UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

JDS Uniphase Corporation
Petitioner

v.

Capella Photonics, Inc.
Patent Owner

Patent No. RE42,368
Filing Date: June 15, 2010
Reissue Date: May 17, 2011

Title: RECONFIGURABLE OPTICAL ADD-DROP MULTIPLEXERS WITH SERVO CONTROL AND DYNAMIC SPECTRAL POWER MANAGEMENT CAPABILITIES

DECLARATION OF SHELDON MCLAUGHLIN

Inter Partes Review No. Unassigned

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I, Sheldon McLaughlin, declare as follows:

I. INTRODUCTION AND QUALIFICATIONS

1. I have been asked by JDS Uniphase Corporation ("JDSU") to opine on certain matters regarding U.S. Patent No. RE42,368, hereinafter referred to as the'368 patent. Specifically, this declaration addresses the obviousness of the '368 patent in light of prior art.

A. Education and other background information

2. I hold the positon of Senior Principal Optical Development Engineer in the Exploratory Research Group at JDS Uniphase. I received my B.Sc. degree in Engineering Physics from Queen's University in Kingston, Ontario in 1996, my M.A.Sc. degree in Engineering Science from Simon Fraser University in Burnaby, BC in 1999, and my Postgraduate Certificate in Optical Sciences from the University of Arizona in Tucson, Arizona in 2010. I began my career in optical communications in 1990 as a student at Bell-Northern Research in Ottawa, Ontario. I joined JDS Uniphase in Ottawa in 1999. From 1999 to 2002, I worked on optical design and product development of fiber optic components including an interleaver, a tunable dispersion compensator, and an integrated planar lightwave circuit of a reconfigurable optical add-drop multiplexers. From 2002 to the present, I have been primarily responsible for optical design and development of wavelength selective switches at JDS

Uniphase. I designed the optics for the industry's first commercially available MEMS WSS, JDSU's "MWS50", and I have taken a lead role in the optical design and development of each successive generation of JDSU's WSS products since then. I hold 8 US patents relating to fiber optic devices, and I have authored or co-authored approximately 12 journal or conference papers, including 2 invited papers on WSS technology. From 2009 to 2011 I served on the technical program subcommittee for the OFC-NFOEC conference.

B. Materials Considered

3. The analysis that I provide in this Declaration is based on my education and experience in the field of photonics, as well as the documents I have considered, including Ex. 1001 (U.S. Patent No. RE42,368, herein "the '368 Patent"), which states on its face that it issued from an application filed on Mar. 19, 2001.

4. Furthermore, I have reviewed the relevant portions of various relevant publications, some of which represent that state of the art at the time of the alleged invention of the '368 Patent, to which this Declaration relates. These publications include those listed below:

Exhibit 1001:U.S. Reissued Patent No. RE42,368 to Chen et al. ("'368 Patent")

Exhibit 1003: U.S. Patent No. 6,498,872 to Bouevitch et al. ("Bouevitch")

Exhibit 1004: U.S. Patent No. 6,625,340 to Sparks et al. ("Sparks Patent," or "Sparks")

Exhibit 1005: Excerpts from Born et al., PRINCIPLES OF OPTICS, (6th Ed., Pergammon Press 1984)

Exhibit 1006: U.S. Patent No. 6,798,992 to Bishop et al. ("Bishop")

Exhibit 1007: U.S. Patent No. 6,507,421 to Bishop et al. ("Bishop '421")

Exhibit 1009: U.S. Patent No. 6,253,001 to Hoen ("Hoen")

Exhibit 1010: U.S. Patent No. 5,661,591 to Lin at al. ("Lin")

Exhibit 1011: Doerr et al., An Automatic 40-Wavelength Channelized Equalizer, IEEE Photonics Technology Letters, Vol., 12, No. 9, (Sept. 2000)

Exhibit 1015: Ford et al., *Wavelength Add–Drop Switching Using Tilting Micromirrors*, Journal of Lightwave Technology, Vol. 17, No. 5 (May 1999) ("Ford")

Exhibit 1016: U.S. Patent No. 6,069,719 to Mizrahi ("Mizrahi")

Exhibit 1017: U.S. Patent No. 6,204,946 to Aksyuk et al. ("Aksyuk")

Exhibit 1018: U.S. Patent Application Publication No. US 2002/0105692 to Lauder et al. ("Lauder")

Exhibit 1020: Andrew S. Dewa, and John W. Orcutt, Development of a silicon 2-axis micro-mirror for optical cross-connect, Technical Digest of the Solid State Sensor and Actuator Workshop, Hilton Head Island, SC, June 4-8, 2000) at pp. 93-96 ("Dewa")

Exhibit 1021: U.S. Patent No. 6,011,884 to Dueck et al. ("Dueck")

Exhibit 1022: U.S. Patent No. 6,243,507 to Goldstein et al. ("Goldstein

'507")

Exhibit 1023: U.S. Patent No. 6,567,574 to Ma, et al. ("Ma")

Exhibit 1026: U.S. Patent No. 5,875,272 to Kewitsch et al. ("Kewitsch")

Exhibit 1027: U.S. Patent No. 6,285,500 to Ranalli at al. ("Ranalli")

Exhibit 1029: Declaration of Dan Marom as filed in *Inter Partes* Review No. 2014-01166 ("Marom Declaration")

Exhibit 1031: U.S. Patent No. 5,414,540 to Patel et al. ("Patel")

Exhibit 1032: Borella, et al., *Optical Components for WDM Lightwave Networks*, Proceedings of the IEEE, Vol. 85, NO. 8, August 1997 ("Borella")

Exhibit 1033: U.S. Patent No. 6,928,244 to Goldstein et al. ("Goldstein '244")

Exhibit 1035: C. Randy Giles and Magaly Spector, *The Wavelength Add/Drop Multiplexer for Lightwave Communication Networks*, Bell Labs Technical Journal, (Jan.-Mar. 1999) ("Giles and Spector")

Exhibit 1036: U.S. Patent No. 5,872,880 to Maynard ("Maynard")

5. I make special note of the Marom Declaration (Ex. 1029). This declaration was submitted and published in connection with *Inter Partes* Review No. 2014-01166. *Inter Partes* Review No. 2014-01166 also addresses the same patent, RE42,368, at issue in the present Petition for *inter partes* review. I have read the Marom Declaration and it informs my present declaration. For example,

substantial portions of the Marom Declaration are repeated herein without particular attribution, including, but not limited to, those portions herein that discuss the state of the art at the earliest priority filing of the '368 Patent and those portions that discuss Bouevitch, Bishop, Hoen, Dueck, and Lin.

II. LEGAL PRINCIPLES USED IN THE ANALYSIS

6. I am not a patent attorney, nor have I independently researched the law on patent validity. Attorneys for the Petitioner have explained certain legal principles to me that I have relied upon in forming my opinions set forth in this report.

A. Person Having Ordinary Skill in the Art

7. I understand that my assessment of claims of the '368 Patent must be undertaken from the perspective of what would have been known or understood by a person having ordinary skill in the art reading the '368 Patent on its relevant filing date. I will refer to such a person as a "PHOSITA."

8. For the relevant priority date for the '368 Patent, I have used in my declaration the earliest application date on the face of the patent: Mar. 19, 2001. However, I have not yet analyzed whether the '368 Patent is entitled to that date for its priority.

9. Counsel has advised me that to determine the appropriate level of one of ordinary skill in the art, the following four factors may be considered: (a) the types

of problems encountered by those working in the field and prior art solutions thereto; (b) the sophistication of the technology in question, and the rapidity with which innovations occur in the field; (c) the educational level of active workers in the field; and (d) the educational level of the inventor.

10. With a career in optical communications of approximately 25 years, I am well acquainted with the level of ordinary skill required to implement the subject matter of the '368 Patent. I have direct experience with and am capable of rendering an informed opinion on what the level of ordinary skill in the art was for the relevant field as of March 2001.

11. The relevant technology field for the '368 Patent is free-space photonic switching sub-systems, a field related to free-space optics. Based on this, and the four factors above, it is my opinion that the PHOSITA would have been an engineer or physicist with at least a Master's degree, or equivalent experience, in optics, physics, electrical engineering, or a related field, including at least three years of additional experience designing, constructing, and/or testing optical systems.

12. My analysis and opinions regarding the '368 patent have been based on the perspective of the PHOSITA as of March 2001.

B. Prior Art

13. I understand that the law provides categories of information that

constitute prior art that may be used to anticipate or render obvious patent claims. To be prior art to a particular patent claim under the relevant law, I understand that a reference must have been made, known used, published, or patented, or be the subject of a patent application by another, before the priority date of the patent. I also understand that the PHOSITA is presumed to have knowledge of the relevant prior art.

C. Identification of Combinations of Prior Art

14. I understand that the Petitioner is requesting *inter partes* review of claims 1-6, 9-13, and 15-22 of the '368 patent under the grounds set forth in Table 1 below. I will sometimes refer to these combinations as Ground Nos. 1, 2, 3 or 4 in the remainder of my declaration below.

Table 1

Ground	'368 Patent Claims	Basis for Challenge
1	1-6, 9-13, and 15-22	Obvious under § 103(a) by Bouevitch in view of Sparks.
2	1-6, 9-13, and 15-22	Obvious under § 103(a) by Bouevitch in view of Sparks further in view of Lin.
3	12	Obvious under § 103(a) by Bouevitch in view of Sparks in further view of Dueck.
4	12	Obvious under § 103(a) by Bouevitch in view of Sparks and Lin in further view of Dueck.

D. Broadest Reasonable Interpretations

15. I understand that, in *inter partes* review proceedings, the claim terms are to be given their broadest reasonable interpretation (BRI) in light of the specification. *See* 37 C.F.R. § 42.100(b). In performing my analysis and rendering my opinions, I have interpreted any claim terms, for which the Petitioner has not proposed a BRI construction, by giving them the ordinary meaning that they would have to the PHOSITA, reading the '368 Patent with its priority filing date (March 19, 2001) in mind.

16. I understand that the Petitioner has made determinations about the broadest reasonable interpretations of several of the claim terms in the '368 Patent. I have identified these BRIs in Table 2, below.

Table 2

Term	Broadest Reasonable Interpretation (BRI)
"continuously controllable" (claims 1, 15, 16)	"able to effect changes with fine precision"
[Controllable] "in two dimensions" (claims 1, 15, 16)	"actuatable in two axes"
"to control the power of the spectral channel reflected to said selected port" (claims 1, 15, 16)	"to change the power in the spectral channel that is received by a particular port"
"spectral monitor" (claim 3)	"a device for measuring power in a spectral channel"
"servo-control assembly" (claims 3, 4)	"feedback-based control assembly"

"beam-focuser" (claim 11)	"a device that directs a beam of light to a spot"
"controlling dynamically and continuously" (claim 17)	"able to effect changes with fine precision during operation"
"in two dimensions" (claim 17)	"in two axes"
"so as to combine selected ones of said spectral channels into an output multi-wavelength optical signal" (claim 17)	"route different spectral channels to a common path"
"control the power of the spectral channels combined into said output multi-wavelength optical signal" (claim 17)	"to change the power of one or more spectral channels of a set of spectral channels that are, at some point, routed along the same path"

17. My analysis in this declaration assumes that the terms in Table 2, above, are defined using the associated BRIs. From my reading of the '368 Patent, I believe that these BRIs are consistent with how one of skill in the art at the time the '368 Patent was filed would interpret the claim terms.

III. THE '368 PATENT

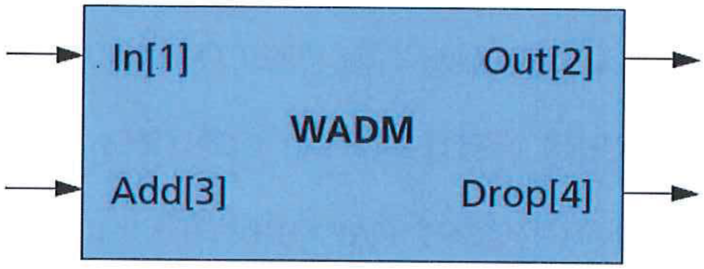
18. As indicated on its face, the '368 Patent reissued from U.S. reissue patent application No. 12/816,084 on June 15, 2010 as a reissue of U.S. patent No. 6,879,750. The '368 Patent claims priority to U.S. provisional application No. 60/277,217, filed on March 19, 2001. The '368 Patent reissued on May 17, 2011.

19. As its title indicates, the '368 patent relates to reconfigurable optical add-drop multiplexers (ROADMs). (*Id.*, Title ("RECONFIGURABLE OPTICAL ADD-DROP MULTIPLEXERS WITH SERVO CONTROL AND DYNAMIC SPECTRAL POWER MANAGEMENT CAPABILITIES").) More specifically, the '368 Patent describes "a wavelength-separating routing (WSR) apparatus and method" (*Id.* at Abstract) which separates a multi-wavelength optical signal into separate channels and directs selected channels into selected output ports.

IV. STATE OF THE ART OF THE RELEVANT TECHNOLOGY AT THE TIME OF THE ALLEGED INVENTION

A. Reconfigurable Optical Add-Drop Multiplexers

20. Early optical wavelength-division multiplexed (WDM) networks had fixed wavelength channel optical add drop multiplexers (OADMs), in order for information to be accessible at the network node. A basic OADM sub-system has four fiber ports, with one 'input' fiber port for receiving a WDM signal, a 'drop' fiber port where the WDM channel that is configured to be dropped will emerge, an 'add' fiber port where the replacement WDM channel will be introduced, and an 'output' fiber port for the complete WDM signal (including the replaced channel) which will lead back to the optical network for transmission to the next node. For example, a WDM add/drop multiplexer from before the filing date of the '368 Patent is shown symbolically below:



(a) Channel connections from input ports (In[1] and Add[3]) to output ports (Out[2] and Drop[4])

(Giles and Spector, Ex. 1035), C. Randy Giles and Magaly Spector, *The Wavelength Add/Drop Multiplexer for Lightwave Communication Networks*, Bell Labs Technical Journal, (Jan.-Mar. 1999) at 210). OADMs were sometimes implemented by using fixed filters to extract a single wavelength channel.

21. For greater flexibility in optical network operation, a reconfigurable OADM (a ROADM) was useful to enable network traffic to grow without requiring manual hardware changes. Different implementations of ROADMs were known at the filing date for the '368 Patent. (*See, e.g.*, Ex. 1017, U.S. Patent No. 6,204,946 to Aksyuk et al. ("Aksyuk") (1997) (entitled "Reconfigurable wavelength division multiplex add/drop device using micromirrors"); Ex. 1033, U.S. Patent No. 6,928,244 to Goldstein et al. (2000) ("Goldstein '244") (entitled "System and method of wavelength add/drop multiplexing having client configurability"); Ex. 1003, Bouevitch at Abstract (disclosing "a configurable optical add/drop multiplexer (COADM)"); Ex. 1018, U.S. Patent Application

Publication No. US 2002/0105692 to Lauder et al., p. 4, Fig. 11.)

B. Wavelength Selective Switches

22. One implementation of ROADMs uses wavelength-selective switches (WSS). WSS is the established category name today for switches that operate on a multi-wavelength optical signal but whose switching function can be tailored per wavelength channel. Circa year 2000 there were a few other names for devices that performed such switching functions such as Wavelength-Routing Switch (or WRS; *see* Ex. 1032, Borella, et al., *Optical Components for WDM Lightwave Networks*, Proceedings of the IEEE, Vol. 85, NO. 8, August 1997 at pp.1292), and Wavelength-Selective Router (or WSR; *see* Ex. 1026, U.S. Patent No. 5,875,272 to Kewitsch et al. at Abstract, 4:15-25). Such conventions as WSR and WRS are now referred to as WSS without loss of generality. WSS can be constructed using various methods and technologies, but in the matter of the '368 Patent, the WSS is implemented in free-space (as opposed to light guided implementations), using the light radiating out of the transmission optical fiber at the switch input port, and spatially separating this WDM light beam into individual beams using a dispersive optics arrangement (similar to an optical spectrometer). In this arrangement, each beam corresponds to an individual channel distinguished by its unique center wavelength. Each input channel/beam is then individually routed by a beam-steering system and then propagates

through the same dispersive optics arrangement, in reverse, to a chosen output port of the WSS, where all the wavelength channels routed to the port are coupled back to the output optical fiber associated with that port.

23. The WSS can serve as the basis for a ROADM. For example, consider a simple WSS with two optical fibers. The ROADM 'input' fiber port WDM signal is introduced to the first WSS optical fiber. Let all the WSS beam steering elements, except one (or more), tilt the WDM channel beams back towards the first WSS optical fiber, and the one (or more) beam steering element(s) tilts the WDM channel(s) to the second WSS optical fiber. The first set of WDM channels exiting the first WSS optical fiber is then attached to the ROADM 'output' fiber port. The one (or more) WDM channel(s) that was tilted to the second WSS optical fiber is attached to the ROADM 'drop' fiber port. A replacement WDM signal introduced at the ROADM 'add' fiber port is then attached to the second WSS optical fiber and is guided by the WSS configuration (via the one or more beam steering element) to the first WSS optical fiber, where it will emerge on the ROADM 'output' fiber port. In this implementation the two WSS optical fibers carry optical signals bi-directionally to/from the WSS (serving as input/output), to be separated outside of the WSS with an optical circulator for each optical fiber. At ROADM nodes the same WDM channels are often added and dropped at the same time - that is, the added

and the dropped channels use the same wavelength, but they contain different information. The dropped channel information is destined for users at the network node, and the same or others users at the network node upload new information to the network onto the added channel.

24. It is advantageous to have the add channel information use the same wavelength as the drop channel (though it is not necessary) for two main reasons: it is known that the dropped wavelength slot is available to accept new information, so no network routing path calculation is invoked and no blocking or contention can occur, and the WSS configuration is already configured by the beam steering element to route the 'add' wavelength channel to the 'output' port, in the implementation described above.

25. These routing techniques were known prior to the '368 priority date. (Bouevitch, Ex. 1003 at 5:15-38; Mizrahi, Ex. 1016 at 1:55-2:45; Aksyuk, Ex. 1017 at 1:56-67.)

26. In addition to routing channels, ROADMs may also be used to control the power of the individual channels at the output fiber port. Power control is used to reduce the power imbalance between wavelength channels, often originating from uneven gain in optical amplifiers. Devices performing such dynamic spectral power control were known before the '368 Patent (Ex. 1015, Ford et al., *Wavelength Add–Drop Switching Using Tilting Micromirrors*, Journal of

Lightwave Technology, Vol. 17, No. 5 (May 1999) at p. 905). Power control can be incorporated in the ROADM function by utilizing WSS that can control not only the switching state but also the level of power attenuation to the switched port. In MEMS-based WSS this switching is typically done by steering individual beams slightly away from the output port such that the misalignment reduces the amount of the channel's power that enters the port. This power control technique using WSSs in ROADMs was known prior to the '368 priority date. (*See e.g.*, Sparks, Ex. 1004 at 4:48-65.) ROADMs use wavelength selective routers (WSRs) to perform switching (*See, e.g.*, Kewitsch, Ex.1026 at 10:64-11:29.) WSRs are also referred to as wavelength selective switches (WSSs). (*See*, *e.g.*, Ranalli, Ex. 1027, U.S. Patent No. 6,285,500 to Ranalli at al. ("Ranalli") at Fig. 1.) As of the '368 priority date, WSRs/WSSs were known. (*See,e.g.*, Kewitsch, Ex. 1026 at Abstract, 4:15-25; Ranalli, Ex. 1027 at Fig. 1; Ex. 1032 at 1292.)

C. Microelectromechanical Systems

27. The embodiment of WSSs relevant to this petition steers light beams using small tilting mirrors, the tilt of the mirrors actuated by MEMS, which stand for Micro ElectroMechanical Systems. WSSs can tilt the individual mirrors using several different operating methods, including analog voltage control. (*See, e.g.*, Ex. 1010, U.S. Patent No. 5,661,591 to Lin at al. ("Lin") at Fig. 3B, 2:3-9.) MEMS is a broad area of technology and can have many

operating modes. Voltage controlled mirror actuation by electrostatic forces are the easiest to design and realize; there are also magnetic, thermal, and piezo methods as well. Electrostatic MEMS can be operated using analog voltage for continuous control, binary voltage for two-state control, and there is also a variant using rapid switching of a binary voltage to mimic analog voltage since the mirror is a slowly moving device and acts as a low pass filter (a technique called pulse width modulation).

28. Prior-art MEMS mirrors could be tilted in one or two axes. (Sparks, Ex. 1004 at 4:18-26 and 42-47; U.S. Patent No. 6,567,574 to Ma, et al. ("Ma"), Ex. 1023 at Fig. 5; Andrew S. Dewa, and John W. Orcutt, *Development of a silicon 2-axis micro-mirror for optical cross- connect*, Technical Digest of the Solid State Sensor and Actuator Workshop, Hilton Head Island, SC (June 4-8, 2000) ("Dewa") Ex. 1020 at p. 93.) Such 2-axis actuating mirrors were known for many years prior to the filing of the '368 Patent. For example, U.S. Patent No. 5,872,880 to Maynard ("Maynard") Ex. 1036, filed on August 12, 1996, is entitled a "Hybrid-optical multi-axis beam steering apparatus" and notes that "An aspect of the invention provides a micromachined mirror which is capable of steering a beam of light with multiple degrees of freedom." (*Id.* 3:9-11.) Maynard also notes that "the micromirror is precisely steered by the application of a controlled electrostatic effect, in either a current or a voltage mode." (*Id.* 3:15-18.)

V. MOTIVATION TO COMBINE

29. I am informed that in order to properly combine the Bouevitch, Sparks and other references for purposes of obviousness, it is important to provide an explanation as to why the PHOSITA would have been motivated to combine those references. It would have been obvious to PHOSITA to combine the disclosures of Bouevitch and Sparks, and other references, as explained in more detail below. In particular, it would have been obvious to replace the (arguably) 1-axis actuating mirrors in the Bouevitch optical switch with the 2-axis actuating mirrors disclosed in Sparks, especially since Bouevitch notes that the 1-axis orientation can be in an arbitrary orientation with respect to dispersion axis, i.e. either horizontal or vertical (Ex. 1003 at 15:30-34). Moreover, it would have been obvious to the PHOSITA to implement the power control function, disclosed in Sparks, in the ROADM of Bouevitch, at least because of the advantages provided by such power control in minimizing signal noise in multiplexed optical signals as disclosed by Sparks. (Sparks, Ex. 1004 at 1:11-25.) These and other reasons are further discussed below. As I discuss later in this declaration, it would also have been obvious to combine the Lin and Dueck references with Bouevitch and/or Sparks.

A. Motivation to Combine Bouevitch and Sparks and Further References

30. First, the PHOSITA would know that techniques used in one reference

would be directly applicable to the other. For example, both Bouevitch and Sparks are directed to similar devices, specifically optical signal switches for use in telecommunications systems (Bouevitch, Ex. 1003 at 1:10-15 and 31-34; Sparks, Ex. 1004 at 4:3-14, 33-38, and 59-60). It is noted that Lin and Dueck are similarly directed to optical signal switches (Lin, Ex. 1010 at Title; Dueck, Ex. 1021 at 3:3-5). Knowing that the references were directed to similar components, fields, and uses, the PHOSITA would have understood that the teachings of any one reference would be readily applicable to the others.

31. Second, the PHOSITA would further know that the 2-axis actuating mirrors of Sparks could be substituted for the 1-axis actuating mirrors in Bouevitch. The actuating mirrors of Sparks and Bouevitch are MEMS-based. (Bouevitch, Ex. 1003 at 14:5-10 and 52-65; Sparks, Ex. 1004 at 4:42-47). The PHOSITA would understand that the principles of operation of the MEMS-based actuating mirrors are essentially the same except that the mirrors of Sparks are actuatable in one more axis than those of Bouevitch. The effect of tilting a MEMS mirror in 2 axes for the steering of a light beam is entirely predictable in view of the effect of a MEMS mirror tilting in 1 axis for the steering of a light beam. Because the implementation of both 1-axis and 2-axis actuating mirrors were known at the time of the '368 Patent, the PHOSITA would also expect that using the 2-axis MEMS-based mirrors of Sparks for directing a beam of light in place of

the 1-axis MEMS-based mirrors of Bouevitch would yield a predictable result of the same functionality (e.g., movement of a reflective surface in a first axis) yet with more control (e.g., the reflective surface moving in a second axis in similar manner as the movement in the first axis). There are virtually no technical obstacles to the substitution of a known 2-axis articulating mirror for a known 1-axis articulating mirror and the advantages of such a substitution are easily recognizable.

32. Third, it would be obvious for the PHOSITA to try Sparks' 2-axis actuating mirrors in Bouevitch because 2-axis actuating mirrors were among a small number of well-known and predictable solutions for beam-deflecting, and the PHOSITA would have expected to have success building devices using either type of mirror. 1-axis and 2-axis actuating mirrors were recognized in the prior art as interchangeable options, the selection of which merely depended on the preference of the engineer. (*See* Bishop '421, Ex. 1007 at 4:17-19 (claiming in the alternative a cross connect with "an array of tiltable mirrors comprising a plurality of mirrors, each mirror being tiltable about ***at least one*** tilting axis"); emphasis added.) Because Bouevitch already disclosed the use of 1-axis MEMS-based mirrors, the PHOSITA would have a high expectation of success in trying Sparks' 2-axis MEMS-based mirrors for any beam reflecting application in Bouevitch, including switching and power control.

33. Fourth, the PHOSITA would have been motivated to use the 2-axis actuating mirrors of Sparks in place of the 1-axis actuating mirrors of Bouevitch to take advantages of the benefits highlighted by Sparks. For example, the 2-axis actuating mirrors are described by Sparks to "precisely direct[] the beam" (Ex. 1004 at 4:21) and to "carefully align the beams so as to ensure that the maximum possible input optical signal is received at the output of the switch" (*Id.* at 4:45-47.) The PHOSITA would have readily recognized the benefits of precise beam control in 2-axes as in Sparks as compared to 1-axis beam control as in Bouevitch and would have been motivated to carry out a straightforward replacement of the 1-axis actuating mirrors of Bouevitch with the 2-axis actuating mirrors of Sparks.

34. Fifth, consistent with Sparks' statement that 2-axis actuating mirrors allows "the maximum possible input optical signal is received at the output of the switch (*Id.* at 4:46-47), the PHOSITA would have realized that Sparks' 2-axis actuating mirrors can help overcome manufacturing deviations. When assembling any optical system such as a WSS, tolerances in component production and assembly cause deviations from the ideal working conditions. Having mirrors with 2-axis angular optimization can reduce or even eliminate the effect of these alignment deviations on the efficiency of light coupling to an optical fiber. The 2-axis actuating mirrors can account for unintentional misalignment due to manufacturing tolerances in both axes whereas a 1-axis mirror would only be able

to adjust for unintentional misalignment in 1-axis.

35. Sixth, the PHOSITA would have been motivated to combine the teachings of Sparks with those of Bouevitch because Sparks addresses a problem, and is directed to a goal, identified in Bouevitch. Specifically, Bouevitch states "In optical wavelength division multiplexed (WDM) communication systems, an optical waveguide simultaneously carries many different communication channels in light of different wavelengths. In WDM systems it is desirable to ensure that all channels have nearly equivalent power." (Bouevitch, Ex. 1003 at 1:18-22.). In seeking to "ensure that all channels have nearly equivalent power" (*Id.*), the PHOSITA would recognize Sparks as relevant and applicable. In this regard, Sparks states:

> The control of optical power levels in optical communications systems is critical in obtaining optimum performance. The power level needs to be sufficient to establish a signal to noise ratio which will provide an acceptable bit error rate but without the power level exceeding a level at which limiting factors (e.g. the onset of non-linear effects) result in degradation of the signal or other co-propagating signals.
>
> In wavelength division multiplexed (WDM) transmission, it is desirable to control the power of the individual optical channels or wavelengths. Channels could be controlled to provide constant system signal to noise ratio. One of the simplest methods of control is to maintain each of the power levels of the individual wavelength components (channels) at substantially the same level. (Ex. 1004 at 1:9-25).

To maintain the desired power level of channels, Sparks teaches:

controlled misalignment of the optical beam path so as to achieve a

> predetermined optical output power . . . If the optical system is being used as part of a WDM system, it is typical for the signal to be demultiplexed into the separate optical channels prior to input to the switch. If desired, each of the channels passing through the switch may be attenuated to whatever degree necessary to achieve the desired effect, e.g. equalisation of optical power across all channels.

(Ex. 1004 at 2:24-36.) As such, the PHOSITA would have been motivated to utilize the 2-axis actuating mirror and power control feature of Sparks which were directly on point with addressing the need, identified by Bouevitch, for all channels having nearly equivalent power.

36. The power control teachings of Sparks "may equally be applied to any optical switch utilising any one or more of reflection, refraction and/or diffraction" (*Id.* at 5:58-62.) Being that light beams in Bouevitch reflect off of reflectors 51, 52 to be aligned with parts 1, 2, or 3 associated with circulator 80a (and the port 85), it would be a straightforward application of the teachings of Sparks to misalign a beam with one of the parts 1, 2, or 3 associated with circulator 80a and/or the port 85 to have the predictable effect of selectively reducing the power of the spectral channel carried by the beam. (Bouevitch, Ex. 1003 at 14:39-60; *see* Fig. 11.) Intentional misalignment between the beam and port 85 could have been precisely controlled with the 2-axis mirror of Sparks which was readily combinable with Bouevitch as discussed above.

37. For at least the reasons discussed above, the PHOSITA would have sought Sparks in addressing the problems and goals identified in Bouevitch in

making a ROADM, and would have found the relevant teachings of Sparks combinable with Bouevitch to achieve a predictable outcome. These known and readily combination teachings render the claims of the '368 Patent obvious, as further discussed herein.

VI. BOUEVITCH AND SPARKS RENDER OBVIOUS ALL PETITIONED CLAIMS

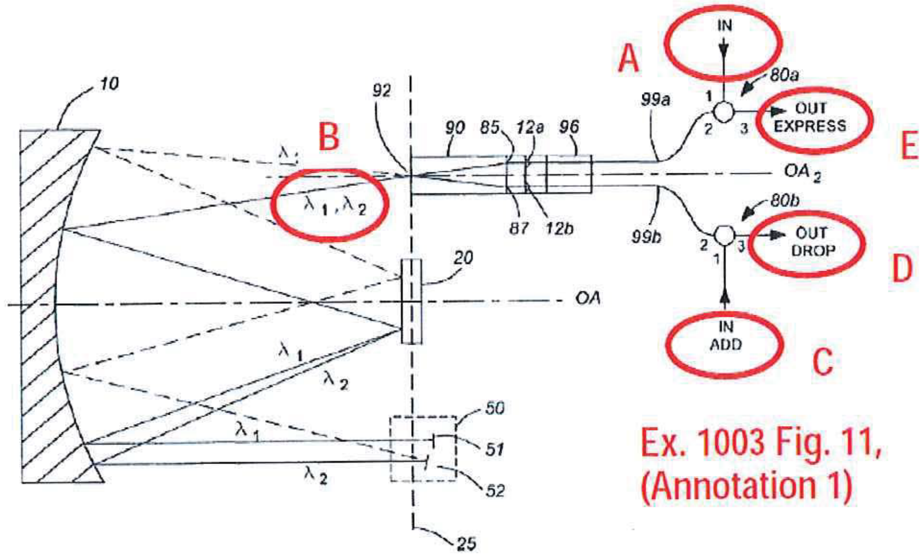
A. Claim 1

(i) Claim 1- preamble

38. Bouevitch discloses a "Configurable Optical Add/Drop Multiplexer (COADM)" (Ex. 1003 at Abstract; *see also Id.* at 5:15–20, 14:14-21, Figs. 1, 11, 3:9-63 (discussing methods of using the COADM).) This COADM is an optical add-drop apparatus, and is synonymous with a ROADM.

(ii) Element 1[a] - input port

39. The first limitation of claim 1 recites "an input port for an input multi- wavelength optical signal having first spectral channels." Bouevitch discloses an input port "IN," annotated as "A" in Fig. 11-Annotation 1, included below. An optical signal is "launched into" the "IN" port. (*Id.*, 14:38–41.) That signal is a multi-wavelength signal with a first spectral channel λ1 and a second channel λ2, as shown at annotation "B" of Fig. 11-Annotation 1 (*id.*, Fig. 11, 14:39-42,):



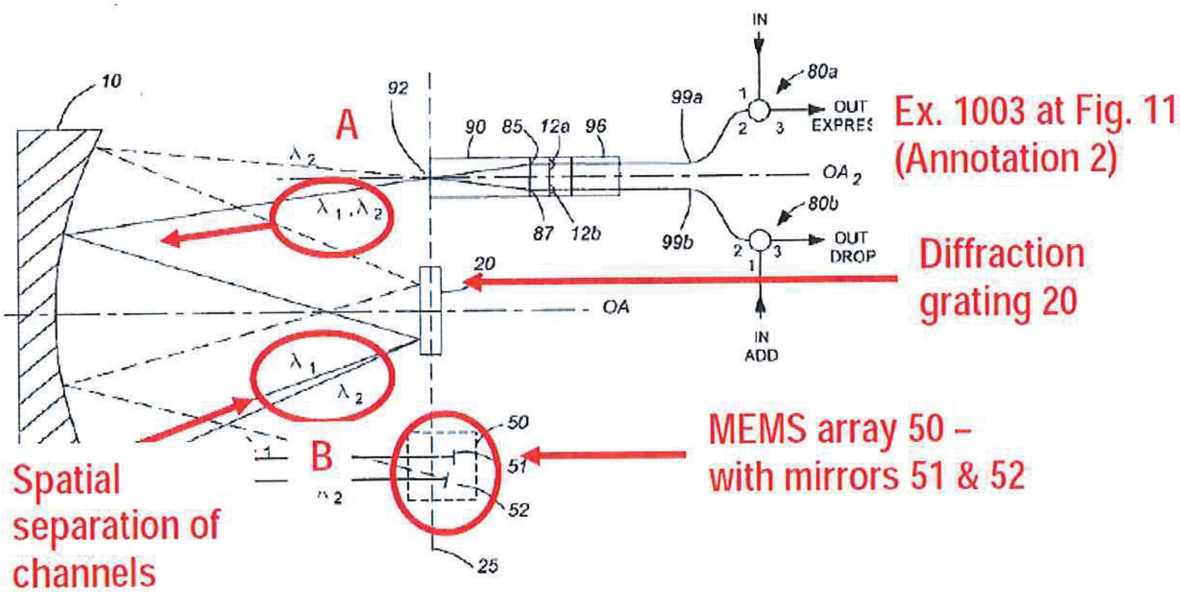
(iii) Element 1[b] – Output & other ports for 2nd channels

40. Other Ports: The first part of limitation 1[b] recites: "one or more other ports for second spectral channels." Bouevitch discloses two ports in addition to the input and output ports. Bouevitch labels one port as 80b, port 1,"IN ADD" (annotated as "C" in *Id.*, Fig. 11-Annotation 1, above). Another is labeled as 80b, port 3, "OUT DROP" (annotated as "D"). (*Id.*) In one example, first spectral channel λ_2 exits the OUT DROP port, and Bouevitch adds a new second channel on the same wavelength λ_2 at the IN ADD port. (*Id.*, 14:27-65.) Although both the added and the dropped channels use the same wavelength, as I noted above, they are separate information bearing channels. Bouevitch discloses the "in/out/add/drop ports" as part of its "configurable add/drop multiplexor". (*Id.* at 10:56-61, 1:11-15.)

41. <u>Output Port:</u> The second part of limitation 1[b] recites: "an output port for an output multi-wavelength optical signal." Bouevitch discloses an output "OUT EXPRESS" output port (annotated as "E," in Fig. 11-Annotation 1, above) wherein a multi-wavelength signal including one of the original input channels (wavelength λ_1) is combined with an added channel (λ_2), which together exit the output port 80a(3). "[T]he added optical signal corresponding to $\lambda 2$ is combined with the express signal corresponding to $\lambda 1$. The multiplexed signal…returns to port 2 of the first circulator 80a where it is circulated out of the device from port" (*Id.* at 15:14-18, Fig. 11.)

(iv) Element 1[c] - wavelength-selective device

42. The next element, 1[c], requires "a wavelength-selective device for spatially separating said spectral channels." Diffraction grating 20 in Bouevitch Fig. 11 is such a device. Figure 11 shows that the grating spatially separates combined channels $\lambda_1\lambda_2$ ("A" at Fig. 11-Annotation 2, below) into separated channels ("B"):



43. Bouevitch states, "[t]he emerging beam of light λ_1 λ_2, is transmitted to an upper portion of the spherical reflector 10, is reflected, ***and is incident on the diffraction grating 20, where it is spatially dispersed into two sub-beams of light carrying wavelengths λ_1 and λ_2, respectively***." (Ex. 1003 at 14:48-53 (emphasis added), 8:10–22.)

(v) Element 1[d] – 2-axis beam-deflecting elements

44. This final element of claim 1 has three subparts. Bouevitch teaches the first two, and Sparks teaches the third. Each subpart is discussed in turn, below.

45. <u>Beam-deflecting Elements:</u> The first part of element 1[d] recites: "a spatial array of beam-deflecting elements positioned such that each element receives a corresponding one of said spectral channels." Bouevitch discloses this element as MEMS mirror array 50 in Fig. 11-Annotation 2, above. Bouevitch

positions its MEMS mirrors to receive and reflect the beams of light carrying the respective spectral channels dispersed by the diffraction grating. Bouevitch discloses "modifying and reflecting a beam of light spatially dispersed by the dispersive element" where, for COADM operations, the "modifying means is preferably a MEMS array 50." (Ex. 1003 at 3:42–45; 14:26-27.) Each mirror in the MEMS array (elements 51 and 52 for Fig. 11-Annotation 2, above) reflects a separate, corresponding beam of light (channels λ_1 & λ_2 respectively) such that the channel reflected by mirror 51 is passed though, and the channel reflected by 52 is dropped. (Bouevitch, Ex. 1003 at 14:52-63, Fig. 11.)

46. Individually / Continuously Controllable: The second part of limitation 1[d] recites wherein each of the elements of the array is "individually and continuously controllable in two dimensions to reflect its corresponding spectral channel to a selected one of said ports." The BRI of "continuously controllable" is "able to effect changes with fine precision" (e.g., this controllability could be obtained through the use of analog or digital controls with sufficiently fine output values). The BRI of "controllable in two dimensions" means "actuatable in two axes." It is noted that in reference to mirror control, the '368 Patent states "each channel micromirror is under analog control such that its pivoting angle can be continuously adjusted." (Ex. 1001 at 4:9 12.) Consistent with the '368 Patent, a mirror that is disclosed to be under analog control would fit

within the scope of "continuously controllable" as recited in the '368 Patent.

47. First, Bouevitch discloses "individual" control of each mirror in MEMS array 50. "[E]ach sub-beam of light…is transmitted to separate reflectors 51 and 52 of the MEMS array 50." (*Id.* at 14:52-63, Fig. 11-Annotation 2). Each reflector is individually controlled in one axis to deflect the respective beam to either the output or the drop port. (*Id.*)

48. Second, Bouevitch indicates that its reflectors are "continuously controllable" because (as discussed below) the amount of power in the spectral signal that is attenuated is a function of the angle of the deflector in that one axis. (*Id.*, 7:35-37 ("The degree of attenuation is based on the degree of deflection provided by the reflector (i.e., the angle of reflection)".) Bouevitch also describes the attenuation resulting from the deflector as "variable." (*Id.*, 12:59-60.), in line with the Bouevitch's attempts to balance the powers of each of the wavelength channels. Hence the mirror's tilt is detuned in angle from the peak (or optimal) fiber coupling to induce controlled amounts of loss. This level of control, required to balance the optical power differentials among the wavelength channels is achieved by controlling the mirrors to be able to effect changes with fine precision to align with the ports (and control power through intentional misalignment as further discussed herein) which is within the BRI for "continuously controllable". Furthermore, the PHOSITA would understand that

the level of control, required to balance the optical power differentials among the wavelength channels, is achieved via analog voltage control.

49. Sparks, likewise, teaches what the PHOSITA would understand as mirrors that are controllable to effect changes with fine precision. Sparks states that the mirrors are actuatable "to achieve **any** desired optical beam power output less than the maximum" (Ex. 1004, 4:54-55, emphasis added) and that "each of the channels passing through the switch may be attenuated to **whatever degree necessary** to achieve the desired effect" (Id. at 2:33-36, emphasis added). As such, the PHOSITA would understand that the mirrors of Sparks are able to effect changes with fine precision and are thus within the BRI of "continuously controllable". Furthermore, the PHOSITA would understand that such precision of mirror control is consistent with the level of fine control provided by analog actuators.

50. This principle of attenuation via control over the MEMS mirror tilt has been established long before the purported priority date of the '678 patent. First, the relationships between the light beam parameters (including beam size, location and angle of incidence) arriving to the output fiber and the amount of attenuation have been long established. One can achieve any level of attenuation for a given beam parameter deviation from ideal conditions. For example, for a beam offset from the optical axis of the fiber, the relationship between the power

coupled and the offset is a Gaussian function. That is, the reduction in power coupling follows a Gaussian relationship, and the power coupling is reduced monotonically as a function of beam offset. This Gaussian behavior further implies that beam offset from ideal conditions can be to any direction. For example, beam tilt deviation from ideal can be either greater than or less than ideal angle. This attenuation principle has been demonstrated with MEMS tilting mirrors before, as shown at least by Sparks.

51. A secondary ground in accounting for the "continuously controlled" aspect comes under Bouevitch+Sparks+Lin. Another prior art reference that discloses analog control of mirrors is U.S. Patent No. 5,661,591 to Lin ("Lin"), Ex. 1010. Lin was assigned to Texas Instruments ("TI"). Lin describes one TI MEMS device, and confirms that continuous and analog control of MEMS mirrors was known prior to the '368 Patent's priority date. For example, Figure 3B of Lin shows a graph comparing the deflection angle of MEMS mirrors to a voltage applied to affect that deflection. Figure 3B shows the relationship as a continuous, roughly linear relationship within the expected operating range of the device (Id. at Fig. 3B):

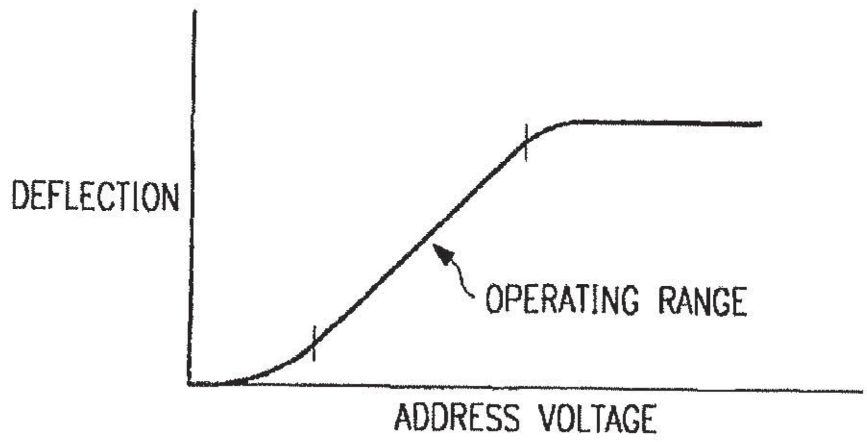


FIG. 3B

52. To the extent Bouevitch does not fully disclose continuous mirror control, it also would have been obvious to substitute one control method for the other, including substituting either Sparks' or Lin's fine (e.g., analog) control into the COADM of Bouevitch. The PHOSITA would do so for at least for the reasons that (1) continuously controlled mirrors were known to be interchangeable with discrete-step mirrors; (2) continuously controlled mirrors allow arbitrary positioning of mirrors and can be used to achieve optimal coupling value or deviations from angle to lead to controllable attenuation; and (3) Lin specifically teaches that its analog, continuous MEMS mirrors would be useful in optical switching applications like Bouevitch's and Sparks' devices. (Lin, Ex. 1010 at 2:6-9.) Such substitution would provide predictable results of fine controllability.

53. With respect to reason (1)—the interchangeability of continuously-controlled mirrors with discrete-step mirrors—this interchangeability is shown in the prior art by references that could use either discrete or analog control to

achieve a large number of potential mirror angles. For example, in Muller and Lau 1998, the article's mirrors used an actuation scheme based on small steps induced by vibration. This has the advantage of being 'latched' into position such that tilt angle is preserved when electrical power fails. Similarly, MEMS mirrors based on analog voltage control can also be tilted to any desired angle in their operation range, but voltage may have to be permanently placed to maintain mirror angle and the resulting optical power coupling value (whether implementing best coupling, i.e. 'ideal,' or detuned for power control).

54. With respect to reason (2)—power balancing—continuously controllable mirrors were obvious to use because such mirrors were known to be useful to address the constantly-changing power-balancing requirements in ROADMs. The power balancing requirement in optical networking is varying in time and is mostly dependent on the network wavelength channel routing assignment at any particular time, due to the optical amplifiers in the networking providing different gain depending on the number and spectral placement of wavelength channels. Hence the power balancing function required of the dynamic gain equalization filter (or the ROADM providing the channel attenuation feature) is constantly changing (hence the term 'dynamic'). This requirement can be met with MEMS mirrors whose tilt angles are continuously changing in response to power variations and this can be easily achieved with fine (e.g., analog) control over the MEMS mirror

tilt together with feedback control.

55. In addition, analog control of the mirrors would be obvious to try within the applications that Bouevitch discloses. The MEMS mirror alternatives available for system design can be broadly classified as 'analog' and 'binary' MEMS tilting mirrors, with binary mirrors having one of two metastable angular positions and analog mirrors generally have no metastable positions and having infinite options within an angular range, depending on the applied voltage conditions. For example, Lin discusses analog control as an alternative to binary (discrete) control of mirrors to increase the precision of the mirror placement. (Ex. 1010, 2:7-9; 3:41-57.) In addition, MEMS mirrors can be either latching or non-latching, with latching mirrors maintaining their position even when electrical power is turned off. In simple two state switching scenarios, a binary latching MEMS mirror design has many advantages. However, Bouevitch is trying to power balance wavelength channels in an optical network, which requires continuous power coupling control to offset the dynamics of the network. The PHOSITA would know that this power balancing is best achieved with analog non-latching MEMS mirrors.

(vi) 2-axis beam-deflecting elements

56. Returning now to both Grounds 1 and 2, the only portion of this part of element 1[d] which may be open to question is a beam deflecting element with a

second dimension (a second "axis" under Petitioner's BRI) of control. But as discussed in §§ IV(C) and (V), above, Sparks discloses a 2-axis beam deflecting element. In particular, Sparks describes "movable micromirrors (16,26), which are fabricated using MEMS technology and are capable of two axis movement, to carefully align the beams so as to ensure that the maximum possible input optical signal is received at the output of the switch." (Ex. 1004 at 4:43-47.)

57. As discussed in § V(A) above, it would be obvious (and PHOSITA would be motivated) to exchange the 1-axis actuating mirrors in Bouevitch with the 2-axis actuating mirrors of Sparks because the two types of mirrors were known to be interchangeable. The exchange would achieve the easily recognizable benefit of greater beam control (e.g., 1 vs. 2 axis articulation and beam deflection). As discussed further below, 2-axis actuating mirrors also have known benefits for power control.

58. Replacing Bouevitch's 1-axis actuating mirrors with Sparks' 2-axis actuating mirrors would have had the known benefit of minimizing the resulting device's size by allowing compact 2-dimensional arrays of optical ports instead of arraying all ports in a single long line to accommodate the 1-axis actuating mirror that can only direct the beam along the single line port array. (Hoen, Ex. 1009, 5:10-12.) Size reduction results from "minimal spacing between crossconnect components," (Bishop, Ex. 1006, 3:10-11), and PHOSITA knew that 2-axis

mirrors allow for beam-steering between more compactly-spaced input/output ports arranged as a 2-D array. (Hoen, Ex. 1009, 1:65-2:13.)

59. An additional benefit for 2-axis mirrors over 1-axis mirrors is the reduced tolerances on assembly of the WSS. The additional degree of MEMS mirror tilt control can be used to find the ideal angle in two dimensional angular space and optimally couple at peak efficiency to the output fiber. Power control (or attenuation) can be obtained by detuning from optimal coupling angle to any direction (in two dimensional angular space).

60. Bouevitch describes how the goal of controlling the MEMS mirrors is to effect the add/drop process, which includes reflecting the spectral channels to selected add/drop ports. (*See, e.g.,* Ex. 1003 at 14:66-15:18.) Similarly, Sparks discusses "having two arrays of such modules, optical signals coming in from a first array may be directed into any of the output fibres of the second array." (Ex. 1004 at 4:33-35.) As such, both Bouevitch and Sparks disclose switches to "redirect a spectral channel to a particular port".

61. Power Control using 2-axis actuating mirrors: The third part of element 1[d] recites wherein each of the beam-deflecting elements is controllable "to control the power of the spectral channel reflected to said selected port." Bouevitch discusses power control by tilting one-axis mirrors to effect a slight misalignment between the beam and the output port. Bouevitch shows how each

MEMS mirror controls the power of a “respective” channel, where "the degree of [power] attenuation is based on the degree of deflection provided by the reflector (i.e., the angle of reflection)." (Ex. 1003 at 1:24-27, 7:23-37; *see also id.* at 1:21-24, 50-53; 5:16-46; 2:22-25; Abstract.)

62. Sparks discusses 2-axis (two dimensional) mirror actuation for both switching (Ex. 1004 at 4:19-22) and power control (*Id.* at Abstract). Regarding power control, Sparks includes:

> a control system to control the mirrors so as to deliberately misalign the optical beam path 30 through the switch. By non-optimally aligning the optical beam path, the optical beam will be attenuated as it passes through the switch due to a reduction in the power of the beam coupled into the output fibre. This permits the switch to be utilised to achieve any desired optical beam power output less than the maximum.
> Id. at 4:48-55.

63. The PHOSITA would be motivated to use the 2-axis system of Sparks within the system of Bouevitch for power control. First, power control was desirable generally and would be just as desirable after switching to 2-axis actuating mirrors for the benefits cited above. Bouevitch notes both the desirability of power equalization across spectral channels, and the need for devices that perform both power control and add/drop functions. (Ex. 1003 at 1:18-22; 1:50-54.) The patentee also recognized this, claiming that "spectral power-management capability is essential in WDM optical networking applications." (Ex. 1001 at 11:34-36.)

64. Second, the PHOSITA would be further motivated to utilize the 2-axis actuating mirror and power control feature of Sparks to address a need identified by Bouevitch. Bouevitch states "In WDM systems it is desirable to ensure that all channels have nearly equivalent power." (Ex. 1003 at 1:21-22.) The power control feature of Sparks can be used to "maintain each of the power levels of the individual wavelength components (channels) at substantially the same level" (Ex. 1004 at 1:23-25.) To address this shared need, Sparks teaches:

> controlled misalignment of the optical beam path so as to achieve a predetermined optical output power . . . If the optical system is being used as part of a WDM system, it is typical for the signal to be demultiplexed into the separate optical channels prior to input to the switch. If desired, each of the channels passing through the switch may be attenuated to whatever degree necessary to achieve the desired effect, e.g. equalisation of optical power across all channels.
> (Ex. 1004 at 2:24-36.)

65. As such, the PHOSITA would have been motivated to utilize the 2-axis actuating mirror and power control feature of Sparks which were directly on point with addressing the need for all channels having nearly equivalent power as identified by Bouevitch.

66. Third, the PHOSITA would be further motivated to choose the Sparks solution of 2-axis tilting mirrors (and configure the optical arrangement such that one axis is associated with output port selection and second port is associated with power control) because choosing a 1-axis actuating mirror for both port selection and attenuation may result in dynamic fluctuations of power crosstalk between

ports as attenuation level is varied. Furthermore, in WSS applications where there are more than two output port options in the fiber array (Bouevitch recognized this, stating: Although only two input/output ports are shown to facilitate an understanding of this device, a plurality of such pairs of ports is optionally provided, Ex. 1003 at 5:32-34), the desire to eliminate dynamic crosstalk would have forced the PHOSITA to choose a switching solution that prevents that dynamic crosstalk. This can be achieved by 2-axis tilting mirrors as in Sparks.

B. Claim 2

67. Claim 2 recites "the optical add-drop apparatus of claim 1 further comprising a control unit for controlling each of said beam-deflecting elements." Bouevitch must contain a control unit for controlling the tilt on the individual mirrors (50, 51) in the MEMS array (50), since individual mirrors in the array require an actuation voltage to be supplied. The role of the control unit is to provide this plurality of voltages, which is required to independently control individual mirrors in the array. The applied voltages are determined according to the specific switching requirement, which specifies for each channel its output port assignment and attenuation control to balance out all the wavelength channel powers. The control unit associated with the optical add-drop apparatus interacts with the optical network level controller, receiving from it optical switching assignments, and internally applies the MEMS mirror voltages to control the

mirror tilts and complete the switching assignment.

68. The Bouevitch device is required to function with some type of control unit. The "selective switching" that Bouevitch performs with its MEMS mirrors would need to be performed by some type of control unit, accepting commands for switching state change from a remote network controller and in response issuing the actuation controls required for completing the switching function.

69. In typical networks, the entire optical network is managed from a centralized operations control center. When the network is required to dynamically change, commands are issued by the operations control center to the network elements such as the WSS. The WSS received the message and has to perform its function according to a defined protocol, changing the switching state, and then signaling back to the ops center that the switching is completed and the channel turn on can commence.

70. Thus each network element, such as the WSS, necessarily has an internal controller with firmware in sync with the network operations. Individual mirrors could not otherwise be manually aligned and maintained in accuracy necessary for the switching operation. Accordingly, a control unit was necessary.

71. To any extent that inclusion of a control unit for controlling the actuation of the mirrors is neither explicit nor implicit, it would be obvious to the PHOSITA to add a control unit to Bouevitch to control the actuation of the mirrors

in the manner described in Bouevitch.

72. Moreover, Sparks discloses control means 130 for controlling the actuation of the switching means 120 (Ex. 1004 at 4:61-65, Fig. 4). The control means can be a "closed-loop servo control system" employed for "controlling the movable micromirrors (16,26), which are fabricated using MEMS technology and are capable of two axis movement, to carefully align the beams" (*Id.* at 4:39-45.) The "control system is used to control the mirrors so as to deliberately misalign the optical beam path 30 through the switch" to obtain "a reduction in the power of the beam" (*Id.* at 4:48-53.). The PHOSITA would have readily understood that the control system of Sparks would have been suitable for controlling the 2-axis actuating mirror of Sparks when incorporated in Bouevitch if there was any doubt over whether a controller of Bouevitch would be able to do the same.

73. To the extent Bouevitch does not already disclose a "control unit," adding the control unit of Sparks (or other control units) to Bouevitch would have been obvious to the PHOSITA because control units such as microprocessors were well known elements with almost universal applicability. These control units are mandatory for such systems, because an optical switch is required to communicate using a protocol with a network level controller, receiving switching commands and responding accordingly. The PHOSITA could have added such a control unit to Bouevitch with no change in the unit's functions (to act as a controller of

electronic elements). Adding this control unit (such as in the form of a microprocessor) would have yielded the predictable result of electronic control to one of ordinary skill in the art—a microprocessor-controlled COADM. The control unit would communicate with the optical network controller on the one hand, and set the internal switching mechanism (analog electrical voltages applied to MEMS mirrors) on the other hand. The communication to the network controller is determined by the protocols set forth by the network controller, and the switching function has to be completed in a fixed time requirement and reported back to the network. All of these requirements would have motivated the PHOSITA to add the control unit of Sparks to Bouevitch if for some reason the PHOSITA failed to understand that a control unit would necessarily be provided in Bouevitch.

C. Claim 3

74. Claim 3 has two parts, referred to in this section by the shorthand "servo-control assembly" and "spectral monitor."

75. Servo Control Assembly: The "servo-control assembly" part of Claim 3 fully recites "wherein the control unit further comprises a servo-control assembly." As discussed in the BRI section, above, the BRI of a "servo-control assembly" is a "feedback-based control assembly." The '368 Patent explains at length the way in which the servo-control assembly measures the actual output power, and then uses that measurement in a feedback loop to further adjust the

MEMS mirrors to ensure that the output power remains where it should.

76. Sparks discloses such a servo control assembly. Specifically, Sparks discloses a "closed-loop servo control system" employed for "controlling the movable micromirrors (16,26), which are fabricated using MEMS technology and are capable of two axis movement, to carefully align the beams" (Ex. 1004 at 4:39-45.) The "control system is used to control the mirrors so as to deliberately misalign the optical beam path 30 through the switch" to obtain "a reduction in the power of the beam" (*Id.* at 4:48-53.). To accomplish this power control, Sparks teaches "a control means 130 capable of receiving an input signal indicative of the power of an optical signal, and being arranged to control the functioning of said switching means for achieving misalignment of said optical beam path. A power measuring means 140 is arranged to provide a signal indicative of the power of the optical signal to the switching means." (*Id.* at 4:61-67; *see also Id.* at Fig. 4, annotated to show internal feedback loop):

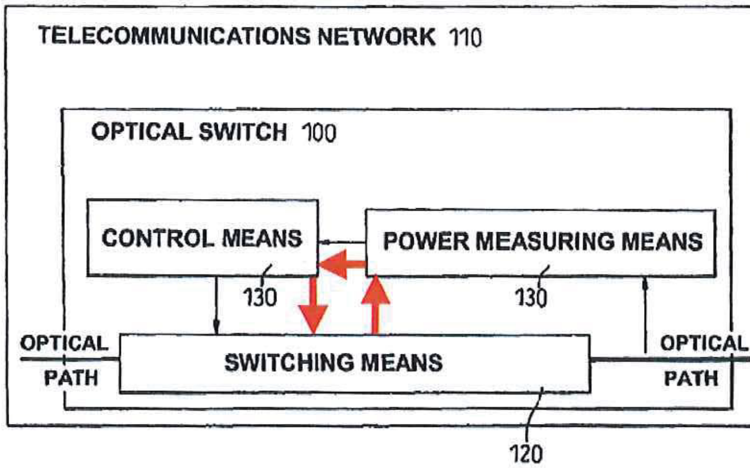


Fig. 4

77. It would have been obvious to the PHOSITA to try the internal feedback loop in Sparks for use in Bouevitch as an alternative to the "external feedback" for power control that Bouevitch explains should be eliminated. (Id. at 10:17-21.) This was obvious because the principal alternatives to provide such feedback would be the use of (1) internal or (2) external feedback. Using the Sparks internal feedback technique was known, and one of skill would be motivated to do so to avoid burdening the network controller with additional communication between network elements which would otherwise be required with external control. (Id.; see also Ex. 1001 at 12:9-15 ("The electronic circuitry and the associated signal processing algorithm/software for such processing unit in a servo-control system are known in the art."))

78. The source of feedback can be either internal or external, though at a

high level they both operate identically. The measurement information is fed back to the controller which then readjusts the MEMS mirrors to the new settings to more accurately satisfy the switching requirement. If the measurement system is internal, then the network communications channel is not utilized and switch operates autonomously. But then the measurement hardware has to be introduced to the switch, which impacts its price. If the measurement system is external than no additional internal hardware is required, and the monitoring elements are typically already present within the network, hence it is more economical but burdens the network controller with additional communication between network elements.

79. Spectral Monitor: The spectral monitor portion of claim 3 requires the control unit to "include[] a spectral monitor for monitoring power levels of selected ones of said spectral channels, and a processing unit responsive to said power levels for controlling said beam deflecting elements." The BRI for the term "spectral monitor" is "a device for measuring power in a spectral channel."

80. Sparks discloses power measuring means 130 for measuring the power of an optical signal and using the measured power of the optical signal for controlling the actuation of the mirrors to provide greater or lesser misalignment with an optical port to achieve a predetermined power output for a particular spectral channel. (Ex. 1004 at 2:46-62.) As depicted in Fig. 4 of Sparks, power

measuring means 130 measures a spectral channel along an optical path and communicates with the control means 130 for closed loop control. Sparks states that "both the input and the output optical signal to the switch could be measured in order to directly indicate the degree of the attenuation of the optical signal as it passes through the switch. This information could be used to provide a closed loop feedback control system to ensure that the desired degree of attenuation is achieved for each optical signal (or channel)." (*Id.* at 2:59-65.) The PHOSITA would understand that because an intended change in misalignment for one spectral channel can be indicated by the power measurement made at the input and output, that the power changes in a single channel, and every channel, can be monitored.

81. As shown above, Sparks demonstrates that it was known at the time of the '368 Patent to use a spectral monitor to monitor one or multiple spectral channels and use a processing control unit to control a servo-control assembly that actuates beam-deflecting mirrors based on the power level information. The PHOSITA would have understood that implementing the known channel monitoring and closed loop servo-control of Sparks referenced above, in Bouevitch, would be a straightforward and predictable change that would help achieve the equalization of the power levels of channel as identified in Bouevitch (Bouevitch, Ex. 1003 at 1:18-22) and solved by Sparks (Ex. 1004 at 1:9-25). As such, the PHOSITA would be motivated to implement the channel monitoring and

closed loop servo-control with 2-axis deflecting mirrors as made known by Sparks in the system of Bouevitch.

82. Moreover, it would also have been obvious to a PHOSITA to use the spectral monitor and closed-loop servo-control of Sparks within the Bouevitch ROADM, which otherwise disclosed an external monitor and feedback. As the patentee stated in the '368 Patent, a "skilled artisan will know how to implement a suitable spectral monitor along with an appropriate processing unit to provide a servo-control assembly in a WSP-S apparatus according to the present invention, for a given application." (Ex. 1001 at 12:11-15.) ROADMs with integrated spectral monitors were in use before the '368 Patent. The PHOSITA would also understand that the feedback from the monitor would need to be processed to turn the power measurement into control signals in the form of analog actuation voltages for the MEMS mirrors. This control loop typically operates continuously, with the OPM periodically measuring (e.g. every 15 minutes) the wavelength channel power distribution and the switch controller readjusting its actuation mirrors to best meet some power control goal, e.g., target power flatness. (Ex. 1011, Doerr et al., An Automatic 40-Wavelength Channelized Equalizer, IEEE Photonics Technology Letters, Vol., 12, No. 9, (Sept. 2000), and references therein (especially 9 and 10).) This operation completes the feedback of the MEMS servo control. For example, the processor would need to determine the amount of tilt change required on the

mirrors to adjust the power output. The PHOSITA had ample motivation to combine the Sparks feedback loop within Bouevitch because PHOSITA would appreciate that the feedback-driven control of Sparks would improve the precision of the mirror-based switching system of Bouevitch. As a contemporary document in the optical switching field stated "the actuation method for [micromirrors] is often imprecise. To achieve a variable switch, it is typically necessary to use a very high level of optical feedback." (Hoen, Ex. 1009 at 2:4-9.)

83. It would be obvious to the PHOSITA to try the internal feedback loop in Sparks for use in Bouevitch as an alternative to the "external feedback" for power control that Bouevitch explains should be eliminated. (Ex. 1003 at 10:17-21.) This was obvious because the only alternatives to provide such feedback would be the use of (1) internal or (2) external feedback. Using the Sparks internal feedback technique was known, and one of skill would be motivated to do so to avoid burdening the network controller with additional communication between network elements which would otherwise be required with external control. (*Id.*; *see also* Ex. 1001 at algorithm/software for such processing unit in a servo-control system are known in the art."))

84. The source of feedback can be either internal or external, though at a high level they both operate identically. The measurement information is fed back to the controller which then readjusts the MEMS mirrors to the new settings to

more accurately satisfy the switching requirement. If the measurement system is internal, then the network communications channel is not utilized and switch operates autonomously. But then the measurement hardware has to be introduced to the switch, which impacts its price. If the measurement system is external than no additional internal hardware is required, and the monitoring elements are typically already present within the network, hence it is more economical but burdens the network controller with additional communication between network elements

D. Claim 4

85. Claim 4 recites "The optical add-drop apparatus of claim 3, wherein said servo-control assembly maintains said power levels at predetermined values." The servo-control assembly of Sparks has been addressed above in connection with the discussion of claim 3. Sparks makes clear that the closed-loop power control feature carries out "controlled misalignment of the optical beam path so as to achieve a predetermined optical output power" (Ex. 1004 at 2:24-25; *see also* Abstract.) Being that the intentional misalignment can be carried out on a channel-by-channel basis as needed to equalize the power levels of all channels (*Id.* at 2:33-38), the PHOSITA wound understand that the power levels of multiple channels can be maintained at predetermined values.

86. It would have been obvious to try the predetermined power settings of

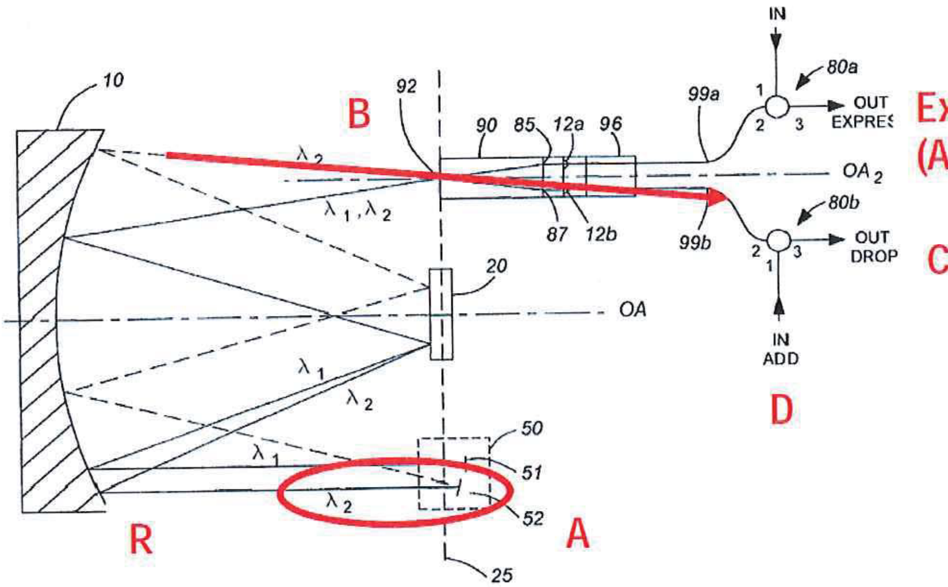
Sparks with Bouevitch. The PHOSITA would have expected a likelihood of success using predetermined values based at least in part on Sparks. As explained previously, Bouevitch states that "it is desirable to ensure that all channels have nearly equivalent power" (Ex. 1003 at 1:21-22) and the servo-control, power control feature of Sparks can be used to "maintain each of the power levels of the individual wavelength components (channels) at substantially the same level" (Ex. 1004 at 1:23-25.) As such, the PHOSITA would have been motivated to implement the servo-control assembly of Sparks in Bouevitch to maintain said power levels at predetermined values.

E. Claim 5

87. Claim 5 recites "The optical add-drop apparatus of claim 2, wherein the control unit controls said beam-deflecting elements to direct selected ones of said first spectral channels to one or more of said second ports to be dropped as second spectral channels from said output multi-wavelength optical signal." Bouevitch is an add-drop multiplexer, and as such, discloses the ability to direct channels to a drop port. (*See* § VI(a)(iv), above.)

88. Petitioner has included Figure 11-Annotation 3 from Bouevitch below. In this figure, beam-deflecting mirror 52 (annotation "A") directs the channel associated with λ_2 along a different path ("B") than the λ_1 channel and finally out of "OUT DROP" port 3 of 80b ("C"). Accordingly, the Figure

illustrates the exact path that a spectral channel, once separated from the other channels, would follow to be dropped. (Bouevitch, Ex. 1003 at 14:60-65, Fig 11.)



Ex. 1003 at Fig. 11, (Annotation 3)

89. As explained for claim 2, above, it would be obvious to use the "control unit" implicit in Bouevitch or plainly disclosed in Sparks to control MEMS mirror 52 to perform this selective beam dropping. (§ VI(B), above.) To achieve switching accuracy necessary to support an optical communications application, a control unit would be necessary to position the individual mirrors 51 and 52. (*See* § VI(B), above.) Accordingly, to the degree that Bouevitch does not inherently include a control unit, using the control unit of Sparks to control the Bouevitch mirrors would be obvious to the PHOSITA. (§ VI(B), above.)

F. Claim 6

90. Claim 6 recites "The optical add-drop apparatus of claim 2, wherein the control unit controls said beam-deflecting elements to direct selected ones of said second spectral channels to said output port to be added to said output multi- wavelength optical signal." This claim is similar to claim 5 except that it relates to adding a channel rather than dropping a channel.

91. Bouevitch discloses a configurable optical add drop module. (§ VI(a)(ii), above.) It is designed to both drop and add channels to a multi-wavelength signal. (§ VI(a)(iv), above.) Bouevitch illustrates the IN ADD port in Figure 11—shown as annotation D in Figure 11-Annotation 3 above—and explains in the corresponding specification portions that channel λ_2 enters at the IN ADD port and is combined with channel λ_1. The combined channels exit together. (Bouevitch, Ex. 1003 at 14:66-15:18.)

92. Bouevitch would have performed this addition with a control unit. But to the degree that the control unit in Bouevitch was not inherent, it would be obvious to use Sparks' control unit to perform this channel addition. (*See* §VI(b), above.) Sparks describes using its control means 130 and switching means 120 to route signals between input arrays and output arrays of fibers consistent with add and drop devices. (Ex. 1004 at 4:33-38 and 59-67, Fig. 4.) As explained in connection with claim 2 above, it would be obvious to use the

control unit of Sparks or any other controller to control MEMS mirror to perform this selective beam switching. (§ VI(B).)

G. Claim 9

93. Claim 9 recites "The optical add-drop apparatus of claim 1, wherein said wavelength selective device further combines selected ones of said spectral channels reflected from said beam-deflecting elements to form said output multi-wavelength optical signal." Bouevitch discloses this combination of channels when a channel is added and then combined with an existing channel. For example, Bouevitch explains, "[a]t the diffraction grating, the added optical signal corresponding to λ_2 is combined with the express signal corresponding to λ_1. The multiplexed signal is returned to the lens 90, passes through port 85, and returns to port 2 of the first circulator 80a where it is circulated out of the device from port 3." (Ex. 1003 at 15:13–18, Figure 11).

H. Claim 10

94. Claim 10 recites "The optical add-drop apparatus of claim 1, wherein said one or more other ports comprise an add port and a drop port for respectively adding second and dropping first spectral channels." Bouevitch discloses these ports at the "IN ADD" port and the "OUT DROP" port. (Ex. 1003 at 14:62–15:1, Fig. 11.) For convenience, Petitioner labeled the ports in

Fig. 11-Annotation 3, above. IN ADD port is labeled as "D" and the "OUT DROP" port is labeled as C. Petitioner previously discussed these two ports when addressing claims 5 and 6. (*See* § VI(e).)

I. Claim 11

95. Claim 11 recites "The optical add-drop apparatus of claim 1 further comprising a beam-focuser for focusing said separated spectral channels onto said beam deflecting elements." As discussed in the BRI section, above, the BRI for the term "beam focuser" is "a device that directs a beam of light to a spot."

96. Bouevitch discloses this beam-focuser element at reflector 10 in Figure 11. Referring to Figure 11-Annotation 3 above, reflector 10 directs the separated beams of light λ_1 and λ_2 from the points on the reflector annotated as R onto the corresponding beam deflecting mirrors 51 and 52 in MEMS array 50. (Ex. 1003, Figs. 11, 6a, 15:7-11, 14:14-20, 48-55; *see also id.*, Fig. 1, 8:46–49 (A beam of light "is reflected from the diffraction grating 120, and is transmitted through lens 110b, where it is collimated and incident on the modifying means 150."); *see also* Sparks, Ex. 1004 at 4:16-22 ("a focussing lens 12") Fig. 1.) Bouevitch's description of other examples of reflector 10 (examples that Bouevitch describes as compatible with the Fig. 11) confirms that the reflector focuses channels onto the MEMS mirrors. Specifically, "The plurality of ***sub-beams of light*** are transmitted to the spherical reflector 610

where they are collimated and transmitted to the modifying means 150 where they ***are incident thereon as spatially separated spots*** corresponding to individual spectral channels." (Bouevitch, Ex. 1003 at 10:41-47; emphasis added.) The "modifying means 150" includes the MEMs array 50 of Fig. 11. (*Id.*)

J. Claim 12 – Grounds 1, 3, and 4

97. Claim 12 recites "The optical add-drop apparatus of claim 1, wherein said wavelength-selective device comprises a device selected from the group consisting of ruled diffraction gratings, holographic diffraction gratings, echelle gratings, curved diffraction gratings, and dispersing prisms." The section addresses claim 12 first under Petitioner's Ground No. 1 of Bouevitch+Sparks, and then under Ground Nos. 3 & 4 of Bouevitch+Sparks+Dueck and Bouevitch+Sparks+Lin+Dueck.

98. Under Ground 1, it would have been obvious to use any of the types of wavelength-selective devices recited in claim 12, as each type was known in the prior art (*e.g., see* Sparks, Ex. 1004 at 5:36-38 stating that the switch can be "a controllable diffraction grating" type), the PHOSITA knew them to be interchangeable as wavelength-selective devices, and each was one of a small set of possible choices that would have been obvious to try. All these dispersive elements are known to separate different wavelengths due to their wavelength

dependence in operation (whether diffraction or refraction). For example, Bouevitch references the use of prisms as wavelength- selective devices through Bouevitch's incorporation by reference of Patel. (Ex. 1031; incorporated in Bouevitch, Ex. 1003 at 1:37-39.) Patel notes that prisms are one type "frequency-dispersive mediums" that include diffraction gratings. (Ex. 1031 at 3:20-36.) In addition, these options for wavelength- selective devices are discussed in Ex. 1037, Born et al., PRINCIPLES OF OPTICS, at 407-414 (6th Ed., Pergammon Press 1984).

99. Alternatively, it was also obvious to combine Bouevitch+Sparks (or Bouevitch+Sparks+Lin) with other known teachings of specific types of wavelength-selective device for WDM devices. For example, Dueck discusses "ruled diffraction gratings," and Ranalli discusses grating prisms. (Ex. 1021, *Id.* 6:26-30; see also Ranalli, Ex. 1027 at 6:33-36.) I will refer to the combination of Bouevitch+Sparks+Dueck as Ground 3 and Bouevitch+Sparks+Lin+Dueck as Ground 4. All these elements are known to disperse wavelengths. Diffraction gratings, whether in the form of ruled, holographic, or Echelle are all conforming to the same diffraction formula and same physics. They only differ in their manufacturing technique. It would be obvious to try such a ruled diffraction grating in the devices of Bouevitch and Sparks under Grounds 3 or 4, and PHOSITA would be motivated to do so because Dueck describes its grating as part

of the "best mode" of separating wavelengths in WDM devices, which include the Bouevitch and Sparks devices. (Ex. 1021, *Id.* 6:26-30.)

K. Claim 13

100. Claim 13 recites "The optical add-drop apparatus of claim 1, wherein said beam-deflecting elements comprise micromachined mirrors." The MEMS (micro electromechanical systems) one-axis and two-axis mirrors discussed in Bouevitch and Sparks are beam-deflecting micromachined mirrors. MEMS are often described in the prior art as "micromachined mirrors" (*see, e.g.*, Goldstein, Ex. 2022, 3:48-50 stating "In free-space MEMS crossconnects, micromachined mirrors are utilized as the switching elements.") or micromachined elements ((*see* Muller and Lau 1998); *see also* §§ IV.C, VI(a)(iv)(iii)(discussing element 1[d], above).) These are miniature movable mechanical structures made typically of silicon and employ and modify manufacturing techniques of microelectronics. The structures that are fabricated can also be micromirrors that are typically metal plated (gold or aluminum) to enhance the reflectivity. These mirrors may be movable or tiltable about one or two axes. Different actuation mechanisms exist, including electrical, magnetic, thermal, and piezo. The simplest to fabricate MEMs mirrors are the electrical type, where a voltage potential exerts an attractive force on a mirror, and results in continuously-controlled mirror tilt.

L. Claim 15 – Grounds 1 and 2

101. Claim 15 is an independent claim that very closely resembles claim 1. The preamble and first two elements of claim 15 are identical to the preamble and elements [a]-[b] of claim 1. These elements are disclosed by Bouevitch for the same reasons set forth in claim 1. To avoid unnecessary repetition, those arguments are not copied here. They are incorporated by reference.

102. The remaining elements of claim 15 are discussed below. The only substantive difference between the rest of claim 15 and the other elements of claim 1 is that claim 15 replaces the "other ports" of claim 1 with "drop ports" for dropped channels. But this change does not impact validity. The differences are expressly disclosed in the applied references.

(i) Element 15[c] – drop ports for dropped channels

103. Claim 15 recites "one or more drop ports for selected spectral channels dropped from said multi-wavelength optical signal." Petitioner identifies this element as element 15[c]. Bouevitch discloses the "drop port" of element 15[c] as the "OUT DROP" port in element 80b port 3. Petitioner labels this port as "D" in Fig. 11-Annotation 1, above. This drop port is used for dropped channels. A spectral channel with wavelength λ_2 is dropped from the combined λ_1 and λ_2 multi-wavelength input signal and sent out the OUT DROP port. (*Id.*, 14:27-65; § VI(a)(iv) (discussing element 1[b], above).)

(ii) Element 15[d]-[e]

104. The next element of claim 15—referred to as 15[d], recites "a wavelength-selective device for spatially separating said multiple spectral channels." This element is identical to claim 1[c], and is disclosed by Bouevitch for the same reasons discussed for 1[c]. (§ VI(a)(iv)(ii).)

105. The next element of claim 15—referred to as 15[e], recites "a spatial array of beam-deflecting elements…" This element is identical to claim 1[d] and is disclosed by Bouevitch+Sparks for the same reasons discussed for 1[d], above. (§ VI(a)(iv)(iii).)

(iii) Element 15[f] – dropped channels to drop ports

106. Finally, the last element of claim 15, identified here as 15[f], recites "whereby a subset of said spectral channels is directed to said drop ports." To the extent this element is considered a limiting element, Bouevitch discloses dropping subset channel λ_2 from the combined set of channels λ_1 and λ_2 and directing λ_2 out the OUT DROP port. (Ex. 1003 at 14:27-65; § VI(k)(ii) & VI(a)(iv) (discussing elements 15[c] and 1[b], above).)

M. Claim 16 – Grounds 1 and 2

107. Claim 16 is another independent claim. The only difference between claim 16 and claim 15, above, is that claim 16 focuses on add ports instead of drop ports. Claim 16 recites one or more ***add*** ports for ***adding*** channels to the

multi- wavelength output channel instead of one or more ***drop*** ports for ***dropping*** channels. Specifically, claims 15 and 16 are identical but for claim 16's recitation of element 16[c]: "one or more add ports for selected spectral channels to be added to said output multi-wavelength optical signal," and 16[e]: "whereby said spectral channels from said add ports are selectively provided to said output port."

108. Thus, Bouevitch+Sparks disclose all elements of claim 16 (other than [c] & [e]) for the same reasons as discussed for claim 15, above. (*See* §VI(k).) This same combination also teaches elements 16[c] & [e], as discussed below.

(i) Element 16[c] – Add ports for added channels

109. Element 16[c] recites "one or more add ports for selected spectral channels to be added to said output multi-wavelength optical signal." Bouevitch labelled "IN ADD" (annotated as "C" in *Id.*, Fig. 11-Annotation 1, above). (*See* §§ VI(a)(iv), VI(e) (discussing element 1[b] and claim 6, above).) Bouevitch explains that the purpose of the add port is for allowing a selected subset of channels to be added to a multi-wavelength signal. Specifically, Bouevitch adds spectral channel λ_2 at the IN ADD port. (Ex. 1003 at 14:66-15:18.) Channel λ_2 is then added into the output multi-wavelength optical signal. (*Id.* at 14:66-15:18 (explaining addition of channel λ_2 entering at annotation "D" in Fig. 11-

Annotation 1 to another channel (λ_1), which together exit output port "C").)

(ii) Element 16[e] – Addition of channels from add ports

110. With respect to element 16[e] ("whereby said spectral channels from said add ports are selectively provided to said output port"), Bouevitch teaches that added channel λ_2 from the IN ADD port is selectively added to the final output channel that exits the "OUT EXPRESS" port (annotated as "E," in Fig. 11- Annotation 1, above). Depending on the orientation of MEMS mirror 52 in Fig. 11, the added channel λ_2 is either directed to the OUT EXPRESS port, or is reflected back along the same optical path to the ADD port from where it originated, thus dropping the channel. (Ex. 1003 at 14:38-15:18.)

N. Claim 17

111. Claim 17 is a method claim version of claim 1 with very minor additions. The preamble of claim 17 recites "A method of performing dynamic add and drop in a WDM optical network." Bouevitch describes a method for operating a "Configurable Optical Add/Drop Multiplexer (COADM)." (*See* § VI(a)(ii), above; Bouevitch, Ex. 1003, Abstract; *see also Id.*, 3:9-63, 5:15–20; 14:14-21; Figs. 1, 11.) The "dynamic" portion of this preamble is discussed below for element 17[c]. Bouevitch also describes WDM (wavelength division multiplexing) as the background of the Bouevitch invention, in which the COADM operates to add/drop different wavelengths that are multiplexed together in the input port. (*See*

Ex. 1003 at 1:18-30, 14:14-15:18; § VI(a).)

(i) Element 17[a] – Separating signal into channels

112. What is identified here as claim 17[a] recites "separating an input multi-wavelength optical signal into spectral channels." Bouevitch discloses this step at Figure 11, where diffraction grating 20 spatially separates combined channels $\lambda_1\lambda_2$ ("A" at Fig. 11-Annotation 2, above) into spatially-separated channels. (*See, e.g.*, § VI(a)(iv)(ii) (element 1[c]), above; Bouevitch, Ex. 1003 at annotation "B,"14:48-53, 8:10–22.)

(ii) Element 17[b] – Imaging channels

113. What is identified here as claim 17[b] recites "imaging each of said spectral channels onto a corresponding beam-deflecting element." Claim 21 confirms that one type of such "imaging" is focusing, by reciting "the method of claim 17, wherein said ***imaging comprises focusing*** said spectral channels onto said beam–deflecting elements." (Emphasis added.)

114. Bouevitch discloses this imaging step by using reflector 10 in Figure11-Annotation 3, above, to image (focus) each channel onto a corresponding MEMS mirror element. (See § VI(h)(claim 11)). The "Gaussian waist" is formed at the focus, further demonstrating the same condition.

(iii) Element 17[c] – Dynamic & continuous 2-axis control

115. What is identified here as claim 17[c] recites: "controlling dynamically

and continuously said beam-deflecting elements in two dimensions so as to combine selected ones of said spectral channels into an output multi- wavelength optical signal and to control the power of the spectral channels combined into said output multi-wavelength optical signal." The only substantive difference between claim 17[c] and claim 1[d] is the addition in 17[c] of "controlling ***dynamically*** and continuously." Thus, other than for "dynamically," the method step of claim 17[c] is disclosed by Bouevitch+Sparks for all the reasons discussed for claim 1[d], above. (*See* §VI(a)(iv)(iii).)

116. As for "dynamically" controlling the beam-deflecting mirrors, both Bouevitch and Sparks contemplate this manner of control. The plain and ordinary meaning of "dynamically" in the context of the '368 Patent is "during operation." (*See* Ex. 1001 at 3:22-23 (contrasting routing that is fixed during operation: "the [prior art] wavelength routing is intrinsically static, rendering it difficult to dynamically reconfigure these OADMs.")

117. Both Bouevitch and Sparks teach dynamic control during operation. Bouevitch's device can be used as a "dynamic gain equalizer and/or configurable add/drop multiplexer," which includes dynamic control of the mirrors that perform those actions. (*Id.*, 2:24-25.) Sparks teaches closed-loop 2-axis control (*Id.* at 4:39-47) which the PHOSITA would have understood to mean making adjustments to the deflection of the beam in response to real-time monitoring of the channel

power level.

O. Claim 18

118. Claim 18 recites "The method of claim 17, wherein said selected ones of said spectral channels comprises a subset of said spectral channels, such that other non-selected ones of said spectral channels are dropped from said output multi-wavelength optical signal." Claim 18 is substantively identical to apparatus claim 15, whereby "a subset of said spectral channels is directed to said drop ports," and is disclosed by Bouevitch+Sparks for the same reasons discussed for claim 15. (*See* § VI(k).) Bouevitch is directed to optical add/drop multiplexers involving dropping one subset of channels, adding others, and passing the resulting combination on through an output port. For example, Bouevitch describes selecting a subset of combined channels $\lambda_1\lambda_2$ (i.e., the subset λ_1) to pass through to the output, while the non-selected channel, λ_2, is dropped. (*See, e.g.*, §§ 0, VI(e).) Also, Sparks describes using selectively routing signals between input arrays and output arrays of fibers consistent with add and drop functionality. (Ex. 1004 at 4:33-38 and 59-67.)

P. Claim 19

119. Claim 19 recites "The method of claim 18, wherein said controlling comprises reflecting said non-selected ones of said spectral channels to one or more drop ports." Claim 19 is also substantively identical to apparatus claim 15,

where the beam-deflecting elements reflect a subset of their corresponding channels to one or more drop ports. Thus, claim 19 is disclosed by Bouevitch+Sparks for the same reasons as for claim 15. For example, if input channel is not selected for retention, it is reflected along a path where it exits the "OUT DROP" port in Bouevitch. (Ex. 1003 at 14:60-65, § VI(k), above.)

Q. Claim 20

120. Claim 20 recites "The method of claim 17 further comprising imaging other spectral channels onto other corresponding beam-deflecting elements, and controlling dynamically and continuously said other beam-deflecting elements so as to combine said other spectral channels with said selected ones of said spectral channels into said output multi-wavelength optical signal." The only limitations this dependent claim adds to the operations recited in parent claim 17 is imaging (focusing) "other channels" to "other beam-deflecting elements" to combine the resulting channels into one output signal.

121. In addition to the two channels and respective mirrors addressed for claim 17 (§ VI(n), above), Bouevitch discloses arbitrarily-sized ROADMS and explicitly discuss embodiments that process additional channels by selectively reflecting them to respective deflecting elements. (Ex. 1003 at 8:8-43 (discussing dropping λ_3, while passing through "the other 7 channels having central wavelengths λ_1-λ_2 and λ_4-λ_8."); *see also* Sparks, Ex. 1004 at 4:33-38 and 59-67

for switching beams between multiple input fibers and output fibers consistent with add/drop devices.)

122. In addition, it would be obvious to perform the add/drop steps of Bouevitch on additional spectral channels, as more channels provides additional (and desirable) capacity in a WDM system. (Ex. 1001 at 1:31-42.) Sparks further demonstrates multiple output multi-wavelength optical signals, by having a plurality of output ports. (Ex. 1004 at 4:33-38 and 59-67.) Bouevitch also discloses multiple input and output ports between which channels are selectively routed. (Ex. 1003 at 10:56-61.) Hence the devices of Bouevitch and Sparks perform the same function of being capable of switching multiple wavelength channels from an input port to multiple output ports.

R. Claim 21

123. Claim 21 recites "The method of claim 17, wherein said imaging comprises focusing said spectral channels onto said beam–deflecting elements." Claim 17[b] already recites "imaging each of said spectral channels onto a corresponding beam-deflecting element." And Bouevitch discloses the recited "imaging" by using reflector 10 in Figure 11-Annotation 3, above, to image (focus) each channel onto a corresponding MEMS mirror element. (*See, e.g., Sparks,* Ex. 1004 at 4:16-22 ("a focussing lens 12"), Fig. 1.)

S. Claim 22

124. Claim 22 recites "The method of claim 17 further comprising monitoring a power level in one or more of said selected ones of said spectral channels, and controlling an alignment between said input multi-wavelength optical signal and corresponding beam-deflecting elements in response to said monitoring." As extensively discussed above, both Bouevitch and Sparks concern switches that redirect (deflect) selected spectral channels to selected outputs of the switches by actuating reflective surfaces. As also discussed in connection claim 3 above, Sparks describes the use of a feedback loop to control alignment of the angle of a mirror to control intentional misalignment with an output port to regulate signal power. (*See, e.g.* Ex. 1004 at 4:29-32 and 46-65, Figs. 1 and 4.) Actuation of the mirror can be responsive to the monitored power of one or more selected spectral channels. (*Id.* at 2:48-65.) The movement of the mirror changes alignment (e.g., angular alignment) between the input path of a beam of the one or more spectral channel and the mirror. (*Id.* at 2:39-47; *see also* Fig. 1 showing mirrors 16, 26 moving relative to an input beam from fibre 2.) The reasons behind PHOSITA motivation for using the closed loop power control feature of Sparks in Bouevitch have been address previously (see e.g., §V and §VI(A) and (C) discussing claims 1 and 3.)

VIII. CONCLUSION

125. I reserve the right to offer opinions relevant to the invalidity of the '368

Patent claims at issue and/or offer testimony in support of the Declaration. 134. In signing this Declaration, I recognize that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case. If required, I will appear for cross- examination at an appropriate and convenient place and time.

126. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 28 U.S.C. § 1001.

Dated: Feb. 12, 2015

Respectfully submitted,

Sheldon McLaughlin

Sheldon McLaughlin