UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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WATERS TECHNOLOGIES CORPORATION
Petitioner

v.

BIOMEDICAL DEVICE CONSULTANTS & LABORATORIES
Patent Owner

_____

Case No. IPR2018-00498
US Patent 9,186,224

_____

PETITION FOR *INTER PARTES* REVIEW OF US PATENT NO. 9,186,224

TABLE OF CONTENTS

TABLE OF AUTHORITIES

CASES

Page(s)

STATUTES AND RULES

LIST OF EXHIBITS

Exhibit No.	Short Name	Description
1001	'224 Patent	US Patent No. 9,186,224 to McCloskey *et al.*
1002	Original Application	USSN 14/523,104, filed on October 24, 2014
1003	Billiar	Declaration of Prof. Billiar
1004		Curriculum Vitae of Prof. Billiar
1005	Office Action	Office Action mailed March 20, 2015
1006	Interview	Interview Summary mailed May 14, 2015
1007	Response	Amendment & Response Mailed June 17, 2015
1008	Allowance	Notice of Allowance mailed September 17, 2015
1009	Inventor Declaration	Inventor Declaration dated May 10, 2013 (and filed with Response Mailed June 15, 2015)
1010	Pickard	US Patent No. 4,682,491 to Pickard
1011	St. Jude	US Patent No. 5,916,800 to Elizondo *et al*. and assigned to St. Jude [*sic*] Medical, Inc.
1012	Woodward	US Patent No. 3,208,448 to Woodward
1013	Iwasaki	Iwasaki *et al.*, *Implications for the Establishment of Accelerated Fatigue Test Protocols for Prosthetic Heart Valves*, Artificial Organs Vol. 26 No. 5:420-429 (2002).
1014	Reul	Reul *et al.*, *Durability/Wear Testing of Heart Valve Substitutes*, J Heart Valve Dis Vol. 7, No. 2: 151-157 (March 1998).

Exhibit No.	Short Name	Description
1015	ISO 5840	International Standard ISO 5840, Cardiovascular implants – Cardiac valve prostheses, Fourth Edition, (March 2005).
1016		Certificate of Service for Complaint in Biomedical Device Consultants & Laboratories of Colorado, LLC v. TA Instruments – Waters LLC, Civil No. 0:17-cv-03403 DWF-SER (D. Minn)
1017	Girard	Declaration of Michael Girard In Support of Motion for Preliminary Injunction in Civil No. 0:17-cv-03403
1018	'224 Claims	Claims of US Patent No. 9,186,224

I. INTRODUCTION

US Patent No. 9,186,224 (the '224 Patent) is directed to a method for operating an "accelerated" test system for evaluating a valved prosthetic device. Both the Patent Owner and the Patent Office in its Notice of Allowance point to the incorporation of an "excess volume area" in an "accelerated" system as the point of novelty. But, as Patent Owner admitted in the underlying prosecution, there is nothing new about incorporating an "excess volume area" into a system for testing replacement heart valves. And, contrary to Patent Owner's statements to the Patent Office, doing so in an "accelerated" system had been well known for at least 10 years prior to the earliest claimed priority date of the '224 Patent.

II. CLAIMED PRIORITY DATE AND PRIOR ART

The earliest claimed priority date of the '224 Patent is March 6, 2009. (Ex1001['224 Patent] cover page). Each reference pre-dates this date by more than one year and qualifies as 102(b)-type prior art:

Reference	Short Name	Publication Date
US Patent No. 4,682,491 to Pickard	Pickard	July 28, 1987
US Patent No. 3,208,448 to Woodward	Woodward	February 2, 1962
US Patent No. 5,916,800 to Elizondo et al. and assigned to St. Ju[d]e Medical, Inc.	St. Jude	June 29, 1999
Iwasaki *et al.*, *Implications for the Establishment of Accelerated Fatigue Test Protocols for Prosthetic Heart Valves*, Artificial Organs Vol. 26 No. 5:420-429 (2002).	Iwasaki	May 2002
Reul *et al.*, *Durability/Wear Testing of Heart Valve Substitutes*, J Heart Valve Dis Vol. 7, No. 2: 151-157 (March 1998).	Reul	March 1998
International Standard ISO 5840, Cardiovascular implants – Cardiac valve prostheses, Fourth Edition, (March 2005).	ISO 5840	March 2005

III. RELIEF REQUESTED

Petitioners request *inter partes* review of all claims (*i.e.*, claims 1-7), on the following grounds, as explained below and in the Declaration of Professor Kristen Billiar. Woodward, St. Jude and Iwasaki have not been considered by the Patent Office. And the combination of Pickard and Woodward and/or St. Jude is new.

Ground	'224 Claims	Basis
1a	1-7	35 USC 103: Obvious in view of Pickard and Woodward
1b	1-7	35 USC 103: Obvious in view of Pickard, Woodward, and St. Jude
2a	1-4	35 USC 102: Anticipated by St. Jude
2b	3-7	35 USC 103: Obvious in view of St. Jude and Pickard
2c	6-7	35 USC 103: Obvious in view of St. Jude and Iwasaki

IV. GROUNDS FOR STANDING

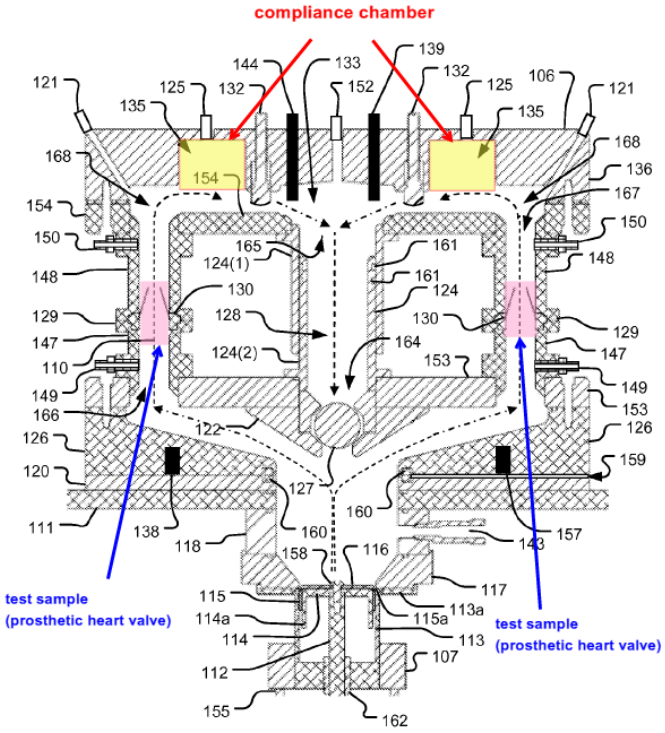
Petitioner certifies that the '224 Patent is available for IPR. This Petition is being filed within one year of service of a complaint against Petitioners. (Ex1016). Petitioner is not barred or estopped.

V. OVERVIEW OF THE '224 PATENT

A. The challenged patent

The '224 Patent describes a testing system for evaluating prosthetic vascular devices and heart valves. (Ex1001['224 Patent] 1:21-25). And claims a method of operating such a test system. (*Id.* 18:1-32). The prosthetic devices are placed in a test chamber and then subjected to physiologically appropriate conditions that may include: pressure, temperature, flowrate and cycle times. (*Id*. 2:4-13).

Figure 3 of the '224 Patent illustrates an exemplary testing system containing two heart valves 130:



(FIG. 3, annotated.)

To create the testing conditions within the test chamber 106, piston 114 is driven by a motor up and down and attached flexible diaphragm 115 cyclically increases and decreases the pressure. (*Id.* 6:31-50; 11:51-55). Fluid flow 110 is indicated by the dashed lines traveling from the plenum 118 to the sample holders 129 to exit through the return conduit 168 and into the center conduit 124. (*Id.* 11:66-12:3). Fluid is blocked by a one-way valve 127 on the upstroke to create directional flow. (*Id.* 12:3-6).

"The combination of the compliance chambers 135 and the throttle valves 132 help control undesirable pressure loading or pressure spikes within the sample holder 129 and consequent adverse effects on the test samples 130 when the piston 114 moves in a decompression stroke." (*Id.* 12:18-22). "Compliance chambers and throttle valves associated with each of the sample holders regulate the gradient and back pressure across the prosthetic devices being tested." (*Id.* Abstract). "The compliance chambers 135 provide excess volume area for fluid to move into when the piston 114 performs a compression stroke. As the pressure of the gas in the compliance chamber 135 increases, the volume occupied by the gas decreases to provide additional volume for displacement of the liquid working fluid within the test chamber 106." (*Id.* 12:10-15).

Issued Claim 1 of the '224 Patent is quoted below with the step added during prosecution underlined:

> **Claim 1.** A method for operating an accelerated cyclic test system for evaluating a valved prosthetic device comprising
>
> [a] <u>driving a test system fluid cyclically above a normal physiological rate, at an accelerated pulsed rate of greater than 200 beats per minute within the test system</u>;
>
> [b] storing a volume of test system fluid in an excess volume area during a system driving stroke that opens the valved prosthetic device; and
>
> [c] releasing the stored volume of test system fluid during a return stroke that closes the valved prosthetic device.

A copy of the claims is provided in a separate exhibit for the convenience of the PTAB. (Ex1018). Originally, claim 1 only recited steps [b] and [c]. Step [a] was introduced in during prosecution of the '224 Patent. (Ex1007[Response] 2).

B. The prosecution history of the '224 Patent

During the prosecution of the '224 Patent, the Patent Office concluded that the originally-filed claims were anticipated. Specifically, the Patent Office found that Pickard "teaches a method for operating an accelerated cyclic test system for evaluating a valved prosthetic device ... comprising [b] storing volume of test system fluid in an excess volume area ... and [c] releasing the stored volume of test

system fluid during a return stroke that closes the valved prosthetic device ..." (Ex1005[Office Action] 3[1]). In short, the Patent Office concluded that Pickard anticipated claim 1, prior to the addition of the driving step [a]. (Ex1003[Billiar] ¶[25). The Patent Owner did disagree. (Ex1007[Response] 5-6). Patent Owner's only argument for novelty of the original claims—identical except for the added step [a]—was that Pickard's test system was not an "accelerated" test system. (*Id.* 5-9).

During the prosecution of the '224 Patent, the Patent Office also concluded that claims 2, 3, 6 and 7 were anticipated by Pickard as well. (Ex1005[Office Action] 3-4). Patent Owner also did not challenge these conclusions. (Ex1007[Response] 9).

Although it tried, Patent Owner was unable to convince the Patent Office that the inclusion of the word "accelerated" distinguished the claimed method over Pickard. (Ex1006[Interview]; Ex1007[Response] 5-6).

To overcome the rejection in view of Pickard, Patent Owner amended claim 1 to include new language. Patent Owner amended claim 1 to require "driving a

[1] Page 3 refers to the page numbers provided in the original document (i.e., USPTO page numbers). This page can be found at page 4 of 17 of Exhibit 1005.

test system fluid ... at an accelerated pulsed rate of greater than 200 beats per minute." (Ex1007[Response] 2). But the '224 Patent disclosed nothing about 200 beats per minute for its tests. (Ex.1003[Billiar] ¶29). The specification of the '224 Patent does not have the term "beats per minute" anywhere in it.

Where did "greater than 200 beats per minute" come from? Patent Owner relied on Table 1 of ISO 5840. (Ex1007[Response] 7). ISO 5840 is not referenced anywhere in the '224 Patent. And its contents are not incorporated by reference. ISO 5840 is an International Standard that imposes minimum performance specifications for heart valve prosthetics. (Ex1015[ISO 5840] 1.4).

According to relied upon Table 1 of ISO 5840, operational specifications for cardiac prostheses include minimal operational rates between 30 and 200 beats per minute in accordance with normal and pathological patient conditions. (*Id*. 6.2.1). Patent Owner used that information in ISO 5840 to persuade the Patent Office that "accelerated" means greater than "normal" or "greater than 200 beats per minute." (Ex1007[Response] 6-7; Ex1003[Billiar] ¶33). It is noted that ISO 5840 does not define "accelerated" testing as testing at greater than 200 beats per minute. (Ex1003[Billiar] ¶¶32, 44).

Patent Owner also argued that this new claim language distinguished its amended claim from Pickard. (Ex1007[Response] 5, 8). Patent Owner suggested that Pickard discloses a "real time" system, and that a "real time" system would

have been operated at 72 beats per minute. (*Id.*; Ex1003[Billiar] ¶31). But Patent Owner could not cite to any limiting disclosure of Pickard, because none exists; Pickard does not disclose any particular number of beats per minute for testing. (Ex1003[Billiar] ¶52).

And while Patent Owner admitted that both accelerated testing and the use of an "excess volume area" were well known in heart valve test systems, it asserted the combination was new:

> Thus, while the concept of using a compliance chamber to store excess volume of test fluid in real-time, physiologically accurate, cardiac valve test system is well known…a method in an accelerated cyclic test system that uses an excess volume area is entirely new. (Ex1007[Response] 8).

The Patent Office was unaware that—contrary to Patent Owners assertions—the use of compliance chambers in accelerating testing devices was also well known. (Ex1003[Billiar] ¶¶45-47). For example, over 5 years prior, Iwasaki disclosed that a compliance chamber to store excess volume was added to an accelerated testing device. (Ex1013[Iwasaki] 422 ("the tester was modified to incorporate an air compliance chamber as shown in Fig. 5."); Ex1013[Billiar] ¶45).

In the opinion of Dr. Billiar "Patent Owner obtained allowance based on the incorrect assertion that the use of compliance chambers in accelerated tests systems was new." (Ex1003[Biliar] ¶47).

It is also noted that while Patent Owner argued, and the inventor opined at length, about the inadequacies of, for example, piston pumps and metal bellows in accelerated testing systems, no particular equipment is claimed. (*Compare* Ex1007[Response] 9; Ex1009[Inventor Declaration] ¶¶5-9 *to* Ex1018['224 Claims]).

VI. CLAIM CONSTRUCTION

A claim in an unexpired patent subject to IPR receives its "broadest reasonable interpretation [("BRI")] in light of the specification of the patent in which it appears." 37 CFR § 42.100(b). The BRI does not mean that claim terms are construed so broadly as to be "*unreasonable* under general claim construction principles." *In re Smith Int'l, Inc.*, No. 2016-2303, slip op. at 12 (Fed. Cir. Sept. 26, 2017) (quoting *Microsoft Corp. v. Proxyconn, Inc.*, 789 F.3d 1292, 1298 (Fed. Cir. 2015) (emphasis in original). Neither can the BRI give "claims a legally incorrect interpretation" "divorced from the specification and the record evidence." *Id.* (citations and internal quotations omitted).

Petitioner proposes constructions of the following terms under the BRI. All remaining terms should be given their plain meaning.

A. "accelerated"

The term "accelerated" is not defined in the specification. (Ex1013[Billiar] ¶34). It was defined by amendment to the claims during prosecution to allegedly distinguish the claimed subject matter from Pickard. (Ex1003[Billiar] ¶¶35, 36, and 51; Ex1007[Response] 5-9; Ex1008[Allowance] 3[2]). The claims are directed to a method of operating a system. The word "accelerated" is used twice in the claims. It originally appeared only in the preamble, i.e., "a method of operating an accelerated cyclic test system." But the "Examiner expressed concern that the term 'accelerated' … was insufficient to differentiate the types of test systems disclosed in the cited prior art…" (Ex1007[Response] 5; *see also* Ex1006[Interview]). In order to alleviate the Examiner's concerns, Patent Owner made an amendment to recite the term in the claims. Specifically, the claims were amended to recite "an accelerated pulsed rate of greater than 200 beats per minute within the test system." (Ex1007[Response] 2, 5-6; Ex1003[Billiar] ¶35).

[2] Page 3 refers to the page numbers provided in the original document (i.e., USPTO page numbers). This page can be found at page 7 of 21 of Exhibit 1008.

The term "accelerated" in the preamble should be accorded no patentable weight, consistent with the examination of these claims. But to the extent that the term in the preamble is afforded any patentable weight, it should bear the definition ascribed to it by Patent Owner to obtain allowance and imported into its added step [a]. Patent Owner asserted that a person of ordinary skill in the art recognizes that the term "accelerated" means a system that cycles faster than 200 beats per minute:

> Applicant noted that…the industry (i.e., a person of ordinary skill in the art) recognizes an "accelerated" valve test system to mean a system that cycles faster than a normal physiological rate. It was discussed that the typical upper end of a normal physiological rate is above 200 beats per minute. The Examiner agreed that a limitation describing the system environment as being greater than 200 beats per minute would be sufficient to address this concern with the claim. (Ex1007[Response] 6).

The Examiner explicitly relied on this definition and tied "accelerated" in the preamble to the "above 200 bpm" limitation in his reasons for allowance:

> The *specific limitation of an accelerated cyclic test system for evaluating a valved prosthetic device with a pulsed rate of greater than 200 beats per minute* in independent claim 1 when combined with the limitations of an excess volume area (which is a term of art,

> see remarks of 06/17/2015 p. 8, final ¶) and its location also in independent claim 1 distinguish the present invention from the combined prior art.
> (Ex1008[Allowance] 3 (emphasis added)).

In short, the term "accelerated" was defined in the claim by Patent Owner to mean "cycling above 200 beats per minute." (Ex1003[Billiar] ¶¶34-36).

B. "excess volume area"

The claims of the '224 Patent require storing a volume of test system fluid in "an excess volume area" during a system driving stroke. The specification of the '224 Patent does not provide an explicit definition of this term, and Dr. Billiar is unaware of any special meaning of the term "excess volume area." (Ex1003[Billiar] ¶¶37, 38). The term is used in the specification to refer to a portion of the compliance chambers taken up by fluid as pressure increases during the compression stroke: "compliance chambers 135 provide excess volume area for fluid to move into when the piston 114 performs a compression stroke." (Ex1001 12:10-12). The very next sentence of the specification states '[a]s the pressure of the gas in the compliance chamber 135 increases, the volume occupied by the gas

decreases to provide additional volume for displacement of the liquid working fluid within the test chamber 106." (*Id*. 12:12-15).

According to the file history, the Patent Owner appears to have convinced the Patent Office that the term "excess volume area" is a term of art. (Ex1008[Allowance] 3 ("an excess volume area (which is a term of art, see remarks of 06/17/2015 p.8, final ¶)"; Ex1003[Billiar] ¶37). But nowhere within Patent Owner's remarks is a definition or a citation to a definition of "excess volume area" given. (Ex1003[Billiar] ¶37). Instead, this section of the remarks contains Patent Owner's unsupported argument that while compliance chambers were known in so-called "real-time" test systems, their use in "accelerated" systems was allegedly new:

> Thus, while the concept of using a compliance chamber to store excess volume of test fluid in real-time, physiologically accurate, cardiac valve test system is well known for the purpose of substituting for the arteries of the human circulatory system (in fact, compliance is required by ISO 5840 in Annex L and detailed guidelines for compliant chambers are provided in Annex F) a method in an accelerated cyclic test system that uses an excess volume area is entirely new. As described in the specification of this application, "the compliance chambers 135 assist in minimizing the effects of

> large and quickly changing pressure gradients (i.e., pressure loading or pressure spikes) across test samples 130 placed within the test chamber 106." (See, ¶0061.) In methodologies of prior commercial accelerated test systems, there were no specific design elements or system features to address this phenomenon of pressure spikes, which were therefore viewed as an accepted drawback associated with testing at accelerated rates. As described in the present application, the compliance chamber may also be used to fine-tune the pressure-gradient across the valve sample being tested. The prior art of record fails to teach the claimed method in the context of an accelerated cyclic test system. None of these concerns, goals or solutions addressed and achieved by the claimed method are contemplated or recognized in the prior art of record. Thus, Pickard cannot be held to anticipate the invention of claim 1 because a method performed within an accelerated cyclic test system was not even a consideration in the context of the disclosure of Pickard.
>
> (Ex1007[Response] 8-9).

Nowhere in Patent Owner's Remarks, or in the sections of the ISO 5480 referred to therein, is a definition of "excess volume area" provided. (Ex1003[Billiar] ¶¶36-37; Ex1015[ISO 5840], Annex L, Annex F).

Petitioner's expert, Dr. Billiar is unaware of any special meaning of the term "excess volume area." (Ex1003[Billiar] ¶38). In other words, the

term "excess volume area" is not a term of art. (*Id.*). After reading the specification of the '224 Patent and its prosecution history, Dr. Billiar understands this term to indicate a location or a space where fluid displaced by a pulsatile pump can flow into. (Ex1003[Billiar] ¶¶38-39). Consistent with the specification, and by no means contrary to the evidence contained in the prosecution history, the term should be given its ordinary or plain meaning. (Ex1003[Billiar] ¶¶37-39).

VII. THE SCOPE AND THE CONTENT OF THE PRIOR ART

A. It was known to use compliance chambers in accelerated test systems

Recall that in order to obtain allowance Patent Owner convinced the Patent Office that "while the concept of using a compliance chamber to store excess volume of test fluid in real-time, physiologically accurate, cardiac valve test system is well known…a method in an accelerated cyclic test system that uses an excess volume area is entirely new." (Ex1007[Response] 8; Ex1008[Allowance] 3). But the prior art disclosed exactly that many years prior. (Ex1003[Billiar] ¶45). For example Iwasaki *et al.*, published a paper disclosing this combination in 2002. (Ex1013[Iwasaki]).

1. Iwasaki

As the title evidences, Iwasaki is directed to "Accelerated Fatigue Test Protocols for Prosthetic Heart Valves." (Ex1013[Iwasaki] 420). One of the goals of Iwasaki's research "is to establish a reliable methodology for accelerated fatigue tests of prosthetic test valves." (Ex1013[Iwasaki] Abstract). The test systems of Iwasaki are operated at cycle rates of 400 to 1200 bpm. (*Id*. 422-423). And Iwasaki discloses use of an "excess volume area" in an accelerated test system. Specifically, Iwasaki discloses adding a compliance chamber to an accelerated testing device to store excess volume. (Ex1013[Iwasaki] 422 ("the tester was modified to incorporate an air compliance chamber as shown in Fig. 5."); Ex1003[Billiar] ¶45). Indeed the motivation to make accelerated testers is the same as that cited by the inventor in his Declaration during prosecution: the accelerated testing requirements of ISO 5840. Compare detailed discussion of ISO 5840 in Ex1007[Response] 7-8 and Ex1009[Inventor Declaration] ¶10 to, for example, the very first line of Iwasaki: "Accurate estimation of durability in a timely manner is one of the most important unresolved issues in the basic research of artificial organs." (Ex1013[Iwasaki] 420). And motivation to add the compliance chamber was the same as that admitted by the Patent Owner in its response ("for the purpose of substituting for the arteries of the human circulatory

system" at Ex1007[Response] 8). Iwasaki cites the use of compliance "to model the elastic effects of the aorta" and because without it, there was "insufficient opening" of the valve. (Ex1013[Iwasaki] 422). Iwasaki operated its accelerated cyclic test system with its air compliance chamber at 1200 bpm prior to May 2002. (*Id*. 423).

2. Reul

Iwasaki was not alone in publishing on the combination of an accelerated cyclic test system and excess volume area. In March of 1998, an article entitled "*Durability/Wear Testing of Heart Valve Substitutes*" by Reul *et al.*, was published in the Journal of Heart Valve Disease. (Ex1014[Reul]). This 1998 article reports on the use of air compliance in accelerated cyclic test systems. Reul teaches testing heart valves in its new design having adjustable compliance at rates of 600 bpm and 1000 bpm. (*Id.* 154; Ex1003[Billiar] ¶45). In the opening paragraph of this paper Reul notes that "[f]or all testers, time history of loading and pressure difference across the valve are a function of test frequency, compliance and other factors." (*Id*. 151). Reul discloses an accelerated valve test system designed and manufactured prior to March 1998 that incorporates "an adjustable compliance chamber … for additional control of loading forces." (*Id*. 153; Ex1003[Billiar] ¶¶45-46. Reul explains that "peak loading forces for a …valve have been varied

by changing the air compliance at a constant test rate, bypass throttle and stroke settings." (Ex1014[Reul] 154). In other words, "compliance chambers were known to provide excess volume area to avoid pressure spikes." (Ex1003[Billiar] ¶46).

In short, "Patent Owner obtained allowance based on the incorrect assertion that the use compliance chambers in accelerated test systems was new." (Ex1003[Billiar] ¶47). This combination was known for over ten years. Iwasaki discloses an accelerated testing system with compliance chambers as of 2002. (Ex1013[Iwasaki] 422; Ex1003[Billiar] ¶45). Reul discloses an accelerated testing system with compliance chambers as of 1998. (Ex1014[Reul] 153; Ex1003[Billiar] ¶45). And, as discussed below, St. Jude disclosed this combination in 1999.

B. Pickard describes the claimed method—and is not limited to any specific bpm value or range

US Patent No. 4,682,491 was issued in 1987 to Pickard and describes a cyclic test system for evaluating a valved prosthetic device prior to implant in the human body. (Ex1010[Pickard]). Pickard teaches methods in which prosthetic heart valves are mounted in a flow channel (19), and a pulsatile flow is delivered to a circulatory loop (18). (Ex1010[Pickard] 13:52-14:15, FIG. 3, FIG. 8). The orientation of the valves defines the fluid flow direction. Referring to Figure 3

(reproduced in annotated format below), fluid travels counter-clockwise—through a first test chamber 126 including heart valve 200.

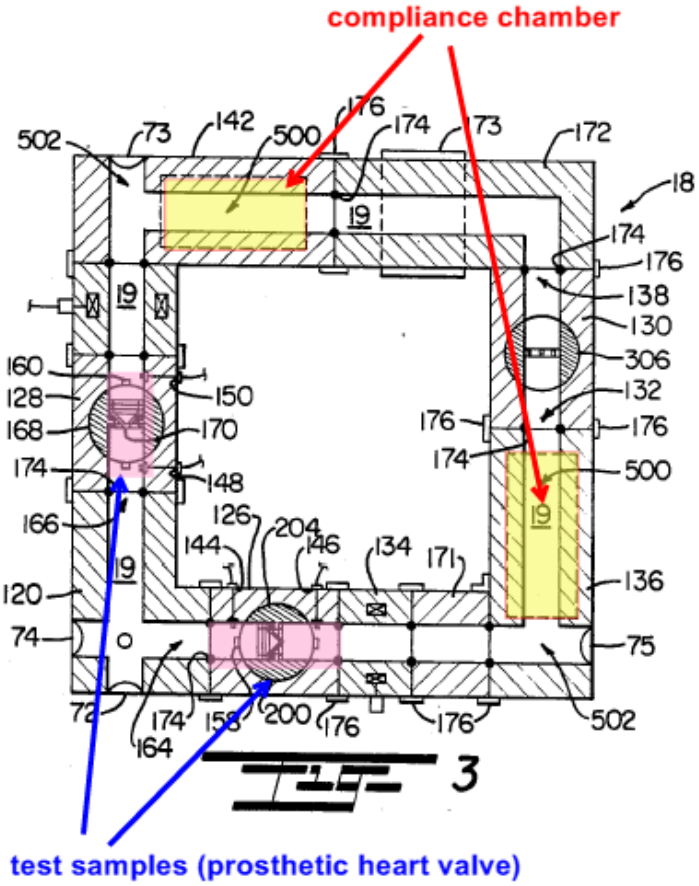


FIG. 3

Since restriction element 132 does not allow the passage of fluid as rapidly as it is driven by the power stroke of the pump, excess fluid is received in the first compensation module (136), i.e., compliance chamber. (Ex1003[Billiar] ¶49). During the recovery or return stroke, the excess fluid in the compensation module (136) passes though the resistance element (132) through the second compliance

chamber (142) so it may pass the second test chamber (128) and be returned into intake chamber (120) and pump (46). (*Id.*). In short, as was undisputed during prosecution, Pickard discloses the entirety of claim 1 as it was originally-presented to the Patent Office (*i.e.*, prior to amendment adding "driving a test system fluid cyclically above a normal physiological rate, at an accelerated pulsed rate of greater than 200 beats per minute within the test system."). (Ex1003[Billiar] ¶¶24, 48-50).

In its attempt to distinguish its amended claims from Pickard, Patent Owner argued that "Pickard discloses a "real-time" test systems (e.g., operating at physiologic rates on the order of 72 beats per minute…)" that "fail to teach the claimed method in the context of an accelerated cyclic test system." (Ex1005[Office Action] 5, 9). However, like the disclosure of the '224 Patent, Pickard does not recite a specific operational rate. (Ex1003[Billiar] ¶¶51-52).

Pickard does disclose a "method and apparatus for testing of a prosthetic heart valve under individualized test conditions simulating a specific human circulatory environment into which the valve may be placed." (Ex1010[Pickard] 2:58-62). And Pickard touts the advantage of customizing the testing procedure to correspond to a specific individual's circulatory system to help guard against malpractice and product liability claims. (*Id.* 2:27-45). In the opinion of Dr.

Billiar, a patient does not have one heart rate. (Ex1003[Billiar] ¶53). As such, simulation of the circulatory environment of a patient would include testing across the range that would be experienced by the patient. (*Id.*). "It is my opinion that Pickard is not limited to 72 bpm or any range including up to 200 bpm asserted by Patent Owner and the inventor Dr. Weinberg." (*Id.*).

Moreover, as Patent Owner acknowledged, "the typical upper end of a normal physiological rate is ***above*** 200 beats per minute." (Ex1007[Response] 6 (emphasis added)). As such, its narrow interpretation limiting Pickard to 72 beats per minute (or up to 200 beats per minute) is not justified. (Ex1003[Billiar] ¶54). Applicant may have chosen to limit its claims in a way that does not distinguish it from Pickard, but it cannot limit Pickard retrospectively and contrary to its explicit teachings.

C. Woodward evidences normal physiological heart rates of up to 270 beats per minute

US Patent No. 3,208,448 issued in 1965 to Kenneth Woodward. (Ex1012[Woodward]). It was not cited during prosecution. Woodward is generally directed to an artificial heart that duplicates the human heart's essential functions, including beats per minute or pulse. (*Id*. Title; 3:23-26, 40-44). Woodward teaches that it was known that a normal physiological heart rate for a normal young adult includes a range of from 60 (resting) to 160-180 bpm (heavy

exercise) to 240-270 (short exhaustive work). (Ex1013[Woodward] 13:38-49; Ex1003[Billiar] ¶55). In the opinion of Dr. Billiar, "Woodward discloses that a normal physiological range can go up to 270 bpm." (Ex1003[Billiar] ¶55). This is consistent with Patent Owner's admission that "the typical upper end of a normal physiological rate is above 200 beats per minute." (Ex1007[Response] 6). Woodward evidences that the range of normal physiological heart rates overlap with the claimed range of greater than 200 beats per minute.

D. St. Jude describes methods of operating an accelerated cyclic test system with a compliance chamber or fluid reservoir located downstream of a heart valve.

US Patent No. 5,916,800 issued on June 29, 1999 to St. Ju[d]e Medical, Inc. (Ex1011[St. Jude]). It was not cited during prosecution. St. Jude is directed to methods and systems for processing (*e.g.*, testing and evaluating) biological materials such as, for example, heart valves. (*Id*. 2:31-45; Ex1003[Billiar] ¶72). St. Jude discloses a test system operating above 200 bpm, e.g., 1000 bpm. (*Id*. Example 2; Ex1003[Billiar] ¶¶67, 72, 73). In addition, St. Jude teaches operating at, below, or above normal physiological conditions. (Ex1011[St. Jude] 2:45-50; Ex1003[Billiar] ¶72). And St. Jude discloses the use of a reservoir or other structure to hold excess volume. (Ex1011[St. Jude] Example 1; 11:38-39 ("The test system will be a self-contained loop with a compliant fluid reservoir …").

This reservoir is downstream of the heart valve being evaluated. (*Id.*; Ex1003[Billiar] ¶72).

St. Jude teaches a system and method to "evaluate the function, durability, and design of a … heart valve." (Ex1011[St. Jude] 4:44-48; Ex1003[Billiar] ¶73). The pulse evaluation circuit of St. Jude is driven by a pneumatic pump at about 1000 bpm to evaluate the durability of a heart valves. (Ex1011[St. Jude] 11:4-11, 11:38-55, 4:65-5:6; Ex1003[Billiar] ¶73).

Referring to the pulse evaluation circuit 60 shown in FIG. 3, fluid is forced or driven by pneumatic pump 64 cyclically ("pneumatic pump changing cycle from pressure to vacuum") within the circuit 60 up to about 1000 bpm. (Ex1011[St. Jude]10:15-11:17; Ex1003[Billiar] ¶79). St. Jude teaches driving the test fluid toward chamber 12, which opens heart valve 15 allowing the test fluid to pass into chamber 11 holding compliant structures 16. (Ex1011[St. Jude] 10:15-11:17, FIG. 3; Ex1003[Billiar] ¶82). Because, the check valve in container 13 is closed during this portion of the cycle of the pump, the test fluid is stored in the excess volume reservoir of chamber 11. (*Id.*). On the return stroke, the pressure is released closing the heart valve in chamber 12 and opening the check valve of chamber 13 thereby releasing the test fluid from chamber 11. (Ex1003[Billiar] ¶¶74, 88). The

chamber 11 with compliant structures 16 is downstream from the heart valve as shown in Figure 3. (*Id.* ¶75; FIG. 3 from St. Jude annotated below).

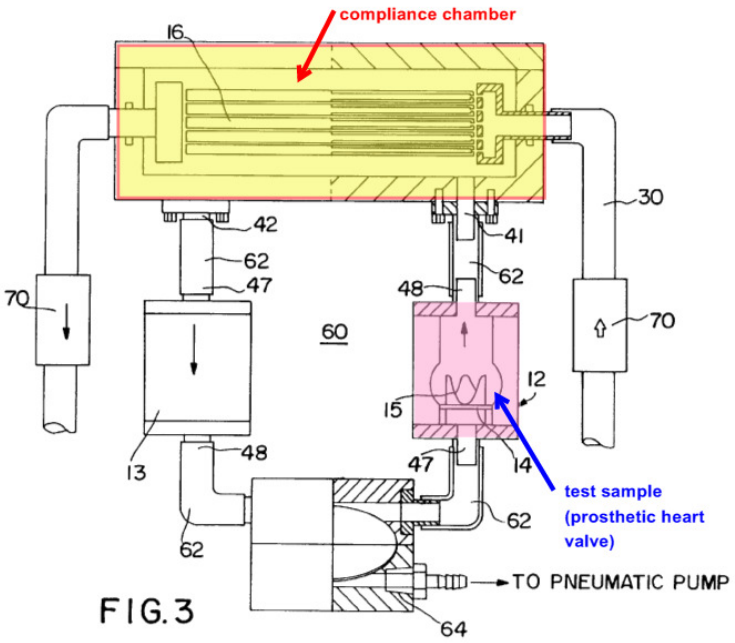


FIG. 3

St. Jude also depicts and describes an embodiment where a fluid reservoir 24 is substituted for chamber 11. (Ex1011[St. Jude] 2:24-25, 4:44-52 and 7:22-27, FIG. 6 annotated below). The fluid reservoir 24, is located downstream of, or on the outflow side of, heart valve 14. (*Id.*). The pulse evaluation units shown in both embodiments (FIG. 3 and FIG. 6), include pneumatic pumps 64 and heart valves (in holders 14) positioned the same way within the fluid flow in conduit 62. (*Id.* FIG. 3; FIG. 6; *see also* Ex1003[Billiar] ¶76).

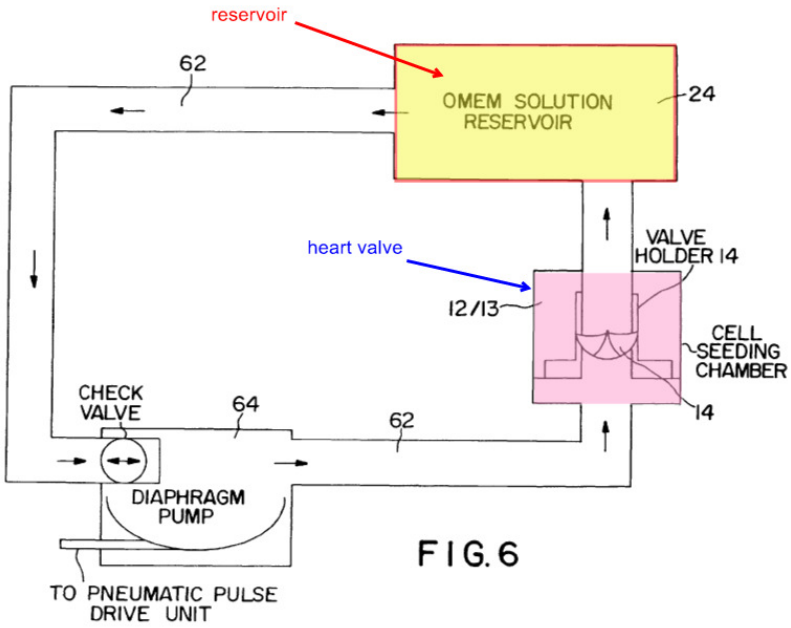


FIG. 6

VIII. THE PERSON OF ORDINARY SKILL IN THE ART

The '224 Patent generally relates to cyclic testing of cardiovascular devices such as a valved prosthetic device. (Ex1003[Billiar] ¶18). After reviewing the '224 Patent and its prosecution history, Dr. Billiar opined that, the relevant field is testing of cardiovascular devices. (*Id.* ¶19).

A POSITA would have at least: (a) a bachelor's degree in biomedical engineering, or a related field, such as mechanical engineering, biomechanical engineering, or bioengineering, who also has at least 3-5 years of experience with cardiovascular devices; or (b) an advanced degree in the same areas of academic

study with at least 1-2 years of corresponding experience. (Ex1003[Billiar] ¶¶19-20).

IX. DETAILED EXPLANATION OF GROUNDS FOR UNPATENTABILITY

A. Ground 1a: All Claims are Rendered Obvious by Pickard in light of Woodward.

During prosecution, the Examiner cited Pickard as novelty destroying. (Ex1005[Office Action] 3-4). In response, Patent Owner amended the claims to recite "driving a test system fluid cyclically above a normal physiological rate, at an accelerated pulsed rate of greater than 200 beats per minute within the test system." (Ex1007[Response] 7).

Patent Owner argued that this amendment distinguished the claims over Pickard, because Pickard was directed to a system that operates at 72 bpm. (*Id*. 5). But Pickard does not teach a specific rate. (Ex1003[Billiar] ¶¶52-53). Rather, Pickard teaches that its "object of the present invention to provide a method and apparatus for testing of a prosthetic heart valve under individualized test conditions simulating a specific human circulatory environment into which the valve may be placed." (Ex1010[Pickard] 2:57-61).

A specific rate is also missing from the '224 Patent, and was introduced during prosecution relying on the 2005 edition of ISO 5840. (Ex1007[Response] 6). Specifically, Patent Owner relied on the ISO 5840 Standard, in order to

persuade the Patent Office that "accelerated" means at greater than 200 bpm. (*Id.*; Ex1003[Billiar] ¶33). But while ISO 5840 imposes design specifications and minimum performance specifications for heart valve prostheses, it does not provide a definition of "accelerated" cyclic testing as testing at a rate of greater than 200 beats per minute. (Ex1003[Billiar] ¶32; Ex1015[ISO 5840] 1.4).

Pickard does not teach ***use up to 200 beats per minute and go no more***. (Ex1003[Billiar] ¶¶53-54). "Like the '224 application, Pickard did not disclose any particular number of beats per minute for testing." (*Id*. ¶52; *see also* Ex1002[Original Application]). And there is no justification or reason to use ISO 5840 to limit Pickard's disclosure. (*Id*. ¶¶32, 53-54, 59).

One of Pickard's stated objectives is to mimic a range of heart rates for individualized testing. (Ex1010[Pickard] 2:57-61, 4:62-5:5; Ex1003[Billiar] ¶¶52-53). Further, Pickard recognizes an advantage in performing and recording parametric test data to guard against malpractice and product liability claims. (Ex1010[Pickard] 2:24-35; Ex1003[Billiar] ¶54). As such, "Pickard provides explicit motivation to test the typical upper end of a normal physiological rate—which Patent Owner tells us is above 200 beats per minute—to ensure the device is safe for use in the patient." (Ex1003[Billiar] ¶54; Ex1007[Response] 6).

As stated by Dr. Billiar "Woodward teaches us that it was known that the heart rate a normal young adult, can range of from 60 bpm (resting) to 160-180 bpm (heavy exercise), and can extend up to 240-270 (short exhaustive work)." (Ex1003[Billiar] ¶55; Ex1012[Woodward] 13:43-47). "In other words, Woodward discloses that a normal physiological range can go up to 270 bpm." (Ex1003[Billiar] ¶55).

Accordingly, while Pickard does not provide a specific rate, it would be obvious to modify the method of Pickard to include testing above 200 bpm so as to include testing of a normal young adult during short exhaustive work (240-270 bpm) as disclosed in Woodward; and one would be motivated to do so given Pickard's stated objectives. (Ex1010[Pickard] 2:24-35, 2:57-61, 4:62-5:5; (Ex1003[Billiar] ¶¶56, 58). As Dr. Billiar states "a person of ordinary skill in the art would understand Woodward to teach that a normal physiological range includes 270 bpm and that a person of ordinary skill in the art viewing Pickard in light of Woodward would understand that operating the methods of Pickard at a pulsed rate of greater than 200 bpm, such as at a rate of 240-270 bpm would be advantageous to be able to test the full parameter range of a circulatory environment of patients." (Ex1003[Billiar] ¶58). Further, a POSITA would reasonably expect the combination to be successful. Dr. Billiar opines "it would

not have challenged one of ordinary skill in the art before 2009 to operate Pickard's test system at 240-270 bpm given the minimum frequency range including 200 bpm in ISO 5840, and one of ordinary skill in the art would have had a reasonable expectation that Pickard's method and devices would work at such a rate. At the relevant time, one of ordinary skill in the art would have a reasonable expectation that using Pickard's systems and methods at up to the 270 bpm, disclosed in Woodward, would be successful." (Ex1003[Billiar]¶60).

Finally, during prosecution, "Patent Owner argued that Pickard's system compliance served a different purpose that the excess volume area of the '224 Patent claims." (Ex1003[Billiar] ¶64, citing Ex1007[Response] 5). This is not correct; Pickard and the '224 Patent disclose the same purpose for their compensation chamber/excess volume area. (Ex1003[Billiar] ¶64). Pickard teaches the use of compliance is for the purpose of avoiding pressures spikes. (Ex1010[Pickard] 3:46-55 ("Excess fluid pressure is compensated by means of air pressure…so that the fluid compensation chamber acts as the veins and arteries of the human body."). The '224 Patent teaches the purpose of the compliance chambers is to avoid pressure spikes, i.e., to "control undesirable pressure loading or pressure spikes." (Ex1001['224 Patent] 12:18-21).

Claim 1. [Preamble] A method for operating an accelerated cyclic test system for evaluating a valved prosthetic device comprising

As unrefuted during prosecution, Pickard teaches a method for operating a cyclic test system for evaluating a valved prosthetic device. (Ex1005[Office Action] 3; Ex1007[Response] 6; Ex1003[Billiar] ¶49).

"An apparatus and method for testing prosthetic heart valves prior to implant in the human body provides a test chamber having a flow channel therethrough and a passageway which receives a mounting fixture for a heart valve. The test chamber is used in a mock circulatory loop with the flow channel being in the loop…. A pump cyclically drives a fluid through the loop, and flow meters and pressure sensors monitor the test. A data processor monitors and processes the flow data and controls the pump to create a desired flow waveform." (Ex1010[Pickard] Abstract).

An object of Pickard is to "to provide a method … for testing of a prosthetic heart valve under individualized test conditions simulating a specific human circulatory environment into which the valve may be placed." (*Id.* 2:57-61).

Woodward states: "It is known that the pulse rate for a normal young adult varies from about 60 c.p.m. (resting) to 160-180 c.p.m. (heavy exercise) with rates for short exhaustive work to 240-270 c.p.m." (Ex1012[Woodward] 13:43-47).

It would have been obvious to operate Pickard's system to cycle above 200 bpm (e.g., 205, 240, 270) in view of Woodward's disclosure and Pickard's stated patient safety objectives. (Ex1003[Billiar] ¶¶54-57).

Claim 1. [a] driving a test system fluid cyclically above a normal physiological rate, at an accelerated pulsed rate of greater than 200 beats per minute within the test system;

Although Pickard lacks an explicit recitation of any particular "beats per minute" value or range, its disclosed methods and stated objectives lead a POSITA to driving Pickard's system at the claimed rate.

In Pickard, "[f]luid is driven through circulatory loop 18 in a pulsatile or cyclical manner by means of a piston pump 46." (Ex1010[Pickard] 7:42-43). And thus, Pickard teaches driving test fluid cyclically. *See also* (Ex1010[Pickard] 15:23-28("The preferred method also includes the steps of measuring the pressure of fluid in the flow channel on either side of the heart valve when the heart valve is in the test position and cyclically driving fluid through the flow channel and then measuring the flow rate of fluid as the heart valve opens and closes.").

Again, Pickard teaches entering data for an individual to mimic their own circulatory system: "individualized parametric data according to a specific individual's circulatory system may be fed into the computer and waveform generator to generate the precise pumping action of an individual's heart. The

waveform generator… can cause the pump to precisely mimick this pumping action. The computer may then implement a feedback loop … so that the circulatory loop fairly accurately simulates an individual's circulatory environment into which a selected prosthetic valve will be placed." (Ex1010[Pickard] 4:62-5:5; *see also* 2:35-42; 2:57-61).

Woodward discloses: "It is known that the pulse rate for a normal young adult varies from about 60 c.p.m. (resting) to 160-180 c.p.m. (heavy exercise) with rates for short exhaustive work to 240-270 c.p.m." (Ex1012[Woodward] 13:43-47).

Patent Owner also admitted that during the patent office interview: "[i]t was discussed that the typical upper end of a normal physiological rate is above 200 beats per minute." (Ex1007[Response] 6).

"While [Patent Owner] chose to specify this particular dividing line into the claims to gain allowance, this does not change the disclosure of Woodward, which explicitly provides the upper end of 270 bpm." (Ex1003[Billiar] ¶59).

During prosecution, in order to obtain allowance, Patent Owner "convinced the examiner that a 'normal physiological rate' is between 30 and 200 bpm using ISO 5840. And that an "accelerated" rate is anything above 200 bpm." (Ex1003[Billiar] ¶59, citing Ex1007[Response] 7). And Patent Owner's

expert in the corresponding litigation also defined "normal physiological rate" as "between 30-200 beats per minute." (Ex1017[Girard] ¶26 (3rd row)).

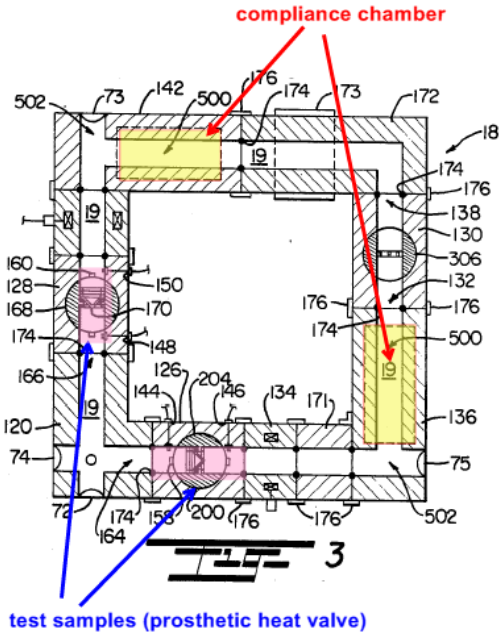
It would have been obvious to operate Pickard's system to cycle above 200 bpm (e.g., 205, 240, 270) in view of Woodward's disclosure and Pickard's stated patient safety objectives. (Ex1003[Billiar] ¶¶54-60).

"In my opinion, it would not have challenged one of ordinary skill in the art before 2009 to operate Pickard's test system at 205 bpm given the minimum frequency range including 200 bpm in ISO 5840, and one of ordinary skill in the art would have had a reasonable expectation that Pickard's method would work at such a rate." (*Id*. ¶60).

Claim 1. [b] storing a volume of test system fluid in an excess volume area during a system driving stroke that opens the valved prosthetic device; and

As unrefuted during prosecution: Pickard teaches a method for operating a "cyclic test system for evaluating a valved prosthetic device (**abstract**) comprising storing a volume of test system fluid in an excess volume area (**col. 15, lines 23-52; at least elements 136 and 142; see fig. 2; see also col. 5, lines 58-62**) during a system driving stroke that opens the valved prosthetic device (**col. 3, lines 9-57; see fig. 2 and associated text**);" (Ex1005[Office Action] 3 (emphasis original)).

Pickard describes a compensation chamber (also referred to as a compliance chamber) that provides an excess volume reservoir: "the preferred method is directed toward a simulated circulatory system that has a flow channel containing a test fluid and which includes a … fluid restriction element in the flow channel, a compensation chamber which provides…an excess fluid compensation reservoir...." (Ex1010[Pickard] 15:45-55).



"Since restriction element 132 does not allow the passage of fluid as rapidly as it is driven by the power stroke of pump 46, excess fluid is received in first compensation module 136 under compliance pressure from diaphra[g]m 518 that is controlled by air pressure through hose 528. During the recovery strokes, the

excess fluid in first compensation chamber 136 passes through resistance element 132, through second compensation chamber 142 so it may pass through the heart valve in second test chamber 128 and be returned into intake chamber 120 and pump 46 through intake orifice 124." (*Id*. 13:67-14:10). *See also* (Ex1003[Billiar] ¶49).

Claim 1 of Pickard recites a pump for cyclically pumping the fluid by a power and recovery stroke. And that fluid being pumped during the power stroke accumulates in the first compensation reservoir. Then during the recovery stroke, that same heart valve closes to force fluid through to the intake. Claim 1 of Pickard recites, in part: "pump means for cyclically pumping fluid alternately by a power stroke and a recovery stroke, said fluid being pumped during the power stroke through said fluid inlet towards said first and second test chambers whereby one of said first and second heart valves passes the fluid therethrough while the other one of said first and second heart valves resists fluid flow, fluid being pumped during the power stroke accumulating under pressure in said first and second compensation reservoirs, and during the recovery stroke whereby said one of the heart valves closes and the other one of the heart valves opens so that said first and second fluid pressure compliance means force fluid through the other one of heart valve back into said intake chamber, said restriction means being

selectively adjustable to permit flow of a volume of fluid over a time period of one pump cycle which volume is equal to the volume of fluid displaced by the power stroke of the pump;" (Ex1010[Pickard] 17:29-48; *see also* Ex1003[Billiar] ¶50).

In claim 9, Pickard describes ports for observing the opening of the valve on the power stroke, and it's closing on the recovery stroke: "9. Apparatus according to claim 1 including a plurality of optical view ports positioned for viewing the opening and closing of said first and second heart valves in the test position during successive power and recovery strokes of said pump means." (*Id*. 18:27-31).

Claim 1. [c] releasing the stored volume of test system fluid during a return stroke that closes the valved prosthetic device.

As unrefuted during prosecution Pickard discloses the above storing step and then "releasing the stored volume of test system fluid during a return stroke that closes the valved prosthetic device (**col. 14 lines 4-10**)." (Ex1005[Office Action] 3 (emphasis in original)).

"During the recovery strokes, the excess fluid in first compensation chamber 136 passes through resistance element 132, through second compensation chamber 142 so it may pass through the heart valve in second test chamber 128 and be returned into intake chamber 120 and pump 46 through intake orifice 124." (Ex1010[Pickard] 14:4-10, claims 1 and 9; Ex1003[Billiar] ¶¶49-50).

Patent Owner's own reference specifies that Pickard's machine operates—at a minimum—at 200 beats per minute. And Patent Owner admits, and Woodward explicitly discloses, that normal physiological rates include rates above 200 beats per minute. It would not have presented a challenge to operate at, say 205 bpm, and Pickard's safety objectives are explicit motivation to operate above 200 bpm. As to Patent Owner's assertions that the objectives of compliance are different in its methods—avoiding pressure spikes is explicitly disclosed as the objective in BOTH. In view of the teachings of Pickard and Woodward and the motivations described above (and incorporated herein), claim 1 is unpatentable under 35 USC 103.

Claim 2. The method of claim 1, wherein the excess volume area enlarges in response to a pressure on the test system fluid during the driving stroke and decreases during the return stroke.

The detailed explanation of Ground 1a, claim 1 is incorporated by reference. As unrefuted during prosecution: "**Regarding claim 2, Pickard** teaches that the excess volume area enlarges in response to a pressure on the test system fluid during the driving stroke and decreases during the return stroke (**col. 3, lines 46-57 teaching that the fluid pressure compensation chamber acts by means of air pressure through a diaphragm like "veins and arteries of the human body."**

i.e. enlarges due to greater pressure and vice versa; see also fig. 2)."

(Ex1005[Office Action] 3 (emphasis original); Ex1007[Response] 9).

"A fluid pressure compensation chamber is associated with each conduit between the respective chamber and the restriction chamber and each includes a fluid compensation reservoir having one resilient side wall defined by a diaphra[g]m that expands to receive excess fluid. Excess fluid pressure is compensated by means of air pressure on an opposite side of the diaphra[g]m so that the fluid compensation chambers act as the veins and arteries of the human body." (Ex1010[Pickard] 3:46-55; *see also* Ex1003[Billiar] ¶62; ¶43).

"Pickard teaches 'the excess volume area enlarges in response to a pressure on the test system fluid during the driving stroke and decreases during the return stroke'..." (Ex[Billiar] ¶62, citing, Ex1010[Pickard] 3:46-57).

Claim 3. The method of claim 2, wherein the excess volume area provides a spring force counter to and in response to the pressure on the test system fluid.

The detailed explanation of Ground 1a, claim 2 is incorporated by reference. As unrefuted during prosecution: **"Regarding claim 3, Pickard** teaches that the excess volume area provides a spring force counter to and in response to the pressure on the test system fluid (**col. 3, lines 46-57 teaching that the fluid pressure compensation chamber acts by means of air pressure through a**

diaphragm like "veins and arteries of the human body." i.e. provides spring like pressure to the contained fluid; see also fig. 2)". Ex1005[Office Action] 3 (emphasis in original); Ex1007[Response] 9).

In addition, with respect to Figure 8, it is disclosed that "a resilient diaphra[g]m 518, formed out of polyurethane, … is held in position between the peripheral edge of diaphra[g]m 518 and mounting plate 514. The air inlet port 524 is formed through a central portion of retaining plate 514 .... Thus, pressure may be exerted on fluid in the flow path by varying the air pressure in air chamber 530 so that diaphra[g]m 518 is flexed against the resistance provided by the fluid in chamber 532." (Ex1010[Pickard] 12:58-13:9; *see also* Figure 8.

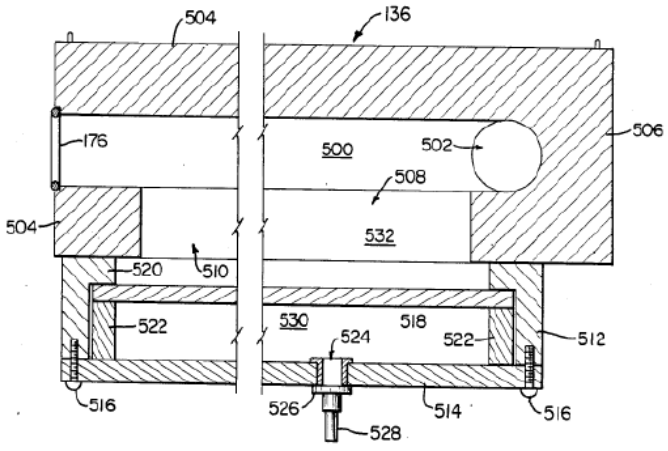


FIG. 8

"Pickard teaches that the 'spring force [is] counter to and in response to the pressure on the test system fluid' at column 12, line 58 to column 13, line 9 ("a

resilient diaphra[g]m 518, formed out of polyurethane, … is held in position between the peripheral edge of diaphra[g]m 518 and mounting plate 514. The air inlet port 524 is formed through a central portion of retaining plate 514 … Thus, pressure may be exerted on fluid in the flow path by varying the air pressure in air chamber 530 so that diaphra[g]m 518 is flexed against the resistance provided by the fluid in chamber 532.")). (Ex1003[Billiar] ¶62).

Claim 4. The method of claim 3 further comprising altering a spring factor of the spring force provided by the excess volume area through selection of a material forming at least a portion of a boundary of the excess volume area.

The detailed explanation of Ground 1a, claim 3 is incorporated by reference. Pickard describes altering a spring factor of the spring force provided by the excess volume area through selection of a polyurethane boundary material. (Ex1010[Pickard] 12:58-13:9; *see also* Figure 8 below; *see also* Ex1003[Billiar] ¶63).

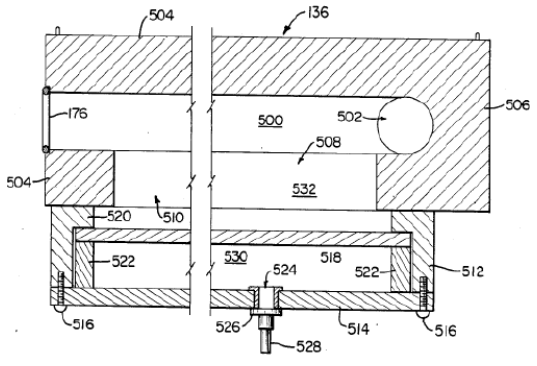


FIG. 8

Referring to Figure 8: "compensation module 136 has a surrounding side wall 504 and an end wall 506. An enlarged rectangular opening 508 is formed through one side of side wall 504 to define a storage reservoir for fluid that is being circulated by pump 46 through the flow path. …. In order to provide compliance, a resilient diaphra[g]m 518, formed out of polyurethane, extends across inwardly projecting shoulder 520 of surrounding wall 512 and is held into a fluid and hermetic seal against shoulder 520 by spacer ring 522 that is held in position between the peripheral edge of diaphra[g]m 518 and mounting plate 514." (Ex1010[Pickard] 12:47-63).

"Pickard describes altering a spring factor of the spring force provided by the excess volume area through selection of a polyurethane boundary material for diaphragm 518 separating the incompressible test fluid and air chamber." (Ex1003[Billiar] ¶63).

Claim 5. The method of claim 4, wherein the material is an elastomeric material that expands and contracts in response to the pressure on the test system.

The detailed explanation of Ground 1a, claim 4 is incorporated by reference. See above for claims 3 and 4, referring to a resilient diaphragm 518 that is cyclically flexed in response to pressure.

For example, as quoted above: "A fluid pressure compensation chamber is associated with each conduit between the respective chamber and the restriction chamber and each includes a fluid compensation reservoir having one resilient side wall defined by a diaphra[g]m that expands to receive excess fluid. Excess fluid pressure is compensated by means of air pressure on an opposite side of the diaphra[g]m so that the fluid compensation chambers act as the veins and arteries of the human body." (Ex1010[Pickard] 3:46-55).

"The material in Pickard is an elastomeric material as it teaches a 'resilient diaphragm 518' and it expands and contracts in response to pressure as it is cyclically flexed in response to pressure." (Ex1003[Billiar] ¶63, citing Ex1010[Pickard] 12:46-63).

Claim 6. The method of claim 1, further comprising compressing a volume of a compressible gas with the volume of test system fluid to provide a spring force counter to and in response to a pressure on the test system fluid when the volume of test system fluid is stored in the excess volume area.

The detailed explanation of Ground 1a, claim 1 is incorporated by reference. As unrefuted during prosecution: **"Regarding claim 6, Pickard** teaches compressing a volume of a compressible gas with the volume of test system fluid to provide a spring force counter to and in response to a pressure on the test system fluid when the volume of test system fluid is stored in the excess volume area (**col.**

3, lines 46-57 teaching that the fluid pressure compensation chamber acts by means of air pressure through a diaphragm like "veins and arteries of the human body." i.e. provides spring like pressure to the contained fluid; see also fig. 2, specifically element 60 and associated text)." (Ex1005[Office Action] 4 (emphasis in original); Ex1007[Response] 9; Ex1003[Billiar] ¶26, 64).

"A fluid pressure compensation chamber is associated with each conduit between the respective chamber and the restriction chamber and each includes a fluid compensation reservoir having one resilient side wall defined by a diaphra[g]m that expands to receive excess fluid. Excess fluid pressure is compensated by means of air pressure on an opposite side of the diaphra[g]m so that the fluid compensation chambers act as the veins and arteries of the human body." (Ex1010[Pickard] 3:46-55).

"In order to provide compliance, a resilient diaphra[g]m 518, formed out of polyurethane, extends across inwardly projecting shoulder 520…." (*Id.* 12:57-60).

"Patent Owner argued that Pickard's system compliance served a different purpose that the excess volume area of the '224 Patent claims." (Ex1003[Billiar] ¶64, citing Ex1007[Response] 5). This is not correct; Pickard and the '224 Patent disclose the use of their compliance chamber for the same purpose. (Ex1003[Billiar] ¶64). Pickard teaches the use of compliance is for the purpose of

avoiding pressures spikes. (Ex1010[Pickard] 3:46-55 ("Excess fluid pressure is compensated by means of air pressure…so that the fluid compensation chamber acts as the veins and arteries of the human body."). The '224 Patent teaches the purpose of the compliance chambers is to avoid pressure spikes, i.e., to "control undesirable pressure loading or pressure spikes." (Ex1001['224 Patent] 12:18-21).

Claim 7. The method of claim 6 further comprising altering a spring factor of the spring force provided by the excess volume area by adjusting the volume of the compressible gas.

The detailed explanation of Ground 1a, claim 6 is incorporated by reference. As unrefuted during prosecution: "**Regarding claim 7, Pickard** teaches altering a spring factor of the spring force provided by the excess volume area by adjusting the volume of the compressible gas (**see col. 4, lines 25-45**)." (Ex1005[Office Action] 4; Ex1007[Response] 9; Ex1003[Billiar] ¶26, 64).

"[S]ignals may [be] used to automatically control the balancing air pressure for the diaphra[g]m of the pressure compensation chambers." (Ex1010[Pickard] 4:32-34).

"The air inlet port 524 is formed through a central portion of retaining plate 514 and a releasable gas coupling 526 is mounted thereto so that air hose 528 may be coupled, in a quick release manner, in gas communication with air chamber 530 formed between diaphra[g]m 518 and retaining plate 514. … Thus, pressure may

be exerted on fluid in the flow path by varying the air pressure in air chamber 530 so that diaphra[g]m 518 is flexed against the resistance provided by the fluid in chamber 532." (*Id.* 12:63-13:9).

"And Pickard teaches 'varying the air pressure in air chamber 530 so that the diaphra[g]m 518 is flexed against the resistance provided by the fluid in chamber 532' which is equivalent to 7's 'adjusting the volume of the compressible gas' to alter the 'spring factor of the spring factor of the spring force provided by the excess volume area.'" (Ex1003[Billiar] ¶64).

B. Ground 1b: All Claims are Rendered Obvious by Pickard in light of Woodward and St. Jude

To the extent it is believed Pickard in light of Woodward alone, does not render claims 1-7 obvious, they are obvious in further view of St. Jude (*i.e.*, obvious in view of Pickard as modified in view of Woodward described above and further modified in view of St. Jude as described herein).

Patent Owner and its inventor appear to believe that Pickard is not particularly relevant to their claimed invention due to the "extremely high cycle requirements" (200 million to 400 million cycles), special equipment ("standard O-rings, cup seals…wear out"), and high cycle rate of their methods. (Ex1007[Response] 8-9). But Dr. Billiar found no such limitations in the claims or

in the specification. (Ex1003[Billiar] ¶65). "It is my opinion that Patent Owner is trying to specify many additional features into the claims that are neither described nor claimed in the '224 Patent." (*Id*.)

Patent Owner asserted during prosecution that one would never even think of using Pickard to perform the claimed method (Ex1007[Response] 8-9), but "all that is required by the claims is to operate Pickard at say, 205 bpm, and that is well within the a normal physiological rate as evidenced by Woodward." (Ex1003[Billiar] ¶66).

But even if Pickard did only specify operating at 72 bpm—which it does not—"St. Jude explicitly teaches operating its heart valve testing system below, at, and above physiological conditions." (Ex1003[Billiar] ¶67, citing Ex1011[St. Jude] 11:1-13). And even if the claims require very high cycle requirements and/or rates—which it does not—St Jude explicitly provides motivation to operate at 1000 bpm in order to test in 3 days the equivalent of 5 years of use. (Ex1003[Billiar] ¶67, citing Ex1011[St. Jude] 11:8-11).

And to the extent "that it is believed that there is some equipment or structure required to run at above 200 bpm, it is disclosed in St. Jude." Ex1003[Billiar] ¶68). While no such equipment or structure is required by the claims, modifying Pickard to include equipment from St. Jude is obvious. (*Id.*).

A person of ordinary skill in the art would naturally combine Pickard and St. Jude since both disclose systems that evaluate heart valves in circulatory loops. (*Compare* Ex1010[Pickard] Abstract *to* Ex1011[St. Jude] 7:20-34; Ex1003[Billiar] ¶69). And as described in detail in Ground 1a and 2a, both disclose the recited method steps for operating such cyclic evaluation test systems recited in claim 1. And further, St. Jude provides explicit motivation to operate a circulatory loop heart valve tester at any rate between 70 and 1000 bpm because St. Jude teaches cycling its own tester between 70 and 1000 bpm. (Ex1003[Billiar] ¶69; Ex1011[St. Jude] 12:1-3).

And while Patent Owner denigrates the Pickard cyclic evaluation test system or pulse duplicator as not being durable and/or capable of cycling at above 200 bpm, an implicit motivation exists to modify the test system and methods of Pickard according to St. Jude to cycle faster. And even though it is not recited anywhere in any claim or the specification—to cycle faster for long periods of time—as explicitly taught in St. Jude. [Ex1011[St. Jude] 11:1-13, 12:1-3). "[A]n implicit motivation to combine exists not only when a suggestion may be gleaned from the prior art as a whole, but when the 'improvement' is technology-independent and the combination of references results in a product or process that is more desirable, for example because it is stronger, cheaper, cleaner, faster,

lighter, smaller, more durable, or more efficient. Because the desire to enhance commercial opportunities by improving a product or process is universal-and even common-sensical—we have held that there exists in these situations a motivation to combine prior art references even absent any hint of suggestion in the references themselves. In such situations, the proper question is whether the ordinary artisan possesses knowledge and skills rendering him capable of combining the prior art references." MPEP 2143(G), citing *DyStar Textilfarben GmbH & Co. Deutschland KG v. C.H. Patrick Co*., 464 F.3d 1356, 1368, 80 USPQ2d 1641, 1651 (Fed. Cir. 2006).

According to Dr. Billiar "it is well within the knowledge and skill of a person of ordinary skill in the art to use the teachings of St. Jude to modify the system of Pickard." (Ex1003[Billiar] ¶70). For example, switching out an allegedly inadequate piston pump of Pickard for a diaphragm pump of St. Jude is well within the skill and knowledge of a person of ordinary skill in the art. (*Id*.)

C. Ground 2a: St. Jude Anticipates Claims 1-4

St. Jude teaches each and every recited feature of claims 1-4. (Ex1011[St. Jude]; Ex1003[Billiar] ¶¶71-95). And to the extent that one reads in a limitation of operating at cycle rates such as 1000 bpm—which is neither described nor claimed in the '224 Patent—St. Jude explicitly discloses such a method. (Ex1003[Billiar] ¶72). St. Jude describes exemplary methods for testing valves at rates ranging from 70 bpm (the alleged rate of Pickard) to 1000 bpm. (Ex1011[St. Jude] 12:1-3 (Example 2); Ex1003[Billiar] ¶72).

St. Jude discloses a method and system which may be used to "evaluate the function, durability, and design of a … heart valve." (Ex1011[St. Jude] 4:44-48; Ex1003[Billiar] ¶¶72-73). In one embodiment, fluid is driven cyclically by a pneumatic pump at about 1000 bpm in a closed loop as it may be "desirable" to "evaluate the durability of the biological material above physiological conditions (about 1000 bpm, or the equivalent of 5 years can be tested in 3 days." (Ex1011[St. Jude] 11:4-11, *see also* 11:38-55; 4:65-5:6). St. Jude also discloses the combination of an excess volume area in combination with an accelerated testing method, which Patent Owner convinced the Patent Office was missing from the prior art. (Ex1008[Allowance] 3; Ex1007[Response] 8; Section VII.D (above and entitled: St. Jude describes methods of operating an accelerated cyclic test

system with a compliance chamber or fluid reservoir located downstream of a heart valve)).

Claim 1. [preamble] A method for operating an accelerated cyclic test system for evaluating a valved prosthetic device comprising

St. Jude's methods include methods for operating accelerated cyclic test systems (Ex1003[Billiar] ¶77, citing Ex.1011[St. Jude] at Example 2 (operating a modified "accelerated life tester"); 1:31-35 ("There is a need for a system and apparatus for evaluating biological material under normal and supra-physiological conditions. Some of this need is represented by a need to modify the current pulse duplicator and accelerated life testers.")).

St. Jude's Abstract states: "[t]he invention involves a method and apparatus for processing biological material, such as heart valves and vascular grafts." (Ex1011[St. Jude] Abstract).

"The present invention also includes a biological material processing, evaluation, and storage system comprising a chamber for processing, evaluating, and storing a pre-determined biological material, such as one or more heart valves…. This system may also include a pulse evaluation circuit." (*Id*. 2:31-38). "Also, the environmental control circuit **20** may be used to alter the temperature of

the system **10**, or parts of the system, when evaluating the biological material under pre-determined stress or accelerated life conditions." (*Id*. 4:19-23.)

"In my opinion there is nothing new in the preamble that is not disclosed in St. Jude." (Ex1003[Billiar] ¶78; *see also* ¶77).

Claim 1. [a] driving a test system fluid cyclically above a normal physiological rate, at an accelerated pulsed rate of greater than 200 beats per minute within the test system;

Referring to Figure 3, St. Jude discloses driving a test system fluid cyclically: "In this exemplary embodiment of the invention, the circuit 60 includes a pneumatic pump 64 or the like, in fluid communication with chamber 11 through conduit 62. The flow path into and out of chamber 11 may be through inlet 41 and inlet 42 (part of the nutrient supply circuit) …." (Ex1011[St. Jude] 4:66-5:4).

Cyclical flow is also taught, e.g., at 10:28-29 ("the process cycle, e.g., pneumatic pump changing pressure from pressure to vacuum") and 11:11-13 ("A more detailed description of the cycling process can be found in the Examples"). (Ex1003[Billiar] ¶79).

St. Jude describes driving cyclically at an accelerated pulsed rate greater than 200 bpm: "For example, it may be desirable to manufacture a biological material at below physiological conditions (e.g., about 0-50 bpm, beats per minute), test the biological material at physiological conditions (about 70 bpm),

and evaluate the durability of the biological material above physiological conditions (about 1000 bpm, or the equivalent of 5 years can be tested in 3 days). This and other variations of the same theme are contemplated by the invention. A more detailed description of the cycling process can be found in the Examples." (Ex1011[St. Jude] 1:4-13). (Ex1003[Billiar] ¶80).

Example 1: "[t]he [test] system will be able to operate below, at, or above physiologic cardiovascular pressures and flow and beat rates." 1:46-48

Example 2: "The valves will be dynamically cycled at rates ranging from physiologic (70 BPM) to durability stages (1000 BPM)." 12:1-3.

Example 3: "The valve can be cycled at rates and conditions ranging from near zero up to physiologic (0-200 BPM), or above (about 1000 bpm)." 12:24-26.

"In my opinion there is nothing new in this step that is not disclosed in St. Jude." (Ex1003[Billiar] ¶81; *see also* ¶¶79-81).

Claim 1. [b] storing a volume of test system fluid in an excess volume area during a system driving stroke that opens the valved prosthetic device; and

St. Jude describes that the driving stroke of pneumatic pump 64 forces the fluid through conduit 62, which opens the valve in container 12 and closes the valve in container 13. The closure of the valve in container 13 causes fluid to be

stored in compliance chamber 11. (Ex1003[Billiar] ¶82, citing Ex1011[St. Jude] 10:48-11:1 and Figure 3 (annotated below)).

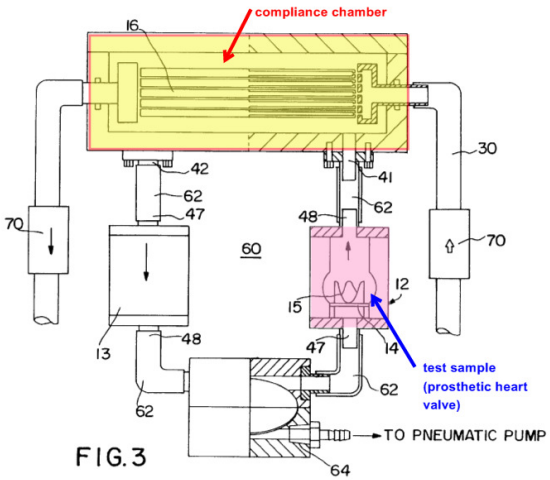
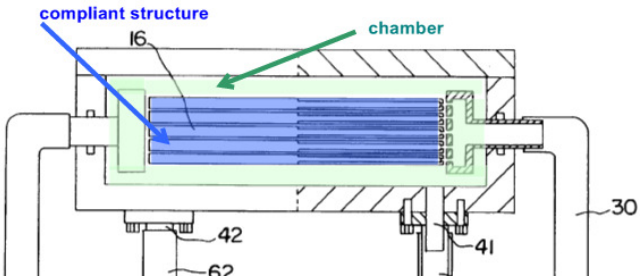


FIG. 3

"In the embodiment of Figure 3 (a portion shown in annotated form below), a volume of test system fluid is stored in the compliance chamber (chamber 11, shown in light green) during the driving stroke. The excess volume area is the area



of the compliant structures (vascular grafts, shown in blue) that are collapsed during the driving stroke a fluid flows into the compliance chamber." (*Id.* ¶84).

"Diaphragm or pneumatic pump **64** functions by forcing a compliant membrane or balloon-like structure within the housing of the pump against a conduit or fluid flow path that runs through the housing. When air is pumped into the balloon, it expands and presses against the conduit, forcing any fluid in the conduit toward container **12** and container **13**. In container **12**, the biological material or check valve is oriented so that the fluid will pass through the chamber **12** and into chamber **11**. In container **13**, the biological material or check valve is oriented so that fluid passing into chamber **13** from the pump side of the circuit will close the valve. Conversely, when pressure in the pump is released by releasing air in the balloon, the lack of pressure will close the valve in container **12** and allow the valve in chamber **13** to open. Such alternating processes simulate the conditions found in the human heart, e.g., a normal physiological condition. By modulating or changing the speed, pressure, and/or temperature of the process, such alternating processes may also be used to test the durability or design of a specific biological material, among other characteristics that can be tested." (Ex1011[St. Jude] 10:48-11:1).

"In accordance with another aspect of the invention, a system may include one or more compliant structures. In a preferred embodiment of the invention, these compliant structures act as a volumetric reservoir to temporarily hold the

fluid. After a pre-determined condition (e.g., amount of time or pressure build-up), the compliant structure will then release the collected fluid. Exemplary compliant structures include but are not limited to flexible bags or flexible containers, and may even include biological material, such as vascular graft material. For example, FIG. 3 shows vascular graft material **16** positioned in chamber **11** across or in the nutrient fluid flow **30**. The vascular graft material retains the nutrient solution until a pre-determined portion of the processing cycle, e.g., pneumatic pump changing cycle from pressure to vacuum." (*Id.*10:15-29).

"In every closed circuit system [like St. Jude's], i.e., not open to atmosphere, there has to be an excess volume area for displaced incompressible fluid to flow into, and St. Jude is no different." (Ex1003[Billiar] ¶83).

"In my opinion there is nothing new in this step that is not disclosed in St. Jude." (Ex1003[Billiar] ¶87; *see also* ¶¶82-87).

Claim 1. [c] releasing the stored volume of test system fluid during a return stroke that closes the valved prosthetic device.

St. Jude discloses releasing the stored volume of test system fluid during a return stroke that closes the valved prosthetic device. (*Id.* ¶88). "[W]hen pressure in the pump is released by releasing air in the balloon, the lack of pressure will close the valve in container **12** and allow the valve in chamber **13** to open."

(Ex1011[St. Jude] 10:59-62; *see also* Ex1003[Billiar] ¶88). "By closing the valve in 12 and opening the valve 13, fluid stored in the excess volume area is released." (*Id.*)

"In my opinion there is nothing new in this step that is not disclosed in St. Jude. The entire claim is anticipated by St. Jude. There is no new element, step or combination thereof." (Ex1003[Billiar] ¶89). Claim 1 is unpatentable under 35 USC 102.

Claim 2. The method of claim 1, wherein the excess volume area enlarges in response to a pressure on the test system fluid during the driving stroke and decreases during the return stroke.

See above for claim 1 and Dr. Billiar's opinion that claim 1 is anticipated by St. Jude, which are incorporated herein. Dr. Billiar also finds that claim 2 is anticipated. "St. Jude teaches all elements of claim 2. Referring again to Figure 3, the compliant structure 16 forms a boundary of the excess volume area. As the compliant structure 16 is compressed by fluid driven by pump 64, excess volume area within the closed system 60 is increasing (by decreasing the volume within the compliant structure 16). Likewise when fluid exits chamber 11 during the return stroke of pump 64, the excess volume area decreases as the pressure on the compliant structure 16 is released." (Ex1003[Billiar] ¶91, citing, Ex.1011 at Figure 3; 10:15-64.).

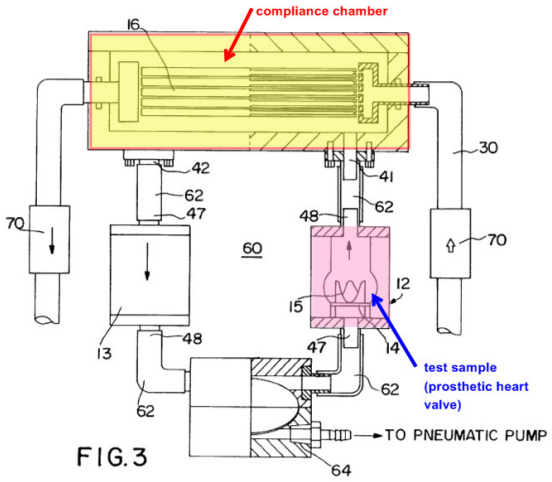


FIG. 3

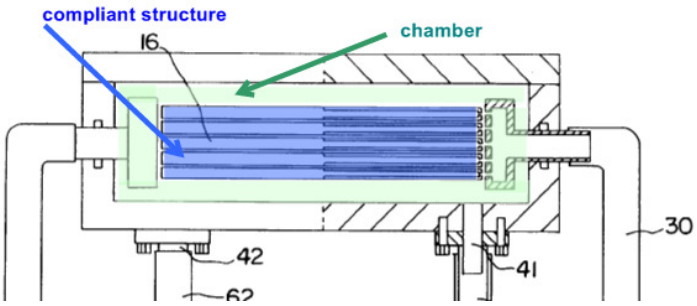
Claim 3. The method of claim 2, wherein the excess volume area provides a spring force counter to and in response to the pressure on the test system fluid.

See above for claim 2 and Dr. Billiar's opinion that claim 2 is anticipated by St. Jude, which are incorporated herein. Dr. Billiar also finds that claim 3 is anticipated. "In my opinion, St. Jude also anticipates claim 3. Once again referring to Figure 3 and its corresponding description in column 10, St. Jude teaches the use of one or more compliant structures that act as volumetric reservoir. (*See* Ex.1011 at 10:15-29.) A person of ordinary skill in the art would understand that a compliant structure is a structure that has compliance, i.e., a structure that undergoes an elastic deformation or change in volume when subjected to an applied force, such as pressure. For example, in terms of volume, compliance = $\Delta V/\Delta P$, where V = volume and P = pressure. In terms of linear deformation, compliance = $\Delta l/\Delta F$, where l = length and F = force. Further since

spring constant = ΔF/Δl, by definition compliance = 1/spring constant (in terms of linear deformation). Therefore, as test fluid enters chamber 11 and applies a pressure on compliant structure 16 shown in Figure 3 of St. Jude, a displacement occurs creating the excess volume area. As compliant structure 16 has compliance, a spring force counters that displacement." (Ex1003[Billiar] ¶93).

Claim 4. The method of claim 3 further comprising altering a spring factor of the spring force provided by the excess volume area through selection of material forming at least a portion of a boundary of the excess volume area.

See above for claim 3 and Dr. Billiar's opinion that claim 3 is anticipated by St. Jude, which are incorporated herein. Dr. Billiar also finds that claim 4 is anticipated. "In the embodiment of Figure 3 (a portion shown in annotated form below), a volume of test system fluid is stored in the compliance chamber (chamber 11, shown in light green) during the driving stroke. The excess volume



area is the area of the compliant structures (vascular grafts, shown in blue) that are

collapsed during the driving stroke a fluid flows into the compliance chamber." (*Id.* ¶84). In Figure 3, vascular grafts (compliant structure 16) are selected to form at least a portion of the boundary. But as discussed below this is just one of several options for choice of compliant structures.

"Again referring to column 10, lines 15-29, St. Jude teaches that 'one or more compliant structures' can be formed from a variety of materials, including but 'not limited to flexible bags or flexible containers, and may even include biological materials, such as vascular graft material.' In Figure 3, St. Jude shows a vascular graft 16 as the compliant structure, which forms a boundary of the excess volume area. (Ex.1011 at 10:44-47.) In Example 1, St. Jude describes that the test system is 'a self-contained loop with a compliant fluid reservoir which may be constructed of vascular graft material and two check valves.' (*Id*. at 11:37-40.) St. Jude also describes using 'adjustable graft compliance' to operate the test system. By disclosing the use of adjustable graft compliance as well as providing a non-limiting list of options for forming the compliant structure 16, St. Jude anticipates claim 4." (Ex1003[Billiar] ¶95).

D. Ground 2b: Claims 3-7 are Rendered Obvious by St. Jude in light of Pickard

As set forth in Ground 2a, St. Jude anticipates claims 1-4. And as set forth in Ground 1a, Pickard discloses the subject matter of claims 1-7 (except for an explicit recitation of cycling above 200 bpm).

St. Jude discloses systems and methods for testing and evaluating heart valves. (Ex1011[St. Jude] 5:15-19). And it also discloses embodiments where additionally, or alternatively, vascular grafts and heart valves are seeded. (*Id*. 5:19-21; 10:41-47). St. Jude teaches that its system (and individual parts for each) and methods can vary depending on these uses, for example to test valves or to seed a graft. (*Id*. at 5:15-18). As such, there is explicit motivation in St. Jude to simplify his Figure 3 system to remove components to test and/or seed vascular grafts if this feature is not needed. (Ex1003[Billiar] ¶99). And according to Dr. Billiar, "the simple substitution of the compliance chamber of Figure 3 (with vascular grafts), with the compliance chamber of Pickard (without grafts) is obvious." (Ex1003[Billiar] ¶99).

Claim 3

The detailed explanations of Ground 1a and Ground 2a are incorporated by reference. As discussed in Ground 1a above, Pickard discloses a method wherein the excess volume area provides a spring force that is counter to the pressure on the

test system fluid. (Ground 1a; Ex1003[Billiar] ¶100). Recall that in Ground 1a, both the Patent Office and Dr. Billiar found that Pickard's compliance chamber shown in detail in Figure 8 teaches the subject matter of claim 3. "It would have been obvious to one of ordinary skill in the art to replace the compliance chamber of St. Jude with the compliance chamber of Pickard as the replacement would be a simple substitution of one compliance chamber type known to work in a closed loop system for another." (*Id*. ¶101).

In Dr. Billiar's opinion, "one of ordinary skill in the art could have substituted St. Jude's compliance chamber with Pickard's compliance chamber. And the results were predictable as both are known to have the same function and were in the same position." (Ex1003[Billiar] ¶102). Compliance chambers and their functions, including mimicking the function of veins and arteries, were known in the art. (*Id.*). Indeed, Pickard explicitly teaches: "Excess fluid pressure is compensated by means of air pressure on an opposite side of the diaphra[g]m so that the fluid compensation chambers act as the veins and arteries of the human body." (Ex1010[Pickard] 3:46-55). In St. Jude, the compliant structures are vascular graft material. (Ex1011[St. Jude] 10:15-29; 11:38-41). "[W]hen a patent simply arranges old elements with each performing the same function it had been known to perform and yields no more than one would expect from such an

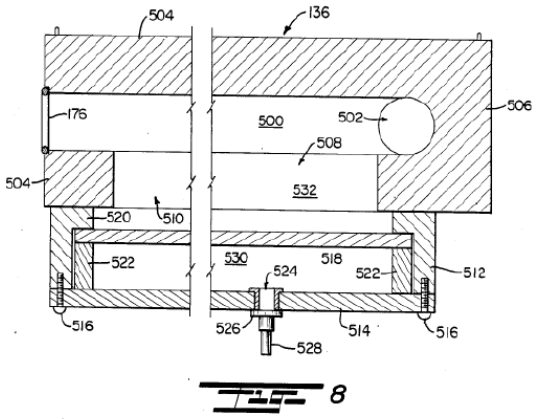
arrangement, the combination is obvious." *KSR International Co. v. Teleflex Inc. (KSR)*, 550 U.S. 398, 417 (2007). (Internal quotations omitted.).

Claims 4 and 5

The difference between the St. Jude and the method of claims 4 and 5 is the altering of the spring factor of the spring force through a selection of a material forming at least a portion of the boundary (claim 4) and wherein the material is an elastomeric material that expands and contracts in response to the pressure on the test system (claim 5).

Once the simple substitution is made, as described immediately above for claim 3 (incorporated herein), the substituted compliant chamber of Pickard provides the subject matter of claims 4 and 5. (Ex1003[Billiar] ¶104).

Pickard describes altering a spring factor of the spring force provided by the excess volume area through selection of a polyurethane boundary material for diaphragm 518. (Ex1003[Billiar] ¶98, citing Ex1010[Pickard] 12:47-63 and Figure 8, reproduced below for convenience.)



"The material in Pickard is an elastomeric material as it teaches a 'resilient diaphragm 518' and it expands and contracts in response to pressure as it is cyclically flexed in response to pressure." (*Id.*).

Claim 6

The difference between the St. Jude and the method of claim 6 is that while St. Jude discloses "storing a volume of test system fluid in an excess volume area," St. Jude does not expressly disclose "compressing a volume of compressible ***gas*** with the volume of test system fluid." (Ex1003[Billiar] ¶106).

Once the simple substitution is made, as described immediately above for claim 3 (incorporated herein), the substituted compliant chamber of Pickard provides the subject matter of claim 6. (Ex1003[Billiar] ¶¶106-109).

"Pickard teaches compressing a volume of a compressible gas with the volume of test system fluid to provide a spring force counter to and in response to

a pressure on the test system fluid when the volume of test system fluid is stored in the excess volume area." (*Id*. ¶107, citing Ex1010[Pickard] 3:46-55 ("A fluid pressure compensation chamber is associated with each conduit between the respective chamber and the restriction chamber and each includes a fluid compensation reservoir having one resilient side wall defined by a diaphra[g]m that expands to receive excess fluid. Excess fluid pressure is compensated by means of air pressure on an opposite side of the diaphra[g]m so that the fluid compensation chambers act as the veins and arteries of the human body.")). Figure 8 depicts a cross section of compensation module 136 including diaphragm 518 compensated by varying air pressure in air chamber 530 to flex the diaphragm against the resistance provided by the fluid in chamber 532.

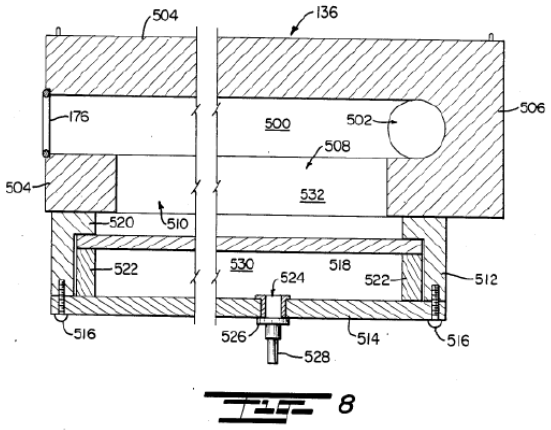


FIG. 8

As Dr. Billiar stated above, "[i]t would have been obvious to one of ordinary skill in the art to replace the compliance chamber of St. Jude with the compliance

chamber of Pickard (Figure 8) as the replacement would be a simple substitution of one compliance chamber type known to work in a closed loop system for another." (Ex1003[Billiar] ¶108). As noted above, compliance chambers and their functions were well known and a POSITA could have substituted St. Jude's compliance chamber with Pickard's compliance chamber with predictable results. (*Id.* ¶109) Both are known the same function and located on the outflow side of the valve. (*Id*.)

Claim 7 (Dependent from Claim 6)

Once the simple substitution discussed above for claim 6 is made (and incorporated herein), "it would be obvious to incorporate the full teaching of Pickard with respect to air compliance." (Ex1003[Billiar] ¶110). Pickard teaches how to alter the spring factor in the excess volume area by adjusting the volume of the compressible gas. (See Ground 1a above; Ex1010[Pickard] 4:32-34, 12:63-13:9; Ex1003[Billiar] ¶110).

E. Ground 2c: Claims 6 and 7 are Rendered Obvious by St. Jude in light of Iwasaki.

Iwasaki was not cited during prosecution. And further differs from Pickard in that it discloses an accelerated fatigue tester. Both St. Jude and Iwasaki teach closed loop accelerated fatigue testers. And Iwasaki teaches air compliance.

Claim 6

St. Jude anticipates claim 1 as shown above in Ground 2a (and incorporated herein). While St. Jude discloses "storing a volume of test system fluid in an excess volume area," St. Jude is silent with respect to "compressing a volume of compressible ***gas*** with the volume of test system fluid."

Iwasaki discloses the modification of a closed loop accelerated fatigue tester to incorporate a ***gas*** compliance chamber. (Ex1013[Iwasaki] 422-423 and Fig. 5 (below); Ex1003[Billiar] ¶112). Iwasaki altered the compliance three different volumes of air compliance (5 ml, 10 ml, and 30 ml). (*Id*. 422-424 and Figs. 6 and 7; Ex1003[Billiar] ¶112).

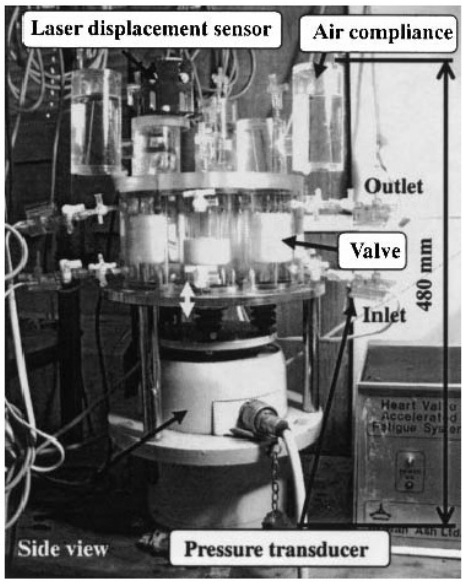


FIG. 5. A modified version of the Rowan Ash accelerated fatigue tester for prosthetic heart valves is shown. A compliance element was added to the original system.

As stated by Dr. Billiar, "both St. Jude and Iwasaki teach the inclusion of a compliance chamber in a closed loop heart valve test evaluation system located on the outflow side of the valve." (Ex1003[Billiar] ¶113). "It would have been obvious to one of ordinary skill in the art to replace the compliance chamber of St. Jude with the air compliance chamber of Iwasaki as the replacement would be a simple substitution of one compliance chamber type known to work in a closed loop system for another." (*Id.*). Again, compliance chambers and their functions were known in the art. (*Id.*) Iwasaki's compliance chamber modeled the elastic effects of the aorta. (*Id.*, citing Ex1013[Iwasaki] 422 ("the upper casing was flat, thus failing to model the elastic effects of the aorta….Therefore the upper casing of the tester was modified to incorporate an air compliance chamber as shown in Fig. 5."). Again, in St. Jude, the compliance structures were vascular grafts. (Ex1011[St. Jude] 10:15-29). Additionally, Pickard also recites the known function of compliance chambers to act as the veins and arteries of the human body to dampen pressure spikes. (Ex1003[Billiar] ¶113, citing, Ex1010[Pickard] 3:46-55).

In the opinion of Dr. Billiar, "one of ordinary skill in the art could have substituted St. Jude's compliance chamber with Iwasaki's air compliance chamber. And the results were predictable as both are known to have the function and were

in the same position—in both St. Jude and Iwasaki the compliance chamber is located on the outflow side of the valve." (Ex1003[Billiar] ¶114).

Claim 7 (Dependent from Claim 6)

The detailed explanation of Ground 2c, claim 6 is incorporated by reference. As opined by Dr. Billiar, "[t]he limitations of claim 6 are at least obvious for the reasons described directly above. Once the simple substitution is made, it would be obvious to incorporate the full teaching of Iwasaki with respect to air compliance." (*Id*. ¶115, ¶¶111-114). As noted directly above, Iwasaki discloses a method of altering the spring factor with varying volumes of air compliance. (Ex1013[Iwasaki] 422-424). Figure 6 of Iwasaki demonstrates the effect of altering the spring factor. (Ex1003[Billiar] ¶115).

In addition, as Dr. Billiar points out, there is explicit motivation for this combination of features. Dr. Billiar points out that "St. Jude teaches that it is beneficial to have adjustable compliance." (*Id.* ¶116, citing, Ex1011[St. Jude] 11:45-48 ("With … adjustable graft compliance, the system will be able to operate below, at, or above physiological cardiovascular pressures and flow and beat rates.")).

In short, "[i]t would have been obvious to use the methods of Iwasaki in St. Jude. St. Jude provides a reason for adjustable compliance. Iwasaki teaches

adjustable compliance by means of adjusting the volume of the compressible gas. Thus, it would have been obvious to one of ordinary skill to make the simple substitution of using Iwasaki's adjustable air compliance for St. Jude's adjustable compliance." (*Id*. ¶116).

X. CONCLUSION

For the reasons above, institution of *inter partes* review of claims 1-7 is requested. Petitioner requests that claims 1-7 be found unpatentable.

XI. MANDATORY NOTICES

Notice of Real Party-In-Interest

The real party in interest for this petition for *inter partes* review is Waters Technologies Corporation with a primary place of business at 34 Maple Street, Milford, MA 01757.

Notice of Related Matters

Patent Owner asserted the '224 Patent against TA Instruments-Waters LLC in a Complaint filed July 27, 2017, and served August 3, 2017. (Ex1017). The case is captioned *Biomedical Device Consultants & Laboratories of Colorado, LLC v. TA Instruments – Waters LLC*, 0:17-cv-03403-DWF-SER (D.Minn.). "TA Instruments—Waters LLC" is a wholly owned subsidiary of Petitioner, Water Technologies Corporation.

Notice of Lead and Backup Counsel and Service Information

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All counsel listed above are at Womble Bond Dickinson (US) LLP, Two International Place, Boston, MA 02110. Petitioner consents to service by email to deborah.vernon@wbd-us.com and 224IPR@wbd-us.com. Powers of Attorney are being submitted with this Petition.

XII. PAYMENT OF FEES

The Patent Office is authorized to charge all required fees set forth in 37 CFR § 42.15(a), including the *inter partes* review request fee and the post-institution fee to Deposit Account **09-0528**. Petitioner further authorizes the Patent Office to charge all fees due and any deficiencies thereof or credit any overpayment to Deposit Account **09-0528**.

Dated: January 15, 2018

Respectfully submitted,

/Deborah M. Vernon, Reg. No. 55,699/

Deborah M. Vernon, PhD
Reg. No. 55,699
Lead Counsel for Petitioner

CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that this Petition complies with the type-volume limitation of 37 C.F.R. § 42.24(a). The word count application of the word processing program used to prepare this Petition indicates that the Petition contains 13,536 words, excluding the parts of the Petition exempted by 37 C.F.R. § 42.24(a).

Dated: January 15, 2018

/Deborah M. Vernon, Reg. No. 55,699/

Deborah M. Vernon, PhD

Registration No. 55,699

CERTIFICATE OF SERVICE

On this date, the undersigned certifies that a copy of the foregoing and all exhibits and power of attorney were served on the Patent Owner by delivering pursuant to 37 CFR §§ 42.6(e) and 42.105(b) on the Patent Owner through its attorney of record listed in PAIR by FedEx, a means at least as fast and reliable as Priority Mail Express®.

Patent Owner's Correspondence Address as listed in PAIR:

Brad J. Hattenbach
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