knowledge and professional judgment. In forming

the opinions expressed in this Declaration, while drawing on my experience in the field of thrombectomy systems, I reviewed the following documents:

- Petition for *Inter Partes* Review of U.S. Patent No. 11,406,402, and the exhibits to the Petition;
- IPR2021-01466 and IPR2022-00608 Final Written Decisions;
- IPR2021-01466 Exs. 1005, 1023, 1030, 2016;
- IPR2022-00608 Exs. 1005, 1023, 2018; and
- *Cardiovascular Thrombus: From Pathology & Clinical Presentations To Imaging, Pharmacotherapy & Interventions*, The Role of Interventional Cardiology in the Management of Thrombotic Conditions in the Pediatric Population

V. Legal Standards

17. I understand that determining whether a given prior art reference anticipates a patent claim is a two-step process. First, the claims must be properly construed. Second, one evaluates whether a single prior art reference discloses each of the properly construed limitations of the claim. I understand that under an anticipation analysis, a single prior art reference must describe each element of the claimed invention, as arranged in the claim. If the prior art reference explicitly or inherently discloses each of the claim limitations, I understand that the prior art reference anticipates the claim and thereby renders

that claim invalid. I understand that for a claim limitation to be inherently disclosed, the reference must necessarily include the claim limitation that is not explicit in the reference.

18. I further understand that mere disclosure of each and every limitation may not be sufficient for a prior art reference to anticipate a claim. I understand that an anticipating reference must enable that which it is asserted to anticipate, meaning the reference must provide to the public an enabling disclosure of the claimed subject matter that permits the public to practice the subject matter without undue experimentation.

19. I understand that a patent claim is invalid for obviousness if the differences between the claimed invention and the prior art would have been obvious to a person of ordinary skill in the art before the filing date of the claimed invention.

20. I understand that determining whether a prior art renders a patent claim invalid as obvious is a two-step process. First, the claims must be properly construed. Second, the properly construed claim is compared against the prior art to determine whether a person of ordinary skill in the art would have found the claimed invention obvious in light of the prior art. I understand that a determination of whether or not a claim would have been obvious requires determining the scope and content of the prior art, ascertaining differences

between the prior art and the claims at issue, resolving the level of skill in the pertinent art, and assessing evidence of secondary considerations when such evidence is presented.

21. I further understand that a claim involving multiple components is not proved obvious just by demonstrating that each element was independently known in the art. Even when all elements were independently known in the art at the time of invention, the obviousness inquiry must still determine whether one of ordinary skill in the art would have had a reason to combine the known elements as expressed in the claim and have had a reasonable expectation of success in doing so.

22. Although I understand that evidence of motivation to combine in the prior art is not required, I understand that it is still important to identify a reason that would have prompted a person of ordinary skill in the art to combine the elements as the invention does.

23. I understand that a prior art reference teaches away from the claimed invention if one of ordinary skill in the art, upon reading the reference, would have been led in a different direction from the path taken by the invention. I further understand that each prior art reference may teach away to different degrees and thus each reference must be examined for what it in fact teaches. I understand that if a person of ordinary skill in the art would not have believed at

the time of the invention that a particular combination of prior art references would have had a reasonable expectation of success, such a combination may not be obvious.

24. I understand that, because the obviousness determination is based on the knowledge of one of ordinary skill in the art at the time of the invention, it is impermissible to use the benefit of hindsight or to rely on the teachings of the claimed invention to determine whether a person of ordinary skill in the art would have found the invention obvious.

VI. Brief Technical Background

25. Blood clots that block or prevent blood flow in a vessel in the brain often cause ischemic strokes. The clot can prevent blood from flowing to the brain, which leads to brain damage and death. Most treatments involve thrombectomy, which is a class of minimally invasive procedures for the removal of the clot by aspiration (i.e., suction), mechanical retrieval, or some combination of the two, to restore blood flow through the occluded blood vessel.

26. Aspiration thrombectomy involves positioning a catheter, coupled to a vacuum source, immediately upstream of the clot and drawing the clot into the catheter. Mechanical thrombectomy involves entrapping the clot material with a stent or mesh that engages the thrombus and then extracting the mesh and clot material through a catheter. Some thrombectomy systems combine the two

methods by first engaging the clot material with a stent or mesh to entrap the clot material, and then applying suction to the clot as the mechanical device is withdrawn through the catheter.

27. Aspiration is conceptually effective, but some significant problems occur in practice.

28. As the '402 patent explains, "[t]he basic configuration for an aspiration catheter includes a length of hollow catheter having a proximal end fluidically connected to a vacuum or suction pump." Ex. 1001, 1:55-58. In this basic configuration, "operation of the suction pump causes fluid and particulates at the distal end of the catheter to enter the distal opening of the hollow lumen and travel to the proximal end of the lumen near or into the suction pump." *Id.*, 1:58-62. "Ideally, this system aspirates the clot entirely out of the neurovasculature and to the proximal end of the aspiration catheter so that extraction and re-establishment of blood flow could be confirmed." *Id.*, 2:4-8. "In practice, however, this rarely occurs." *Id.*, 2:7-8.

29. This is because "[t]hrombi are frequently of a larger diameter than the catheter being used to aspirate them." Ex. 1001, 2:9-10. Therefore, "[f]or aspiration to be successful, the thrombus must deform to conform to the inner diameter of the aspiration catheter." *Id.*, 2:10-12. "During conventional aspirations, it is common for applied vacuum to partially draw a thrombus into

the distal opening of the aspiration catheter's lumen, thereby deforming some of the thrombus to the catheter's inner diameter." *Id.*, 2:12-16. However, "[a]t this point, the thrombus becomes lodged completely within, partially within, or at the distal opening of the aspiration catheter, a condition that can be referred to as corked or corking." *Id.*, 2:16-19. It is not viable to "revers[e] the suction to pressurize the clot and eject it forcibly and uncontrollably out of the distal opening of the aspiration catheter," because such distal movement "could permanently lodge the clot into that vessel, making it impossible to remove, or it could burst the vessel." *Id.*, 2:23-25. "Those of skill in the art know that these situations are to be avoided because of the serious potential risks to the patient." *Id.*, 2:35-37.

VII. The '402 Patent

A. Summary Of The '402 Patent

30. The inventions of the '402 patent relate to an aspiration thrombectomy system to overcome the problems described above. *See* Ex. 1001, 3:26-34. The basic configuration of an aspiration thrombectomy system "includes a length of hollow catheter … connected to a vacuum or suction pump … [where] operation of the suction pump causes fluid and particulates at the distal end of the catheter to enter the distal opening of the hollow lumen." *Id.*, 1:55-61. In other words, the '402 patent relates to a thrombectomy system where

a catheter is used to aspirate clots out of blood vessels. The '402 patent teaches features that address the challenges of conventional aspiration catheter systems, including by controlling "fluid flow in and out" using "a predetermined cycle." *Id.*, cl. 1.

31. The '402 patent clarifies that the claimed controlling of "fluid flow in and out from the distal end of the catheter" addresses the problem of the clot clogging at the distal end of the catheter without ejecting the clot uncontrollably out of the distal opening. The '402 patent thus teaches that when clogging occurs, "[t]he controller is actuated to cause the fluid column to shift distally to the shift distance." Ex. 1001, 26:17-19. "This imparts a controlled reversal of flow to the fluid column within the vacuum channel … that slightly translates the thrombus to a prescribed shift distance … distally relative to the distal opening of the vacuum channel." *Id.*, 26:19-23. After this controlled flow unclogs the distal end, "the controller 10 re-applies vacuum," "and the thrombus 4 accelerates back into the vacuum channel 3." *Id.*, 27:20-23.

32. The '402 patent discloses that "[t]he flow of fluid forward in this exemplar embodiment is intentional, which is in contrast to other exemplary embodiments herein where substantially no forward flow occurs." Ex. 1001, 36:67-37:2. Specifically, "[t]he inventors have discovered that such movement causes either a repositioning of the thrombus or a deformation of the thrombus or

both and that this movement allows the thrombus to pass entirely into and through the vacuum channel … where such passage was not possible before." *Id.*, 26:26-31. "With one or just a few applications to displace the thrombus by the shift distance … with the controller …, the vacuum channel … becomes unclogged." *Id.*, 27:24-27.

33. The '402 patent also discloses "a predetermined cycle." "[T]he controller operating parameters comprise a catheter identifier and the controller is configured to receive the catheter identifier in the automatic response to the catheter being operatively connected to at least one of the vacuum source and the controller and, responsive to the connection, to carry out a pre-determined control pattern associated with the catheter identifier to change the level of vacuum at the distal end of the catheter." Ex. 1001, 12:52-60. In other words, there is a "predetermined cycle" for each catheter where both the pressure amplitude and the period of time that vacuum and positive pressure are applied are set in advance. *Id.*, 9:9-14.

B. Prosecution History

34. I note that, in allowing the claims of the '402 patent, the patent examiner provided the following "statement of reasons for allowance":

> [T]he prior art does not teach or suggest, in the context of the claim, a controller configured to open and close the vacuum valve and the vent valve in a predetermined cycle to change the level of vacuum

> applied to the catheter. Garrison (US 21060220741) discloses a similar device, but the controller disclosed in [0113] changed the cycle of opening and closing the valves based on feedback from sensors and is not a pre-determined pattern.

Ex. 1004, 86. The Examiner stated that the claims of the '402 patent were allowable in particular because the claims recite a controller that is configured to use "a predetermined cycle," as opposed to a controller that "changed the cycle of opening and closing the valves based on feedback from sensors," which is "not a pre-determined pattern." *Id.*

C. Claim Construction

35. It is my opinion that Petitioner fails to show the prior art references render the subject matter of the Challenged Claims unpatentable under any reasonable construction, including their plain and ordinary meaning.

36. It is my opinion that Petitioner's proposal to construe "a positive amount of exit flow" to "includ[e] no exit flow" is incorrect. Pet. 15-16. By its plain terms, "a positive amount" is an amount that is positive, or greater than zero. A POSA would understand "a positive amount of exit flow" requires some non-zero exit flow, so "a positive amount of exit flow" cannot "includ[e] no exit flow." *Id.*

D. Level Of Ordinary Skill In The Art

37. It is my understanding that Petitioner proposes the following description of a POSA:

> A POSA at the relevant time would be either (1) a person with a B.S. in engineering or an equivalent field, with two-four years of academic or industry experience in aspiration embolectomy and thrombectomy or comparable industry experience who would, where appropriate, work or consult with others, including a physician, to develop embolectomy or thrombectomy devices; or (2) an interventional neurosurgeon with at least three years of experience developing and/or using medical devices in embolectomy or thrombectomy procedures, and who would, where appropriate, work or consult with others, including an engineer, to develop such a medical device. A person with less education but more relevant practical experience, or more relevant education but less practical experience, may also meet this standard.

Pet. 11. For purposes of this Declaration, I have applied Petitioner's definition of a POSA, but reserve my right to provide an alternate definition in this or other proceedings. In addition, I note that, while I exceed this level of skill, I am familiar with the qualifications and capabilities of others in the relevant art with this level of skill and am able to provide testimony from the perspective of a POSA with this level of skill.

VIII. Grounds 1-3: In My Opinion, Petitioner Has Not Shown That Claim 1, And Thus All Claims Dependent On It, Are Rendered Obvious By Yang In View Of Mullins And The Knowledge Of A POSA

38. I understand that Petitioner contends that claims 1-20 of the '402 patent are rendered obvious by Yang in view of Mullins. In my opinion, Petitioner has not established a reasonable basis to conclude that any claim of the '402 patent would have been obvious based on Yang alone or in combination with Mullins.

A. Summary Of Prior Art References

1. Yang (Ex. 1012)

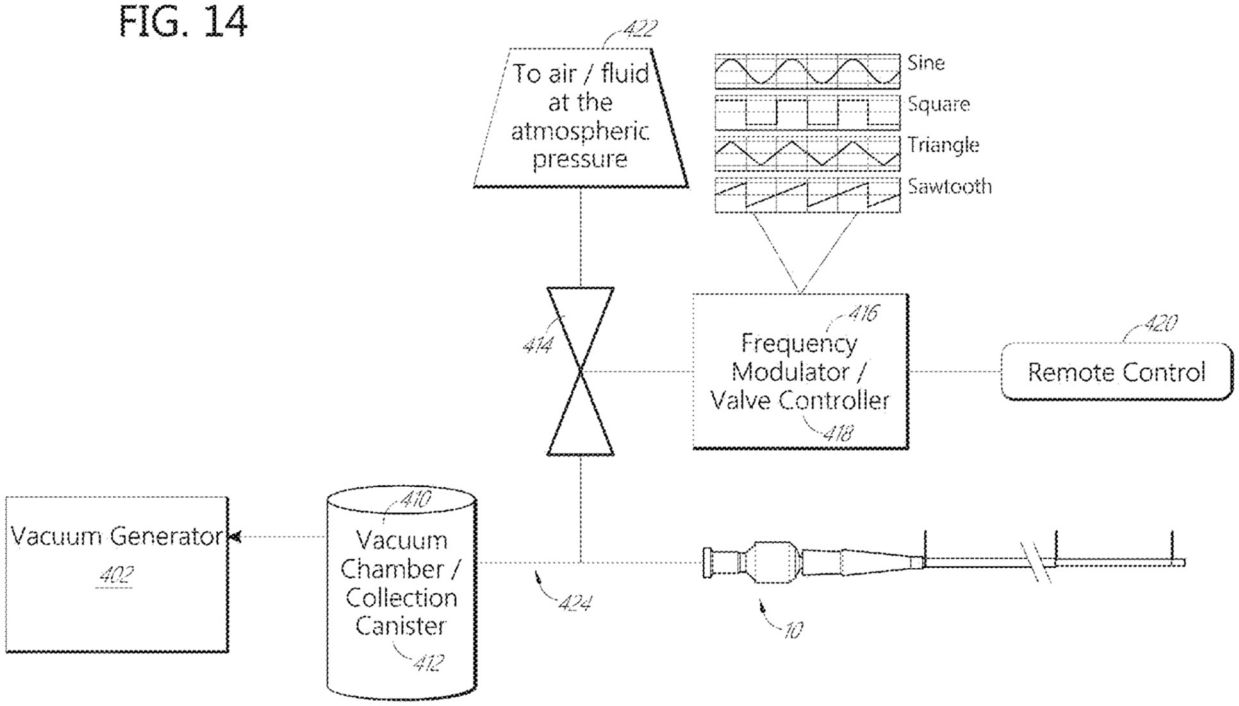
39. Yang is a published patent application titled "Telescoping Neurovascular Catheter With Active Distal Tip." A POSA would understand Yang to be very different than the invention in the '402 patent.

40. Yang discloses that the "telescoping catheter is provided such as for distal neurovascular aspiration" and discloses that the telescoping catheter's "distal sections may be provided with at least one active feature, such as at least one movable jaw or rotatable agitator, to assist in the capture of vascular obstruction." Ex. 1012, Abstract. In discussing the "variety of structures" that the active feature may have, Yang discloses "an axially movable control wire," "a pivot point or hinge," and "flexible petals." *Id.*, [0077]-[0080]. Yang discloses that these structures "provide an active movement such as a biting action in response to the application of an activation force such as a vacuum in lumen 40."

Id., [0077]. These active features also have "the capability to dilate beyond the nominal diameter of the distal section 34," which "provides a conical funnel like tip with an enlarged distal opening, to facilitate introduction of thrombotic material into the lumen 40." *Id.*, [0079].

41. Yang discloses aspirating the clot into the lumen of the catheter "upon application of constant or pulsatile negative pressure within or without the use of jaws or other activation on the distal end of the distal section 34." Ex. 1012, [0100]. The "pulsatile application of vacuum will cause the distal tip 38 to open and close like a jaw, which facilitates reshaping the thrombectomy or biting or nibbling the thrombus material into strands or pieces to facilitate proximal withdrawal under negative pressure through lumen 40." *Id.*, [0101]. Specifically, as shown in Figure 14 copied below, Yang discloses that a "solenoid valve 414 is positioned in and fluidly connects between the air/fluid reservoir 422 at the atmospheric pressure and the aspiration line 424 connecting the catheter 10 to the vacuum chamber 410/collection canister 412." *Id.*, [0131]. Notably, "this system modulates pressure in the catheter 10 by allowing pressure to vary from vacuum to atmospheric pressure." *Id.*

FIG. 14



42. Yang also discloses, referring to Figures 25A-25C copied below, that "experiments showed that an interrupted vacuum can help aspirating a corked clot stuck at the distal end 2512 of the catheter 2510 by loosening the clot and reshaping it to fit into the catheter 2510 after each vacuum and release cycle." Ex. 1012, [0168]. Yang discloses that "[c]ompletely releasing (venting to atmospheric pressure) the vacuum and allowing the clot to relax before reapplying a vacuum is found to aspirate the corked clot most efficiently." *Id.*

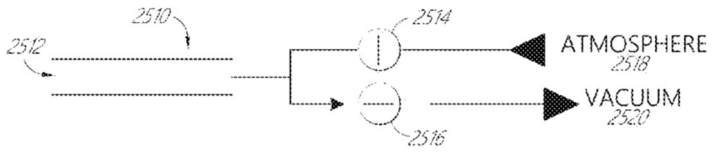


FIG. 25A

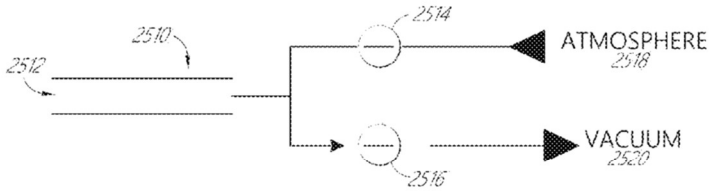


FIG. 25B

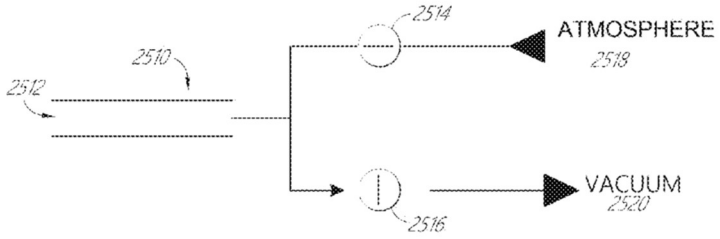


FIG. 25C

43. As shown in Figure 25A, initially, the vent valve is closed and the vacuum valve is open "such that the vacuum is applied to the catheter 2510 to aspirate the clot." Ex. 1012, [0170]. Then, in Figure 25B, the vacuum valve stays open when the vent valve also opens, "dropping vacuum applied to the catheter." *Id.* Finally, in Figure 25C, the vacuum valve closes before the cycle restarts again.

44. In addition, Yang discloses that "[t]he intensity of intermittent or pulsatile vacuum applied to lumen 40 may be adjusted to cause the distal tip 38 of the catheter 10 to experience an axial reciprocation or water hammer effect, which can further facilitate both transluminal navigation as well as dislodging or breaking up the obstruction." Ex. 1012, [0108]. Yang explains that a water hammer commonly occurs "when a solenoid or valve closes and stops and fluid flow suddenly," causing "a pressure surge or wave" to be generated inside the lumen. *Id.* "As the pressure wave propagates in the catheter 10, it causes the catheter 10 to axially vibrate," which "can reduce surface friction between the outer diameter of the catheter 10 and the inner diameter of the vessel wall," enabling the "catheter to track through tortuous anatomies as well as assist capturing thrombus." *Id.*

2. Mullins (Ex. 1008)

45. Mullins discloses an aspiration system that "employ[s] the catheter with a pump which dynamically applies negative or positive pressure to optimally aspirate a clot." Ex. 1008, Abstract. "The system may comprise a lumen pressure sensor and the controller is configured to vary aspiration pressure according to sensed pressure within the catheter lumen." *Id.*, 3:32-35. In other words, "the controller may provide a vacuum or a positive pressure based on measured pressure, and change direction hence altering the pressure and fluid

displacement." *Id.*, 3:56-59. Further, "[t]he controller may have defined upper and lower limits of pressure or displacement to decide whether to apply a vacuum or pressurize." *Id.*, 3:60-62.

46. Notably, "[t]he pump incorporates a sensor which measures the pressure in the catheter lumen." Ex. 1008, 26:35-37. Mullins discloses that "[t]he pump will continuously measure the pressure within the catheter lumen during the procedure." *Id.*, 26:55-56. "The magnitude of this pressure may be used to decide whether a vacuum or pressurizing signal should be applied to the catheter." *Id.*, 26:38-40. Mullins also discloses that "[a] novel aspect of this pump system is the incorporation of feedback into the pump algorithm in order to produce more effective pressure cycling;" in other words, "the ability of the pump to measure the condition in the pump (e.g., pressure or fluid displacement), and continue or alter its behaviour." *Id.*, 27:48-53. An exemplary pump described by Mullins is illustrated in Figure 45, copied below.

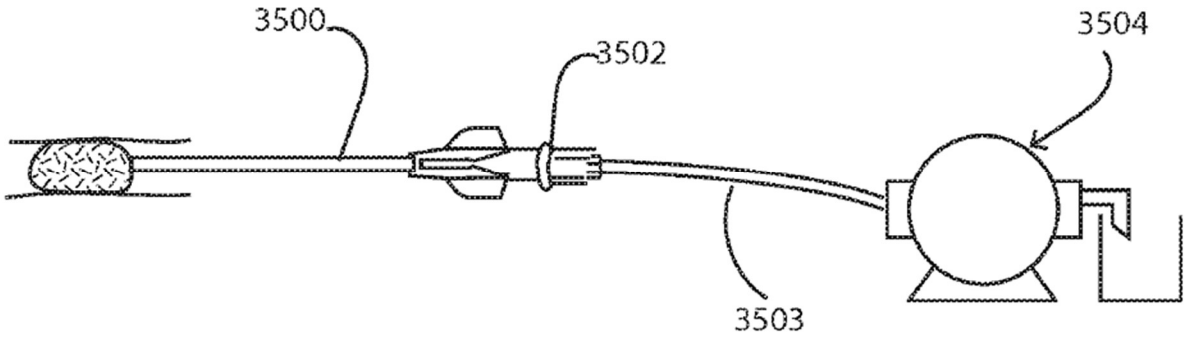


Fig.45

47. Initially, "the pump applies a vacuum enabling the catheter to ingest some of the clot." Ex. 1008, 26:65-66. When the efficiency of ingesting more clot is reduced, "the pump will reverse at some Low Limit of pressure," which "is defined such that during vacuum, a portion of the clot has been aspirated but not so much that the clot has become irreversibly clogged." *Id.*, 26:67-27:6.

48. Then, "[t]he direction of fluid displacement of the pump is now reversed," "thereby increasing the pressure measured." Ex. 1008, 27:18-20. "As the catheter is pressurized (vacuum is reversed), the load which was applied to ingest the clot will be reduced, thereby unloading the clot, and even allowing some or all of the clot to be pushed distally towards the catheter tip," so that the clot "becomes more 'free' within the catheter." *Id.*, 27:21-26. "The pressure is further increased until a High Limit is reached," which "is defined such that the ingested clot may not be completely expelled from the catheter." *Id.*, 27:27-30. "Additional cycling of the clot between the Low Limit and high limit (FIG. 47 (i) to (j)) further macerates the clot … with eventual complete ingestion of the clot, FIG. 47 (n)." *Id.*, 27:31-35.

B. Petitioner fails to show it would have been obvious "to control fluid flow … out from the distal end of the catheter" using "a controller configured to open and close the vacuum valve and the vent valve in a predetermined cycle"

49. Petitioner claims that "Yang alone or in view of Mullins discloses or renders … obvious" the claim limitation "to control[] fluid flow in and out from

the distal end of the catheter." Pet. 33. A POSA would understand that Petitioner fails to identify such disclosure in Yang alone or in Petitioner's proposed combination of Yang and Mullins, or identify a reason why a POSA would have combined Yang and Mullins as Petitioner proposes, as explained in detail below.

1. Yang alone does not disclose or render obvious "a controller … to control fluid flow in and out from the distal end"

50. It is my opinion that Yang does not disclose or render obvious "a controller … to control fluid flow in and out from the distal end." For this limitation, Petitioner offers only two sentences:

> Yang discusses controlling fluid flow in and out from the distal end of the catheter. Ex[1012], ¶¶[0108], [0135], [0168]. ("pulsatile vacuum applied to lumen 40 may be adjusted to cause the distal tip 38 of the catheter 10 to experience an axial reciprocation or water hammer effect….") A POSA would have understood that this reciprocation would cause fluid to move partially in and out at the distal end. Ex[1005], ¶¶149-151.

Pet. 33 (original alternations). As discussed in more detail below, the citations that Petitioner relies on in Yang do not disclose or render obvious "a controller … to control fluid flow in and out from the distal end." Petitioner also fails to provide support for its assertion that a POSA would have understood the axial reciprocation or water hammer effect described in Yang to cause flow out.

a. Yang's Paragraph [0108] does not disclose or suggest controlling flow in and out

51. Petitioner first cites Yang's Paragraph [0108] to argue that Yang discloses controlling flow in and out at the distal end of the catheter. But Petitioner fails to show any disclosure or suggestion of flow out, not to mention any control of such flow out as required by claim 1 of the '402 patent. A POSA would not understand the language in Paragraph [0108] as disclosing or suggesting controlling flow in and out.

52. Yang Paragraph [0108] states that "[t]he intensity of intermittent or pulsatile vacuum applied to lumen 40 may be adjusted to cause the distal tip 38 of the catheter 10 to experience an axial reciprocation or water hammer effect, which can further facilitate both transluminal navigation as well as dislodging or breaking up the obstruction." Ex. 1012, [0108]. The paragraph also explains that "[a] water hammer commonly occurs when a valve closes suddenly at the end of a pipeline system," causing a "pressure surge or wave" to be generated inside the lumen. *Id.*

53. Petitioner argues that the distal tip of the catheter experiencing axial reciprocation or the water hammer effect would cause flow out. However, this paragraph does not contain any mention of flow out of the distal end of the catheter. Instead, Yang discloses that this effect can cause the catheter "to axially vibrate," which "can reduce surface friction between the outer diameter of the

catheter 10 and the inner diameter of the vessel wall," thus enabling the "catheter to track through tortuous anatomies as well as assist capturing thrombus." Ex. 1012, [0108]. In addition, Yang suggests that the effect can facilitate "dislodging or breaking up the obstruction." *Id.*

54. As noted above, I have reviewed the testimony of Mr. Brown, Petitioner's expert, in earlier IPRs where Petitioner challenged other, related patents owned by RapidPulse. I agree with Mr. Brown's statement in earlier IPRs that introducing a positive pressure pulse, such as through the water hammer effect, does not mean the catheter would experience flow out. This is because introducing a positive pressure **pulse** does not mean the overall pressure in the catheter is positive. The Board made this finding in reliance on Mr. Brown's testimony: "We do not find this position to be inconsistent with Petitioner's argument regarding a 'positive pressure pulse' because we credit the testimony of Mr. Brown that a 'positive pressure pulse' does not mean 'positive pressure,' but, rather, means a positive pressure differential (i.e., an increase in pressure)." Ex. 2007, 51 n.12. As Mr. Brown stated and the Board credited, I agree that a positive pressure pulse does not mean an overall positive pressure in the catheter.

55. Similarly, I agree with Mr. Brown that an overall vacuum can exist in the catheter when a positive pressure pulse is introduced. Ex. 2010 ('253

Brown Dep. Tr.), 130:19-24 ("Q. So it's possible to have an overall vacuum state even when a positive pressure pulse is being applied; right? A. You are able to maintain an overall vacuum state even when a positive pressure pulse has been applied."). A POSA would understand that a catheter can experience an overall negative pressure despite application of a positive pressure, and thus introducing a positive pressure pulse does not necessarily result in an overall positive pressure in the catheter.

56. Further, I am in agreement with Mr. Brown that when the catheter maintains an overall vacuum pressure, a positive pressure pulse does not lead to flow out of the distal end of the catheter. Ex. 2010, 125:11-18 ("Q. Okay. Would you agree that when there is a non-zero suction force in the catheter or, in other words, a level of vacuum in the catheter, there would not be flow out of the catheter's distal end? … THE WITNESS: Correct."). A POSA would understand that maintaining an overall vacuum pressure in the catheter means that a positive pressure pulse, such as that introduced from the water hammer effect, does not lead to flow out of the catheter's distal end.

57. Accordingly, it is my opinion that closing a valve, which may lead to a water hammer effect, does not mean there will be flow out from the distal end of the catheter. As I stated above, a water hammer effect is a pressure wave that travels from the suddenly-closed valve to the distal end of the catheter. But

when the system maintains an overall negative pressure, a positive pressure pulse from closing a valve (i.e., water hammer effect) does not mean there would be flow out. In addition, if the distal tip of the catheter is clogged or obstructed, e.g., by a clogged clot, that will further prevent any possible flow out. I am in agreement with Mr. Brown's testimony and the Board's finding on this point. Ex. 2005 ('883 Brown Suppl. Decl.) ¶60 ("[C]losing the vacuum valve does not necessarily lead to a positive pressure or forward flow … because, particularly when the tip of the catheter is obstructed, the system becomes closed and thus, in the absence of an injection of sufficient vent fluid, there would continue to be negative pressure within the catheter, even after the vacuum valve is closed."); Ex. 2007, 43 (relying on Mr. Brown's testimony, finding that "closing the vacuum valve does not necessarily lead to positive pressure of forward flow, particularly when the tip of the catheter is obstructed.").

58. Thus, a POSA would understand that a positive pressure pulse caused by the water hammer effect does not mean there will be flow out at the distal end, and accordingly, Yang's discussion in paragraph [0108] of the water hammer effect does not disclose or render obvious "a controller … to control fluid flow in and out from the distal end" as is recited in claim 1.

59. Petitioner and Mr. Brown fail to discuss and address the pressure that is required for flow out from the distal end of the catheter. For flow out from

the distal end of the catheter, a POSA would understand that the pressure inside the catheter not only has to be positive, but has to exceed the arterial pressure within the vessel of the patient that the catheter is operating in. This is because for the catheter to have flow out, the pressure inside the catheter has to overcome the pressure outside the catheter. I note that Mr. Brown has previously made this point in his testimony. Ex. 2010, 126:15-21 ("Q. Would you agree that to have flow out of the distal end of Teigen's catheter described in the first provisional, the pressure in the catheter not only needs to be positive, but also needs to be above the mean arterial mean pressure? A. I do agree as long as the catheter is in the patient.").

60. I further agree with Mr. Brown that even if the pressure inside the catheter is above the mean arterial pressure, there may still be no flow out if the catheter's distal end is occluded by a clot. Ex. 2010, 126:23-127:5 ("Q. … And assuming that catheter's in the patient and a clot is occluding the distal end of the catheter, even if the pressure inside the catheter is above the mean arterial pressure, there may not be flow out of the catheter's distal end; right? A. That is correct, if the clot is corking the end of the catheter."). A POSA would understand that even a pressure above mean arterial pressure in the catheter still may not lead to flow out when the catheter is clogged.

61. For these reasons, paragraph [0108] of Yang does not disclose or render obvious controlling flow in and out of the catheter.

b. <u>Yang's Paragraphs [0135] and [0168] do not disclose or suggest controlling flow in and out</u>

62. Petitioner also relies on Yang's Paragraphs [0135] and [0168] for disclosure of controlling flow in and out (Pet. 33), but it is my opinion that neither paragraph discloses or suggests controlling flow in and out.

63. Yang's Paragraph [0135] discloses that "axial mechanical vibration or shock waves may be propagated to or generated at the distal end of the catheter using a variety of vibration generators." Ex. 1012, [0135]. However, Yang does not disclose or suggest using the "axial mechanical vibration" or "shock waves" to create flow out. Instead, Yang discloses that "[s]hock waves may be propagated along the proximal section 33 to assist in translumenal advance, and/or distal section 34 by way of pull wire 42, depending upon the desired clinical performance." *Id.* In suggesting a vibration device that "generates transverse and/or longitudinal vibration in the catheter," Yang discloses that the transverse vibration in the catheter "reduces effective contact surface area between the vessel and the catheter 10, which in turn reduces surface friction between the inner diameter of the vessel and the outer diameter of the catheter." *Id.*, [0136]. "In addition, by inducing longitudinal vibration in the catheter 10, the vibrating device 600 breaks static friction between the inner

diameter of the vessel and the outer diameter of the catheter 10, which reduces overall surface friction." *Id.* "By reducing the friction between the inner diameter of the vessel and the outer diameter of the catheter 10, the vibrating device 600 improves catheter trackability through tortuous vasculatures." *Id.*

64. In other words, Yang discloses that the "axial mechanical vibration" and "shock waves" are used to "break[] static friction" so that the catheter can track more easily in the vasculatures. Ex. 1012, [0136]. However, based on this passage, a POSA would understand that "axial mechanical vibration" or "shock waves" as explained in Yang are not disclosures or suggestions of flow out, not to mention control of any such flow out as required by claim 1 of the '402 patent.

65. A POSA would not find disclosure or suggestion of controlling flow in and out in Yang's Paragraph [0168] either. In fact, the paragraph cuts against Petitioner's argument that Yang discloses or suggests flow out. The paragraph discloses "[c]ompletely releasing (venting to atmospheric pressure) the vacuum and allowing the clot to relax before reapplying a vacuum is found to aspirate the corked clot most efficiently." Ex. 1012, [0168]. A POSA would understand this paragraph describes using atmospheric pressure as the highest pressure. Instead of venting to a higher pressure in the catheter, this paragraph teaches "allowing the clot to relax" to "atmospheric pressure." *Id.* As I stated above, when the overall pressure in the catheter is only atmospheric pressure, that does not mean

there will be flow out at the distal end of the catheter. Atmospheric pressure is less than mean arterial pressure outside of the catheter in the vessel. Thus, a POSA would understand that Yang's Paragraph [0168] not only fails to disclose or suggest controlling flow in and out; it instead teaches *against* having flow out.

66. For these reasons, paragraphs [0135] and [0168] of Yang do not disclose or render obvious controlling flow in and out of the catheter.

c. <u>Yang does not render obvious controlling flow out from the distal end</u>

67. Not only does Petitioner fail to identify disclosure in Yang of flow out from the distal end of the catheter, Petitioner also fails to identify any disclosure or suggestion to *control* such flow out as required by claim 1 of the '402 patent. A POSA would not understand Yang to disclosure or suggest control of any flow out, as a POSA would not find disclosure or suggestion of flow out in the first place.

68. Instead of using controlled flow out from the distal end to remove clots that are clogged at the distal tip of the catheter, Yang discloses active features at the distal end for clot removal. For example, Yang discloses that "[t]he distal end of at least one of the proximal and distal sections may be provided with at least one active feature, such as at least one movable jaw or rotatable agitator, to assist in the capture of vascular obstruction." Ex. 1012, Abstract. As another example, Yang also discloses that "the distal tip 38 may be

provided any of a variety of structures which produce an active movement such as a biting section in response to the application of an activation force such as a vacuum in lumen 40." *Id.*, [0077]. "Alternatively, an axially movable control wire may be connected with respect to a side wall of the distal tip 38, to enable cutting action under positive mechanical force." *Id.* Additionally, Yang introduces other active features for the purpose of clot removal at the distal end. *See, e.g.*, *id.*, Abstract, Fig. 4, [0011]-[0013], [0077]-[0080], [0108], [0135]-[0136]. A POSA would understand that Yang discloses active features, instead of using control of flow out, to remove clots that are clogged at the distal tip of the catheter.

69. Yang also does not discuss any of the risks of flow out and potential dangers. In contrast, the '402 patent addresses that it is not viable to "revers[e] the suction to pressurize the clot and eject it forcibly and uncontrollably out of the distal opening of the aspiration catheter." Ex. 1001, 2:23-37. This action is dangerous to the patient because "it could permanently lodge the clot into th[e] vessel, making it impossible to remove, or it could burst the vessel." *Id.*, 2:23-37. The '402 patent further discloses that "[t]hose of skill in the art know that these situations are to be avoided because of the serious potential risks to the patient." *Id.* Yang does not contain any similar disclosure of the risks of uncontrolled flow out, at least because it does not disclose or render obvious flow out at all. A

POSA would understand that Yang does not disclose or suggest any kind of control of this flow out for avoiding risks that Yang does not disclose either.

2. Petitioner fails to identify a reason why a POSA would have sought to combine Yang and Mullins as Petitioner proposes

70. Petitioner argues that "[a] POSA would have been motivated to combine the teachings of Yang and Mullins." Pet. 16. Petitioner also argues that "[a] POSA would have been motivated to implement Mullins's disclosures of forward flow and improvements in unsticking clots to modify Yang's system, which already includes a catheter aspiration system, to provide efficient and effective cyclical aspiration of blood clots." Pet. 17.

71. First, a POSA would understand Yang and Mullins to be completely different systems. While Yang discloses a two-valve system with a vacuum valve and a vent valve (Ex. 1012, [0170]), Mullins does not disclose a valve-based system. In fact, no valve is ever mentioned in Mullins. Instead, Mullins uses a reversible pump to apply vacuum pressure and positive fluid flow. Ex. 1008, 26:31-33 ("The pump 3504 may provide a negative fluid displacement thereby decreasing pressure (enabling a vacuum) or positive displacement, thereby increasing pressure.").

72. Because Yang is a two-valve system and Mullins is a pump system, they operate in fundamentally different ways. In its two-valve system, Yang is able to open the vent valve "while the vacuum valve 2516 stays open." Ex. 1012,

[0170]. And "[b]ecause the release line 2518 and the vacuum line 2520 are in fluid communication, either directly or via at least a portion of the catheter 2510, the vacuum is applied mainly through the release line 2518, dropping vacuum applied to the catheter." *Id.* A POSA would understand that during a period of time in a given cycle, Yang operates with both vacuum and vent valves open at the same time, thus dropping the vacuum applied to the catheter.

73. Mullins, on the other hand, does not offer the same capability. Mullins discloses that "the pump may change direction hence altering the pressure and fluid displacement." Ex. 1008, 26:40-42. A POSA would understand that the pump system in Mullins can only displace fluid in one direction. Mullins's pump cannot apply vacuum pressure and introduce positive fluid flow into the catheter at the same time.

74. As another difference between Yang's and Mullins's systems, Yang discloses a water hammer effect when a valve closes. Yang's system experiences a water hammer effect when fluid rushing toward a valve is suddenly stopped when the valve closes, leading to a "pressure surge or wave" traveling back toward the distal end of the catheter. Ex. 1012, [0108]. As mentioned, Mullins does not use valves, and Mullins contains no mention of any water hammer effect in its pump system. A POSA would understand that Mullins does not address the water hammer effect at all.

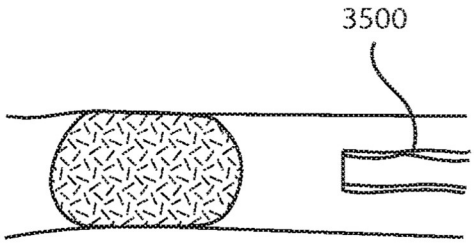
75. Second, Petitioner fails to identify any disclosure in Mullins that flow out is desirable and would thus lead to "improvements in unsticking clots." Pet. 17. A POSA would understand that Mullins does not contain any disclosure or suggestion that forward flow or flow out is desirable.

76. Mullins discloses that "[a]n aspiration system (3500) may employ the catheter with a pump which dynamically applies negative or positive pressure to optimally aspirate a clot." Ex. 1008, Abstract. Specifically, "the pump uses defined upper and lower limits to decide whether to apply a vacuum or pressurize," where "[t]he pump incorporates a sensor which measures the pressure in the catheter lumen." *Id.*, 26:35-49. "[T]he pump will reverse at some Low Limit of pressure," which is "defined such that during vacuum, a portion of the clot has been aspirated but not so much that the clot has become irreversibly clogged." *Id.*, 27:2-6. "Upon reversal, the catheter will begin to pressurize, thereby increasing the pressure measured," which pushes the clot "distally towards the catheter tip," making the clot "more 'free' within the catheter." *Id.*, 27:18-26. Mullins also discloses that "[t]he pressure is further increased until a High Limit is reached … [which] is defined such that the ingested clot may not be completely expelled from the catheter." *Id.*, 27:27-30.

77. Mullins discloses setting a High Limit for when the pump is reversed from introducing positive fluid flow to vacuum, but it does not disclose

or suggest that High Limit is high enough to cause flow out. Ex. 1008, 27:27-30, 27:36-39. Mullins discloses that the High Limit can be "a negative pressure," "0 mmHg," or "a positive pressure." *Id.*, 27:36-39. A POSA would understand setting the High Limit to a negative or zero pressure would not lead to flow out because the pressure in the catheter would not overcome the arterial pressure outside the catheter. Even if the High Limit is set to "a positive pressure," Mullins only discloses that the "High Limit is defined such that the ingested clot may not be completely expelled from the catheter." *Id.*, 27:27-30. In other words, Mullins does not disclose setting the High Limit to a point that may completely expel the clot from the catheter. A POSA would understand Mullins only proposes setting the High Limit such that the flow remains in the catheter and does not disclose causing flow out by pushing the clot completely out of the catheter.

78. In Figure 47 as copied below, Figures 47(h) and 47(l) show that even at or around when the High Limit is reached in the cycle, part of the clot still remains in the catheter, so the catheter remains clogged. As a result, the catheter would not experience flow out, because the clot is never completely pushed out of the catheter.



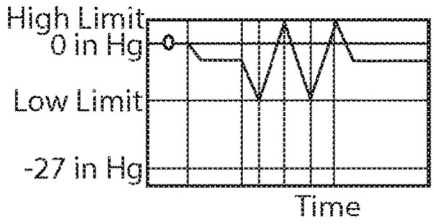
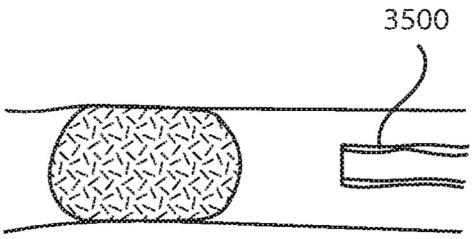


Fig.47(a)



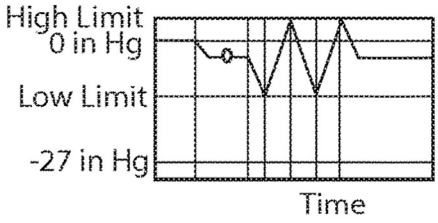
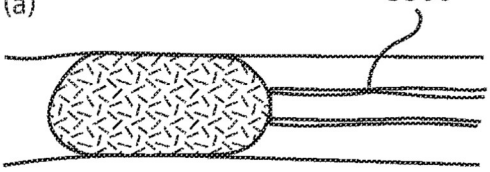


Fig.47(b)



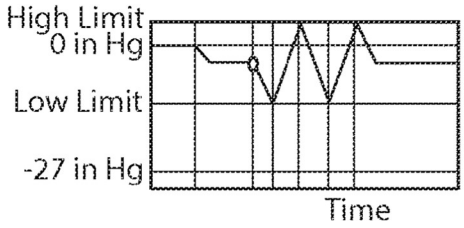
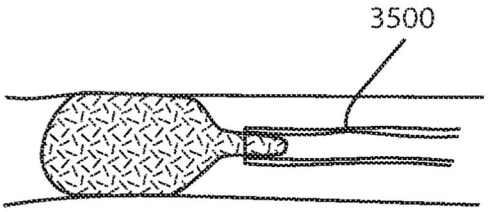


Fig.47(c)



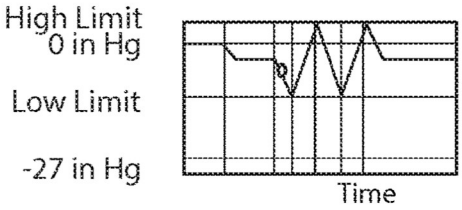
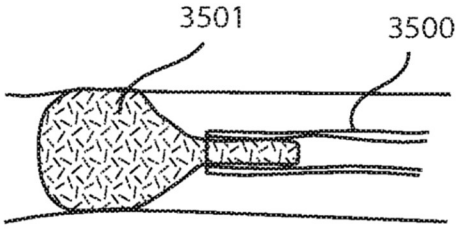


Fig.47(d)



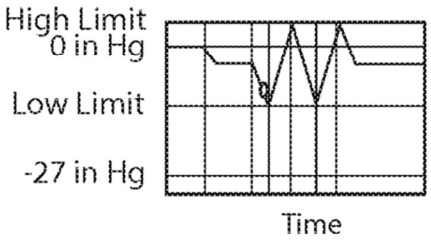
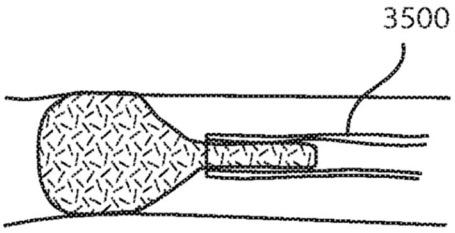


Fig.47(e)



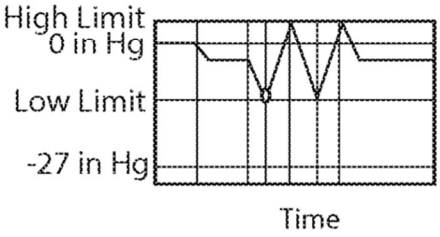
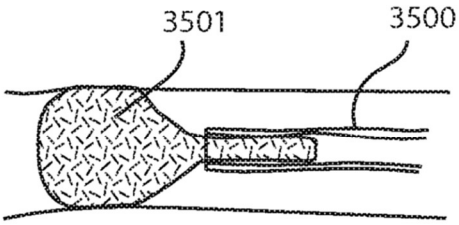


Fig.47(f)



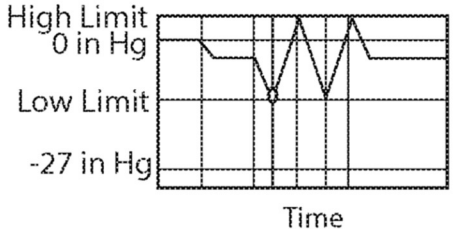
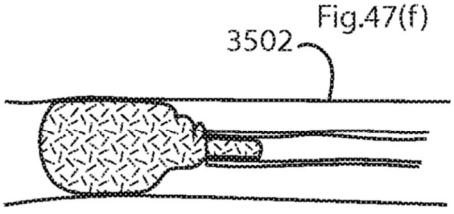


Fig.47(g)



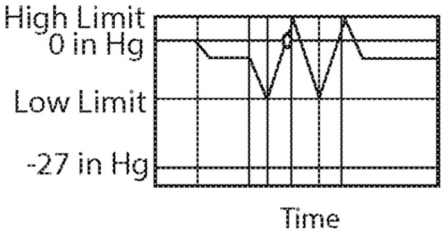
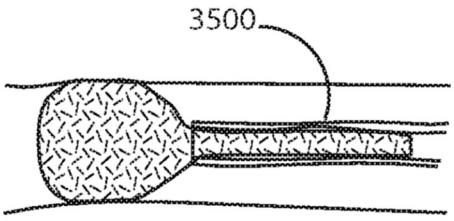


Fig.47(h)



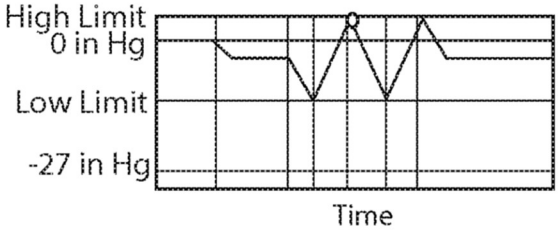


Fig.47(i)

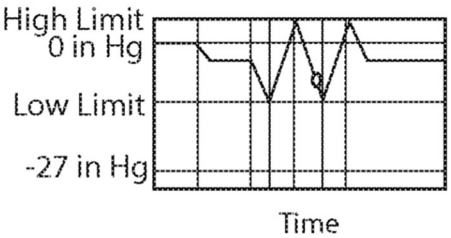
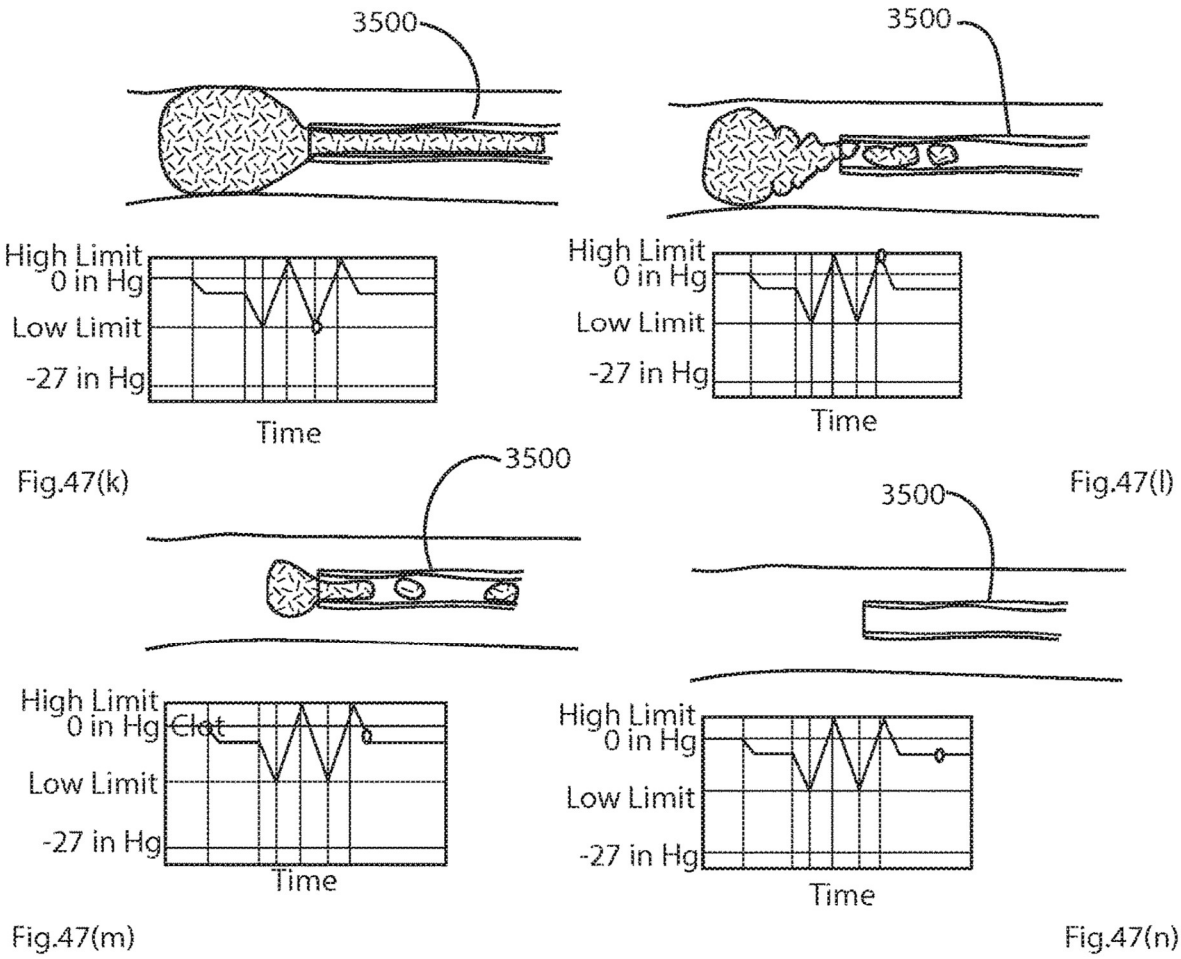


Fig.47(j)



79. Accordingly, as Mullins does not disclose any flow out of the catheter, as demonstrated above, there is no basis to combine its teachings with Yang to implement the combination Petitioner proposes.

3. Combining Yang and Mullins would not yield the claimed invention

80. It is my opinion that even if Yang and Mullins are combined as Petitioner argues, the proposed combination would not yield the claimed invention because it fails to meet two claim requirements: (1) "a controller configured to open and close the vacuum valve and the vent valve in a

predetermined cycle" and (2) "to *control fluid flow in and out* from the distal end of the catheter."

a. Petitioner's proposed combination of Yang and Mullins lacks a "predetermined cycle"

81. Petitioner argues that "[a] POSA would recognize Yang could be configured to achieve the benefits, as taught by Mullins, of cyclical pressure changes, including the use of a pressure sensor." Pet. 17. Petitioner further argues that "it would have been well within a POSA's level of skill to modify the logic of Yang's controller to implement Mullins's teachings, and/or incorporate well-known mechanical components, if needed, to carry out the functionality described in Mullins." Pet. 18. It is my understanding that Petitioner is suggesting to incorporate Mullins's sensor approach to Yang's valve-based system, thus enabling Yang to vary the aspiration pressure based on the sensed pressure in the system.

82. A predetermined cycle as disclosed in the '402 patent is a "fixed cycle" where both the pressure amplitude and the period of time that vacuum and positive pressure are set in advance. Ex. 1001, 9:9-14. A POSA would understand that a predetermined cycle has fixed timing, i.e., the timing of each period of the cycle does not vary depending on conditions other than time. By contrast, a POSA would understand that implementing Mullins's controller logic in Yang means to vary the timing of the vacuum and vent pressure between

cycles based on feedback from a sensor, as disclosed in Mullins. Accordingly, Petitioner's proposed combination of Yang and Mullins lacks the "predetermined cycle" that claim 1 of the '402 patent requires because the cycle would not be predetermined or depend on time; rather, the cycle would depend on other conditions detected by the sensor, which may not be at equal time intervals.

83. Specifically, incorporating the pressure sensor as disclosed in Mullins means that the timing of the cycle is determined based on when the Low Limit and High Limit are reached at the sensor. Ex. 1008, 27:2-35. The combination would thus have **variable** timing where the timing of each cycle can be different depending on when the limits are reached. Mullins particularly discloses that "[a] novel aspect of this pump system is the incorporation of feedback into the pump algorithm in order to produce more effective pressure cycling." *Id.*, 27:48-53. "That is to say, the ability of the pump to measure the condition in the pump (e.g., pressure or fluid displacement), and **continue to alter its behaviour**." *Id.* (emphasis added). Mullins's incorporation of "feedback" into the pump algorithm so that the pump can "alter its behaviour" shows that the timing of the cycles in Mullins's algorithm varies depending on the sensed pressure (or flow) in the catheter over time. A POSA would understand that varying the timing of the cycle depending on the particular conditions at each specific time in the cycle is the opposite of a "predetermined"

or fixed cycle. In fact, the claimed "novel aspect" of the sensor feedback approach as disclosed in Mullins is that it is *not* a predetermined cycle but the incorporation of feedback into the timing of the cycle based on the sensed pressure. *Id.*

84. There are multiple variables that can affect the feedback at the sensor in the proposed Yang and Mullins combination, rendering it not a "predetermined cycle." For example, the feedback of the cycles may vary depending on the amount and speed of blood flow entering the catheter, the density and consistency of the clot, the size of the clot, etc. Thus, the proposed combination using the sensor feedback approach would not result in a "predetermined cycle" because the cycle timing would depend on these variables.

85. A POSA would understand that the length of the vacuum period in the resulting combination would be expected to vary from cycle to cycle, because it depends on the time it takes before the catheter is sufficiently clogged for the sensor to read the Low Limit in each cycle. Ex. 1008, 26:65-27:6 ("Initially when switched on the pump applies a vacuum enabling the catheter to ingest some of the clot, FIG. 47 (d). While further increases in the vacuum ingest more of the clot, FIG 47 (e), the efficiency of increases in the vacuum pressure in ingesting more clot is reduced, FIG. 47 (f). For this reason, the pump will reverse at some Low Limit of pressure, FIG. 47(g). The Low Limit is defined

such that during vacuum, a portion of the clot has been aspirated but not so much that the clot has become irreversibly clogged.").

86. For example, in aspirating a clot, there may be times when it is easier to ingest the clot and times when it is harder because the clot is becoming clogged. The timing of the cycles would differ based on how long it takes for the sensed pressure to reach the High Limit and the Low Limit, respectively. For example, focusing on the Low Limit, when a large clot initially clogs the catheter, the vacuum period may be short because the sensed pressure would quickly reach the Low Limit due to the clogging and limited blood flow into the catheter. When pieces of the clot begin to break off and the amount of blood flowing in begins to increase (*see, e.g.*, Ex. 1008, Fig. 47(l)), the vacuum period may become longer because it is now harder to reach the Low Limit pressure compared to before. Then, when a denser remainder of the clot begins clogging the catheter and blood flow decreases, the vacuum period may become short again because the Low Limit is easily reached in the catheter again due to clogging. The cycle would continue until the clot is fully aspirated and the Low Limit is no longer reached.

87. Similarly, a POSA would understand that, in Mullins, the duration of the positive pressure period before reaching the High Limit also depends on

various factors such as the size of the clot, the amount and speed of blood flowing into the catheter, the density and consistency of the clot, etc.

88. In other words, a POSA would understand that depending on the specific circumstances of the aspiration, such as the nature of the clot to be aspirated, the cycle time would vary depending on the sensed pressure using Petitioner's proposed combination of Yang and Mullins—the opposite of a "predetermined cycle."

89. I note that Petitioner does not address the prosecution history of the '402 patent, where the Examiner found the claims patentable over prior art precisely because of the claimed "predetermined cycle." I agree with the Examiner's conclusion that changing a cycle of opening and closing valves based on feedback from sensors is different from a "predetermined cycle":

> [T]he prior art does not teach or suggest, in the context of the claim, a controller configured to open and close the vacuum valve and the vent valve in a predetermined cycle to change the level of vacuum applied to the catheter. Garrison (US 20160220741) discloses a similar device, but the controller disclosed in [0113] changed the cycle of opening and closing the valves based on feedback from sensors and is not a pre-determined pattern.

Ex. 1004, 86. I agree that, as the Examiner stated, a system where the controller "changed the cycle of opening and closing the valves based on feedback from sensors is not a pre-determined pattern." *Id.* A POSA would understand that the

proposed combination of Yang and Mullins, where the cycle time would vary based on the sensed pressure, would have the sensor feedback-based cycling that the Examiner found not to be a "predetermined cycle." Thus, a POSA would understand that Petitioner's proposed combination fails to meet the claimed "predetermined cycle" requirement in claim 1 of the '402 patent.

b. Petitioner has not shown that its proposed combination of Yang and Mullins would control "flow in and out"

90. It is my opinion that Petitioner also has not shown that its proposed combination would provide "control [of] fluid flow in and out from the distal end," which claim 1 of the '402 patent requires.

91. Mullins's system works based on Mullins's sensor feedback approach, but Mullins does not disclose taking into account effects disclosed in Yang. The main source of pressure in Mullins's system is the reversible pump that can provide vacuum pressure or positive fluid flow. Ex. 1008, 26:31-33 ("The pump 3504 may provide a negative fluid displacement thereby decreasing pressure (enabling a vacuum) or positive displacement, thereby increasing pressure."). The pressure is determined based on a sensor at the pump that is located at the proximal end of the catheter and is connected to the catheter. *Id.*, 28:35-37 ("The pump incorporates a sensor which measures the pressure in the catheter lumen."); *id.*, 29:10-12 ("The pressure sensor is connected to the tube-

lumen, which is connected to the catheter, thereby enabling pressure measurement within the catheter."). Thus, the pressure in turn depends on the state of the catheter, whether the distal end of the catheter is clogged, partially clogged, or not at all. *Id.*, 26:65-27:30. Whether the distal end is clogged leads to pressure changes in the system that is sensed by the pressure sensor located at the proximal end of the catheter, which causes the controller to reverse the direction of the pump. *Id.* For example, the pump will reverse to provide a positive fluid flow when the sensor senses a Low Limit when a portion of the clot has been aspirated and the catheter is clogged, and the pump will switch to vacuum when the sensor senses a High Limit. *Id.*

92. However, a POSA would understand that in addition to the vent pressure introduced by opening the vent valve, Yang also discloses and experiences a "pressure surge or wave" caused by the water hammer effect in closing a valve. Ex. 1012, [0108]. Therefore, the pressure in this system is also affected by the pressure pulse in addition to the state of the valves.

93. I understand that Petitioner relies on combining the embodiments in Yang's Figures 14 and 25 to argue for disclosure of flow out. Pet. 21-28, 31. Even assuming that combined embodiment experiences the water hammer effect, incorporating Mullins's sensor in Yang's controller still would not "control fluid flow in and out from the distal end of the catheter." As I mentioned before, a

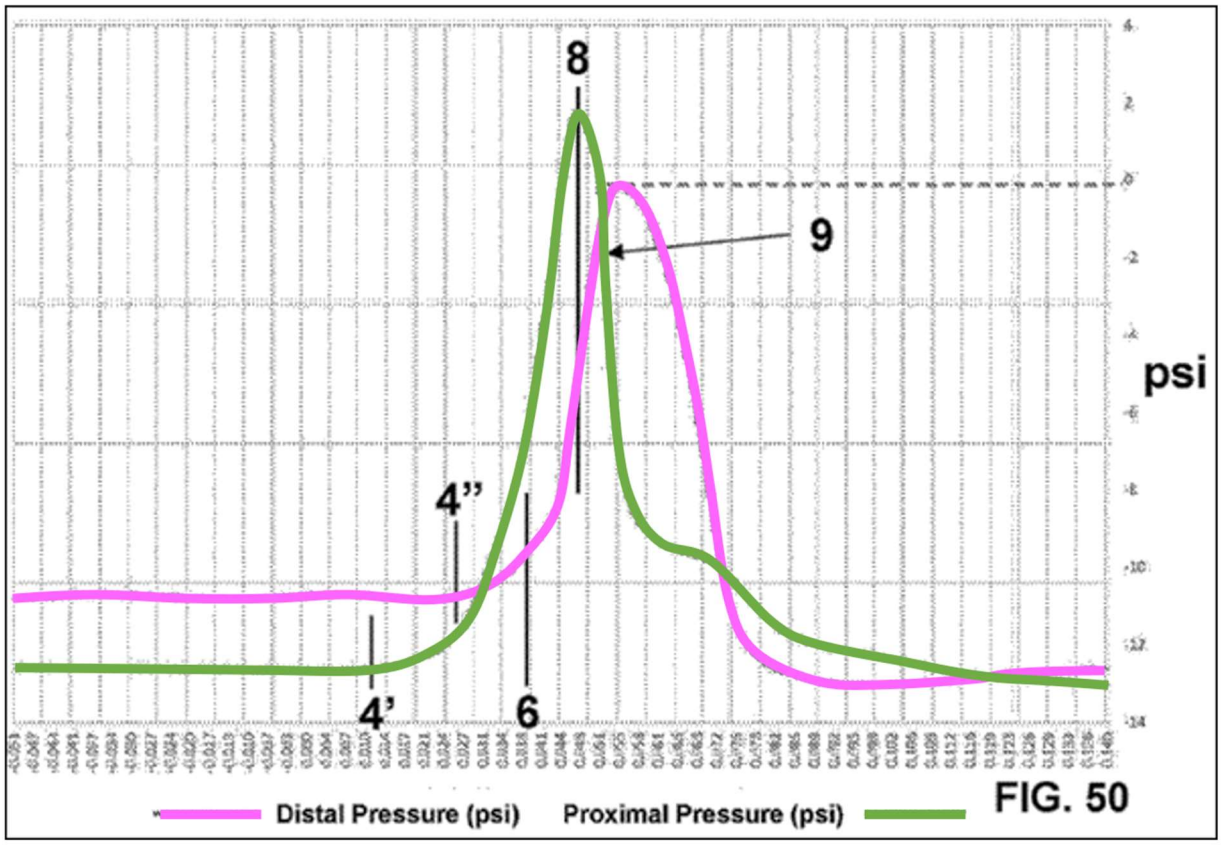
POSA would understand that introducing positive pressure does not necessarily lead to flow out, not to mention any control of it. The proposed combination can be implemented in a manner similar to Grey's approach, which allows for introduction of positive pressure but also maintains an overall suction force in the catheter, such that there is no flow out. Ex. 1010, 2:5-6 ("In some embodiments, the second aspiration fluid may be provided at a positive pressure."); *Id.*, 13:10-11 ("Providing a non-zero suction force in the catheter at all times reduces the risk of occlusive material breaking free of a clot and travelling distally in the vessel.").

94. Petitioner fails to explain how "fluid flow in and out from the distal end of the catheter" would be controlled in the proposed Yang and Mullins combination. Specifically, Petitioner and Mr. Brown do not address that Mullins's sensor would be located at the proximal end of the proposed combination, not the distal end. Petitioner states that "a POSA would have recognized the benefit to Yang's system of monitoring vacuum pressure levels at the distal tip of the catheter, as taught in Mullins." Pet. 18. Petitioner, however, never explains why the proposed combination would monitor vacuum pressure levels at the distal end, as opposed to the proximal end of the catheter.

95. Mullins only discloses monitoring vacuum pressure levels at the proximal end of the catheter. *See* Ex. 1008, 26:35-37 ("**The pump incorporates**

a sensor which measures the pressure in the catheter lumen.") (emphasis added); Ex. 1005 ¶153 (same); Ex. 1008, 29:10-12 ("The pressure sensor is connected to the tube-lumen, which is connected to the catheter, thereby enabling pressure measurement within the catheter."). Petitioner assumes that the pressure sensor is located at the distal end of the catheter in the proposed combination, but that is not where Mullins's sensor is located. Petitioner does not propose moving Mullins's pressure sensor to the distal end of the catheter, or why a POSA would do so. A POSA would understand that the combination Petitioner has proposed would only sense the pressure at the proximal end of the catheter, as disclosed in Mullins.

96. In proposing a combination of Yang and Mullins that uses sensor feedback to determine the cycling of the valves, Petitioner does not address that there can be a significant pressure difference between the proximal end and the distal end of the catheter. This is reflected in Figure 50 of the '402 patent, copied below. For example, the proximal pressure in green can be at its maximum while the distal pressure is relatively low, and in converse, the distal pressure can be at its maximum while the proximal pressure is relatively low.



Ex. 1001, Fig. 50 (annotated). However, neither Yang nor Mullins address this pressure differential between the distal and proximal ends, and Petitioner does not address this in the proposed combination of them. A POSA would not find disclosure or suggestion of controlling fluid flow in and out in Petitioner's proposed combination.

IX. Grounds 4-6: In My Opinion, Petitioner Has Not Shown That Claim 1, And Thus All Claims Dependent On It, Are Rendered Obvious By Ofek In View Of Mullins And The Knowledge Of A POSA

97. As discussed in more detail below, in my opinion, Petitioner has not established a reasonable basis to conclude that claim 1 of the '402 patent and all

claims dependent on claim 1 would have been obvious over Ofek in view of Mullins.

A. Summary Of Ofek (Ex. 1007)

98. Ofek discloses "[a] patency device for catheter assemblies and other elongate tubular devices used for establishing access to an interior body portion of a patient." Ex. 1007, Abstract. "The patency device establishes and preserves patency of one or more lumens defined by the catheter assembly by providing impulses of positive pressure to fluid disposed in the lumen of the catheter assembly." *Id.* In particular, "[t]he impulses are configured to dislodge occlusions that may have formed in the lumen." *Id.*

99. Ofek's patency device 30 and catheter assembly 10 are shown in Figure 1 below. Ex. 1007, 2:37-41.

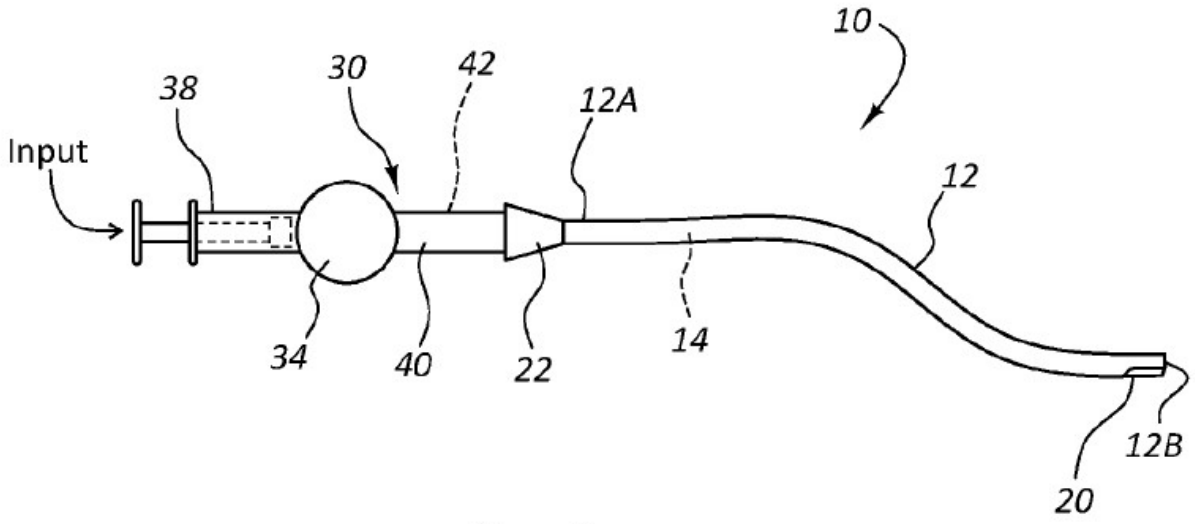


Fig. 1

100. Ofek discloses that "the catheter 10 includes an elongate catheter tube 12 that defines a lumen 14 extending between a proximal end 12A and a distal end 12B of the catheter tube." Ex. 1007, 2:41-44. Ofek specifically notes that the catheter shown is a PICC (peripherally inserted central catheter) but "the catheter in other embodiments can include other catheter types, such as dialysis, CVC, PIV, urinary, arterial, balloon catheters, etc." *Id.*, 2:52-54.

101. Ofek discloses that "the patency device 30 includes a fluid reservoir 34 that is configured, together with a pressure input portion 38, to provide one or more relatively short-duration impulses, of high-pressure fluid to the lumen 14 of the catheter tube 12." Ex. 1007, 2:59-64. "Such impulses, when performed periodically, are configured to prevent the formation of thrombus or other occlusion in the lumen 14, especially at the distal end thereof." *Id.*, 2:64-67. "These short-duration, high pressure impulses can also be used to clear the lumen after occlusions have formed therein." *Id.*, 2:67-3:2. In addition, "periodic use of the patency devices … can also serve to prevent the formation of an occlusion by preventing initial adherence and growth of the occlusion in the first place." *Id.*, 6:64-67.

102. Further, the high-pressure impulses are "interspersed by relatively longer rest periods 84 of negative baseline pressure provided to the catheter tube lumen," which "enables any occlusion dislodged by the impulses to be sucked

proximally up the catheter tube lumen 14 and removed therefrom, thus preventing the dislodged occlusion from entering the bloodstream from the distal end 12B of the catheter tube 12." Ex. 1007, 3:47-57.

103. Ofek also notes that "[t]he occlusion is dislodged by the high-pressure impulses, which are strong enough to dislodge the occlusion but are not of sufficient duration to push it out the distal end 12B of the catheter tube 12." Ex. 1007, 4:33-36. "The subsequent negative pressure rest period following each impulse can act to prevent escape of the clot from the catheter tube 12." *Id.*, 4:37-39. "In this way, any clot or occlusion present in the catheter 10 can be acceptably removed." *Id.*, 4:43-44.

B. Petitioner has failed to show that Ofek discloses "an aspiration catheter" and that Ofek alone or in combination with Mullins renders obvious "a controller configured to open and close the vacuum valve and the vent valve in a predetermined cycle … to control fluid flow in and out from the distal end of the catheter"

104. It is my opinion that Petitioner fails to show that Ofek teaches "an aspiration catheter" and Ofek in combination with Mullins render obvious controlling "fluid flow in and out from the distal end of the catheter" or "a predetermined cycle."

1. Ofek does not disclose "an aspiration catheter"

105. Petitioner fails to show that Ofek discloses "an aspiration catheter." In the context of "aspiration thrombectomy system[s]" (Ex. 1001, 3:26-27), an

aspiration catheter is a catheter for aspirating clots out of the blood vessels. As disclosed in the '402 patent, "[r]emoval by aspiration is effected by placing a source of vacuum, e.g., an aspiration or vacuum catheter, upstream of the clot and drawing the clot into or against the distal end of the catheter." Ex. 1001, 1:51-54. I agree with the textbook definition that an "aspiration catheter" is a catheter that "advance[s] to the thrombosed segment [where] the distal end of the catheter is placed proximal to the clot," and then, "[a] negative pressure … is applied and the clot is suctioned into the catheter." Ex. 2012, 566. I further agree with Mr. Brown's definition of "aspiration catheters," where he confirms the difference between aspiration catheters and other catheters by stating "[t]here are three types of catheter thrombectomy devices — **aspiration catheters to vacuum the clot out of the vessel**, lytic delivery catheters to infuse the clot with targeted thrombectomy drug treatment, and mechanical thrombectomy systems that break up the clot." Ex. 1005 ¶53 (quoting Ex. 1015, 1).

106. A POSA would understand that Ofek does not disclose "an aspiration catheter" in the context of aspiration thrombectomy systems because it does not describe any catheter to aspirate clots out of blood vessels. Ofek does not identify any aspiration catheter in its disclosure. Ofek discloses that "[e]mbodiments of the present invention are generally directed to catheter assemblies and other elongate tubular devices," and that "[a] peripherally inserted

central catheter ('PICC') is one example of such a catheter assembly." Ex. 1007, 2:28-32. Ofek further discloses that "the catheter in other embodiments can include other catheter types, such as dialysis, CVC, PIV, urinary, arterial, balloon catheters, etc." *Id.*, 2:52-54. However, a POSA would not understand any of the listed catheters to be an aspiration catheter—none of those are catheters that aspirate clots in blood vessels.

107. Petitioner cites Ofek's Figures 1, 3, and 5 to argue that Ofek discloses an aspiration catheter, but a POSA would not understand any of the figures to disclose an aspiration catheter either. Figure 1 is "shown as a PICC," which, as I stated earlier, is not an aspiration catheter. Ex. 1007, 2:52-54. A POSA would not understand Figures 3 and 5 as disclosures of an aspiration catheter either. They only show a block titled "To Catheter" that is connected to Ofek's system. *Id.*, Figs. 3, 5. They do not show or suggest an aspiration catheter. In fact, a POSA would not understand there to be any disclosure of an aspiration catheter in Ofek.

108. Ofek also does not disclose aspirating any occlusive material that is outside the catheter into the catheter, such as a clot in a vessel. Instead, Ofek teaches using its system to aspirate occlusions that are *within* the catheter. Ex. 1007, 8:16-22 ("The embodiments of the patency device 30 shown and described in connection with FIGS. 3, 5, 6, and 7 are therefore representative of a multitude

of a variety of patency devices that can be employed to provide fluid impulses for the dislodgment of occlusive material *within* the lumen of a catheter and/or to maintain the patency of the lumen, free from occlusions." (emphasis added)). Indeed, none of the figures of Ofek show a clot being aspirated from outside the catheter into the catheter.

109. In other words, Ofek does not disclose a catheter used to aspirate clots out of blood vessels but instead discloses a device for establishing patency within the catheter. A POSA would understand that Ofek discloses a device to establish patency within the catheter itself, in contrast to an aspiration catheter that, as stated by Mr. Brown, vacuums clots out of blood vessels. Ex. 1005 ¶53.

2. Ofek does not render obvious "a controller … to control fluid flow in and out from the distal end of the catheter"

110. A POSA would understand that Ofek does not render obvious controlling "fluid flow in and out from the distal end of the catheter." Instead, Ofek teaches *against* causing flow out from the distal end of the catheter. Ex. 1007, 4:33-44 ("The occlusion is dislodged by the higher-pressure impulses, which are strong enough to dislodge the occlusion but are not of sufficient duration to push it out the distal end 12B of the catheter tube 12. The subsequent negative pressure rest period following each impulse can act to *prevent* escape of the clot from the catheter tube 12 … In this way, any clot or occlusion present in the catheter 10 can be acceptably removed." (emphasis added)).

111. I agree with Petitioner and Mr. Brown that Ofek purposefully introduces negative pressure to prevent clots from exiting from the distal end of the catheter, leading to no flow out. *See* Pet. 85 ("Ofek utilizes negative pressure in conjunction with the impulses to prevent clots from escaping the distal end and entering the bloodstream."); Ex. 1005 ¶404 (same). A POSA would understand that Ofek discloses avoiding any flow out and does not mention any control of the flow.

3. Petitioner fails to identify a motivation to combine Ofek and Mullins

112. Petitioner argues that "[a] POSA would have been motivated to combine the teachings of Ofek and Mullins" because both Ofek and Mullins "address similar problems related to aspiration thrombectomy and share the common objective of improving the removal of blood clots using dynamic aspiration catheters." Pet. 67; Ex. 1005 ¶356 (same). I disagree. As I stated above, a POSA would not consider Ofek to disclose a method of "aspiration thrombectomy," because it instead discloses a patency device for aspirating clots that are within a catheter lumen. Ex. 1005 ¶356. Thus, Petitioner has not shown a motivation to combine Ofek and Mullins.

4. Combining Ofek and Mullins would not yield the claimed invention

113. Even if a POSA had motivation to combine Ofek and Mullins as Petitioner proposes, the resulting combination would not be the claimed invention.

114. First, Petitioner's proposed combination of Ofek and Mullins, similar to that of Yang and Mullins, fails to disclose opening and closing the vacuum valve and vent valve in "a predetermined cycle." Petitioner argues that "[a] POSA would have been motivated to implement Mullins's disclosures of controlling levels of vacuum and fluid flow in and out of the distal end of the catheter to modify Ofek's system." Pet. 68. Petitioner's proposed implementation thus involves Mullins's control of fluid flow using Mullins's pressure sensor, incorporating that sensor and control algorithm based on feedback from that sensor into Ofek's system such that the timing of the cycle depends on feedback from the sensor. As discussed above, this sensor feedback approach would not be "a predetermined cycle." I agree with the Examiner's reasoning in allowing the '402 patent claims over systems where the timing of the cycle is adjusted based on sensor feedback, as in Petitioner's proposed combination of Ofek and Mullins. A POSA would not find the proposed Ofek and Mullins combination to meet the claimed "predetermined cycle" limitation in the '402 patent.

115. Second, a POSA would understand that combining Ofek and Mullins would not lead to controlling "fluid flow in and out from the distal end of the catheter." In particular, a POSA combining Ofek and Mullins would follow Ofek's teachings *against* having flow out from the distal end of the catheter. Ex. 1007, 3:51-57 ("The negative baseline pressure present between impulses enables any occlusion dislodged by the impulses to be sucked proximally up the catheter tube lumen 14 and removed therefrom, thus preventing the dislodged occlusion from entering the bloodstream from the distal end 12B of the catheter tube 12."); *id.*, 4:33-39 ("The occlusion is dislodged by the high-pressure impulses, which are strong enough to dislodge the occlusion but are not of sufficient duration to push it out the distal end 12B of the catheter tube 12. The subsequent negative pressure rest period following each impulse can act to prevent escape of the clot from the catheter tube 12.").

116. Petitioner's resultant combination requires **ignoring** this aspect of Ofek. A POSA would not find Petitioner provided any support for why a POSA would not follow Ofek's express teachings against having flow out.

X. Conclusion

All statements made herein of my own knowledge are true, and all statements made on information and belief are believed to be true. Further, I am aware that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001. I declare under penalty of perjury that the foregoing is true and correct.

Executed on Nov. 22, 2024, in Mission Viejo, CA.

Brad Culbert