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(54) **METROLOGY SYSTEM**

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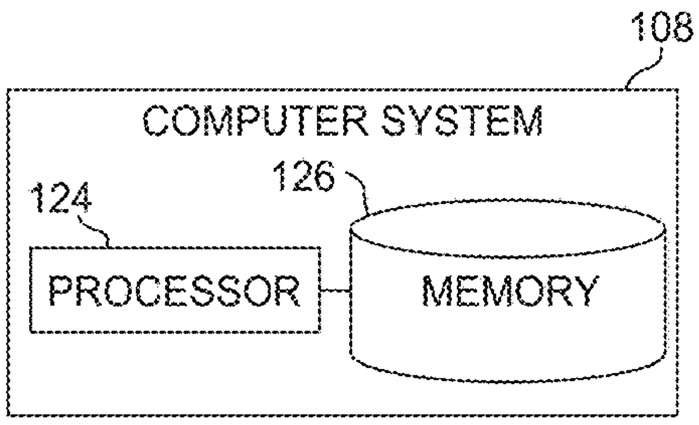
Publication Classification

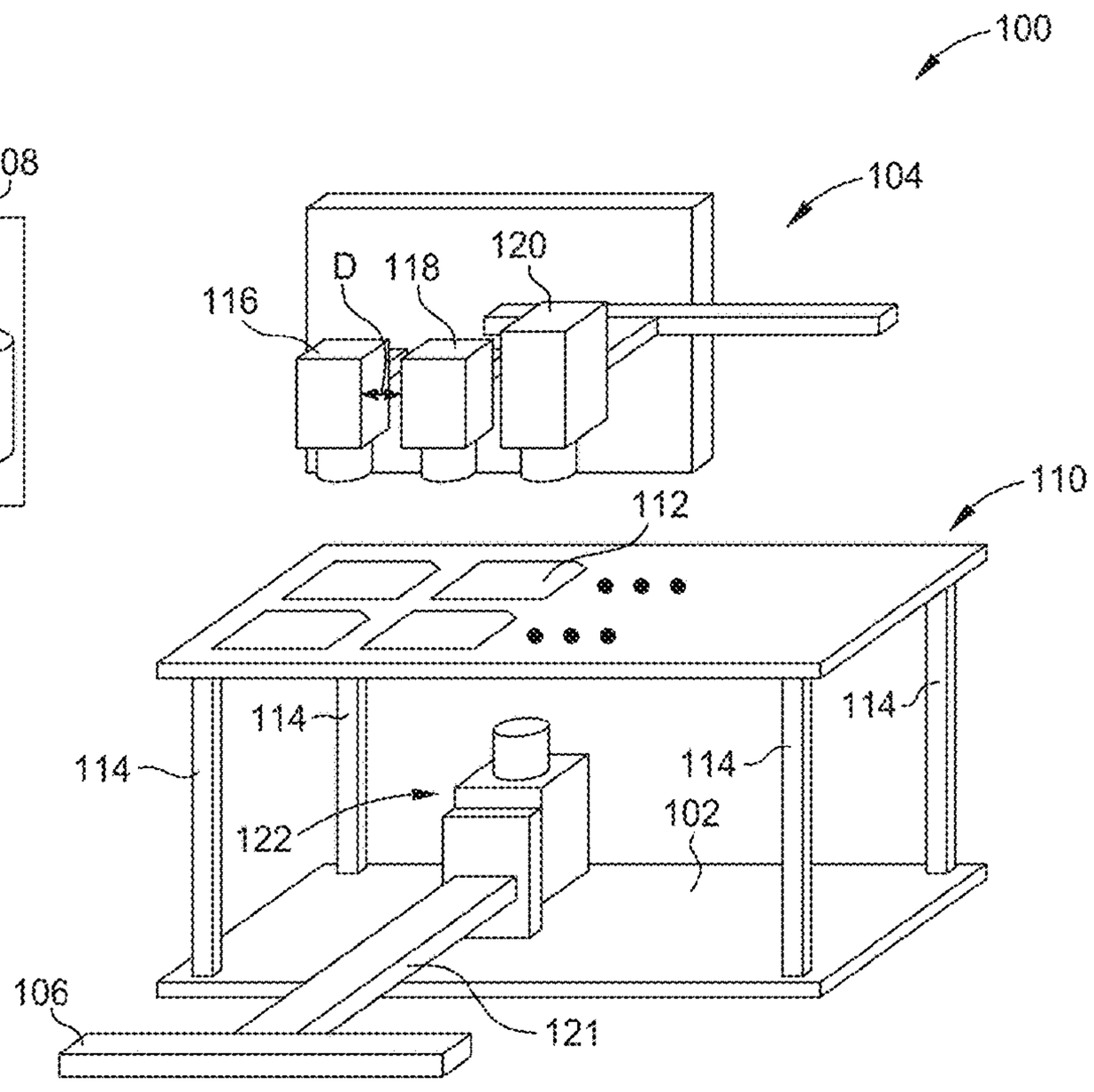
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CPC ***H04B 10/071*** (2013.01)

(57) **ABSTRACT**

The present disclosure describes a metrology system. The system includes a an optical source, a first sensor, and a second sensor. The optical source is positioned on a first side of an optical device held by a stage. The first sensor is positioned on the first side of the optical device. During a first mode, the first sensor detects a first optical signal from the optical source reflected from the optical device. During a second mode, the second sensor moves such that (i) the second sensor is positioned on a second side of the optical device opposite the first side of the optical device and (ii) the second sensor detects a second optical signal from the optical source transmitted through the optical device.





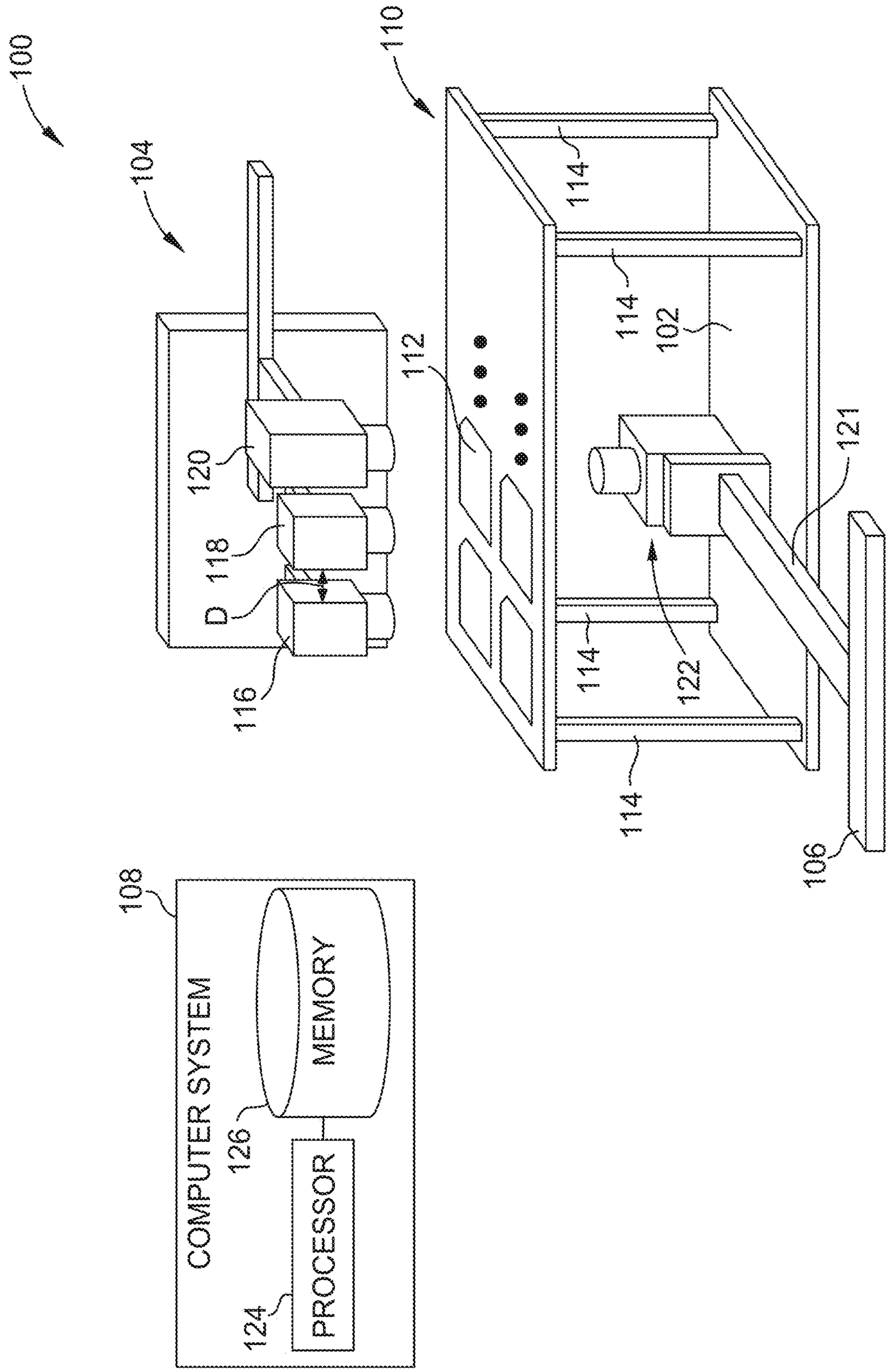

100
104
110
114
114
102
112
120
D
118
116
121
114
122
114
106
108
COMPUTER SYSTEM
126
MEMORY
124
PROCESSOR

FIG. 1

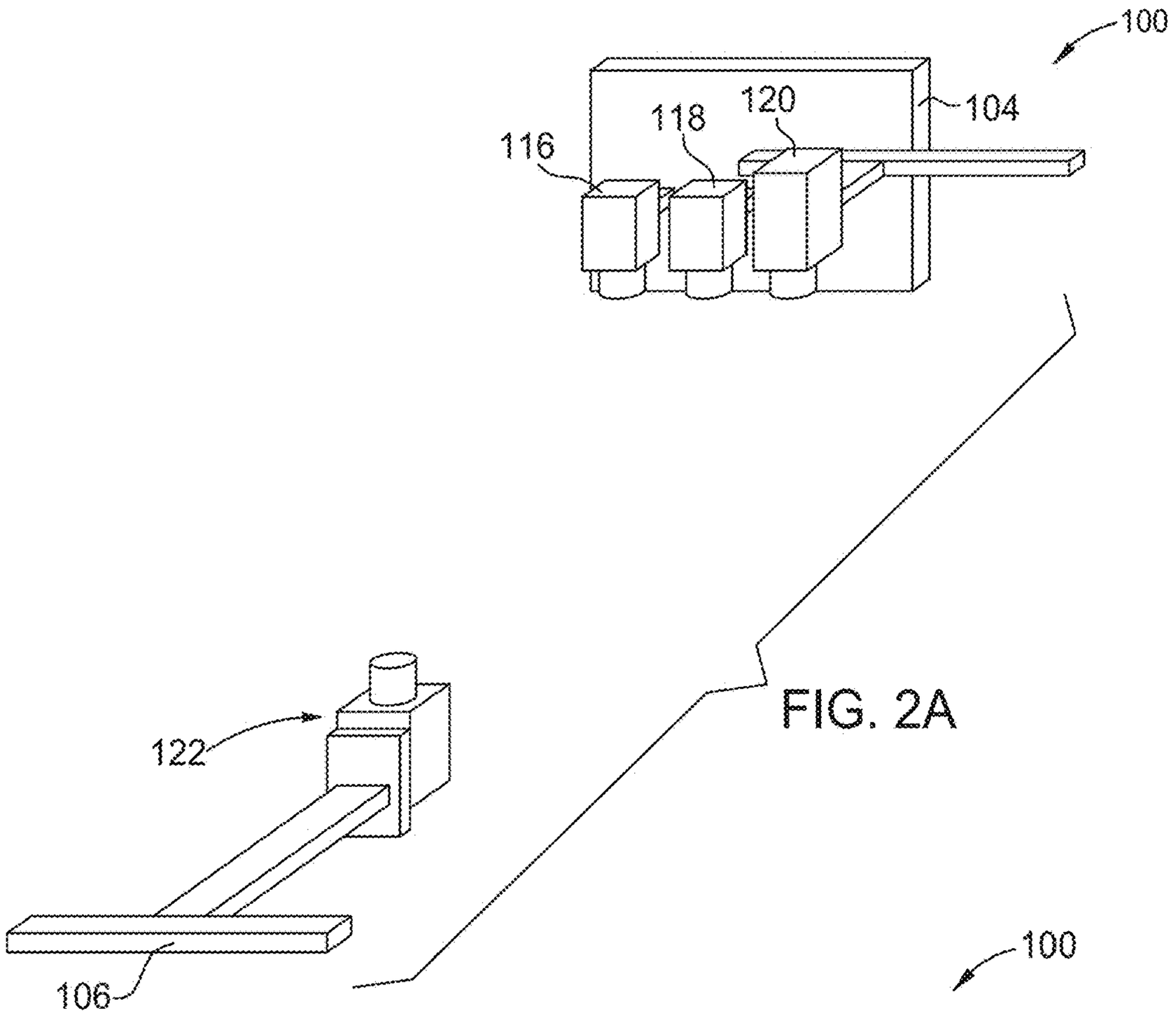

100
104
120
118
116
122
106

FIG. 2A

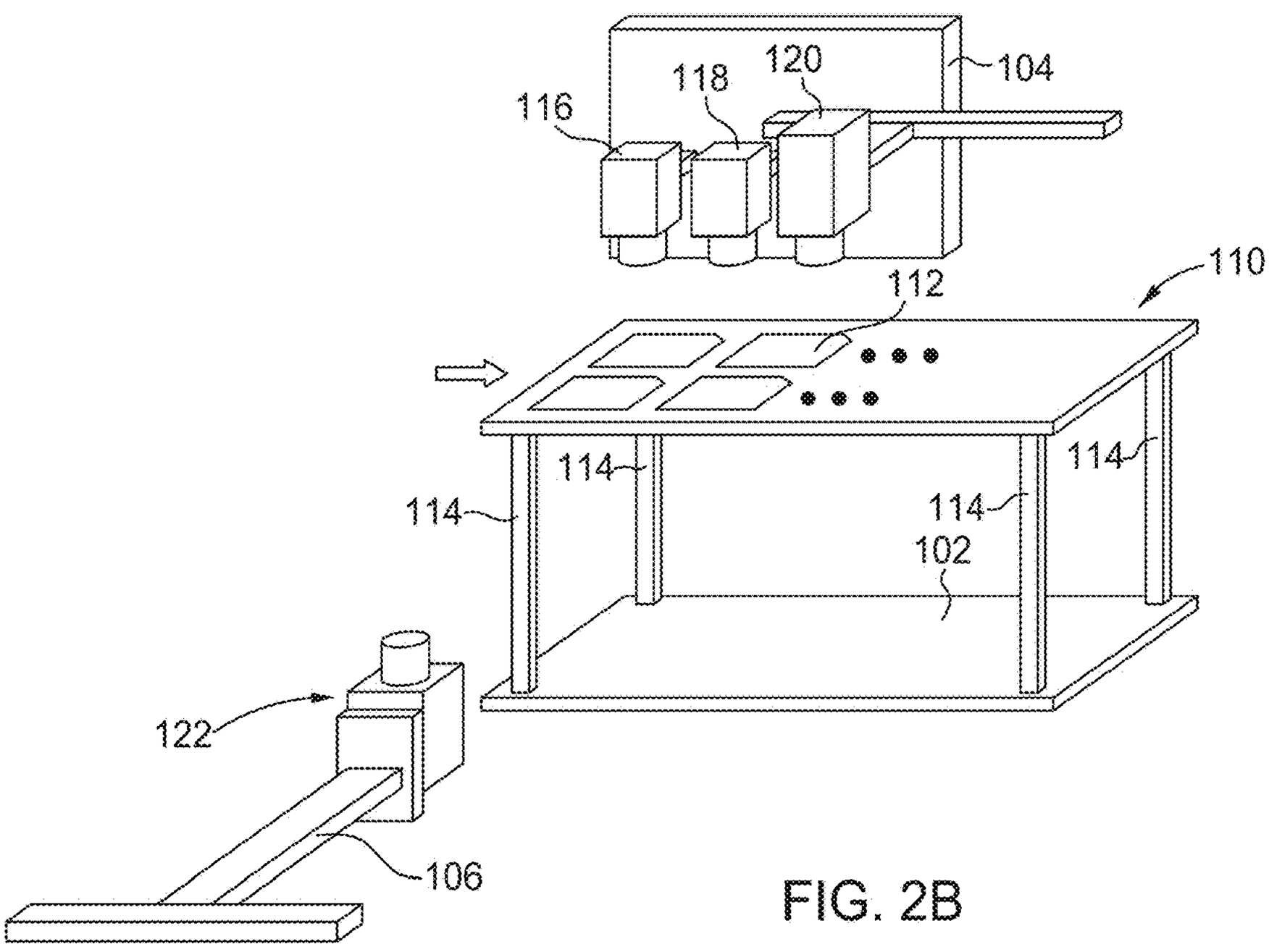

100
104
120
118
116
110
112
114
114
114
114
102
122
106

FIG. 2B

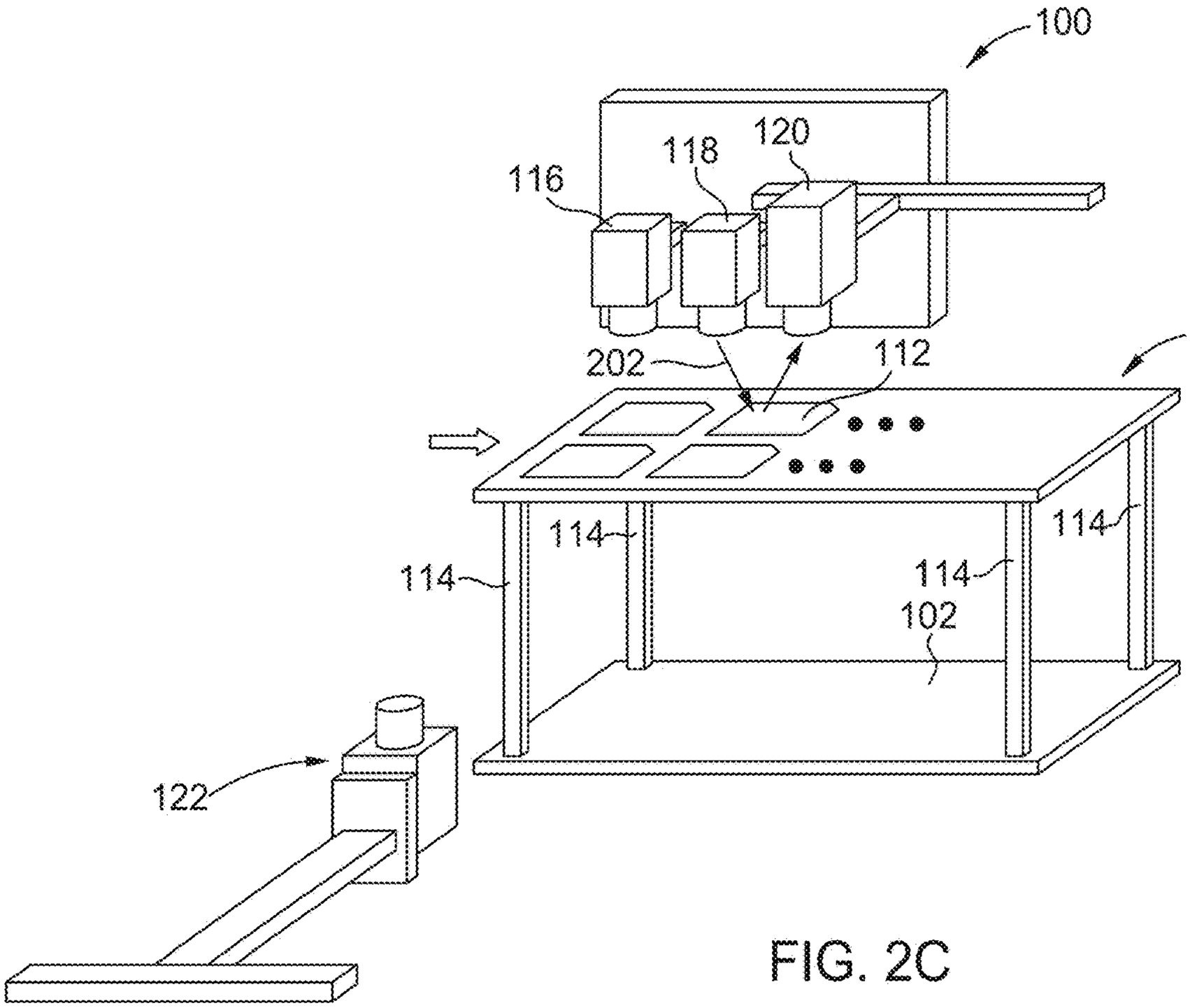

100
116
118
120
110
202
112
114
114
114
114
102
122

FIG. 2C

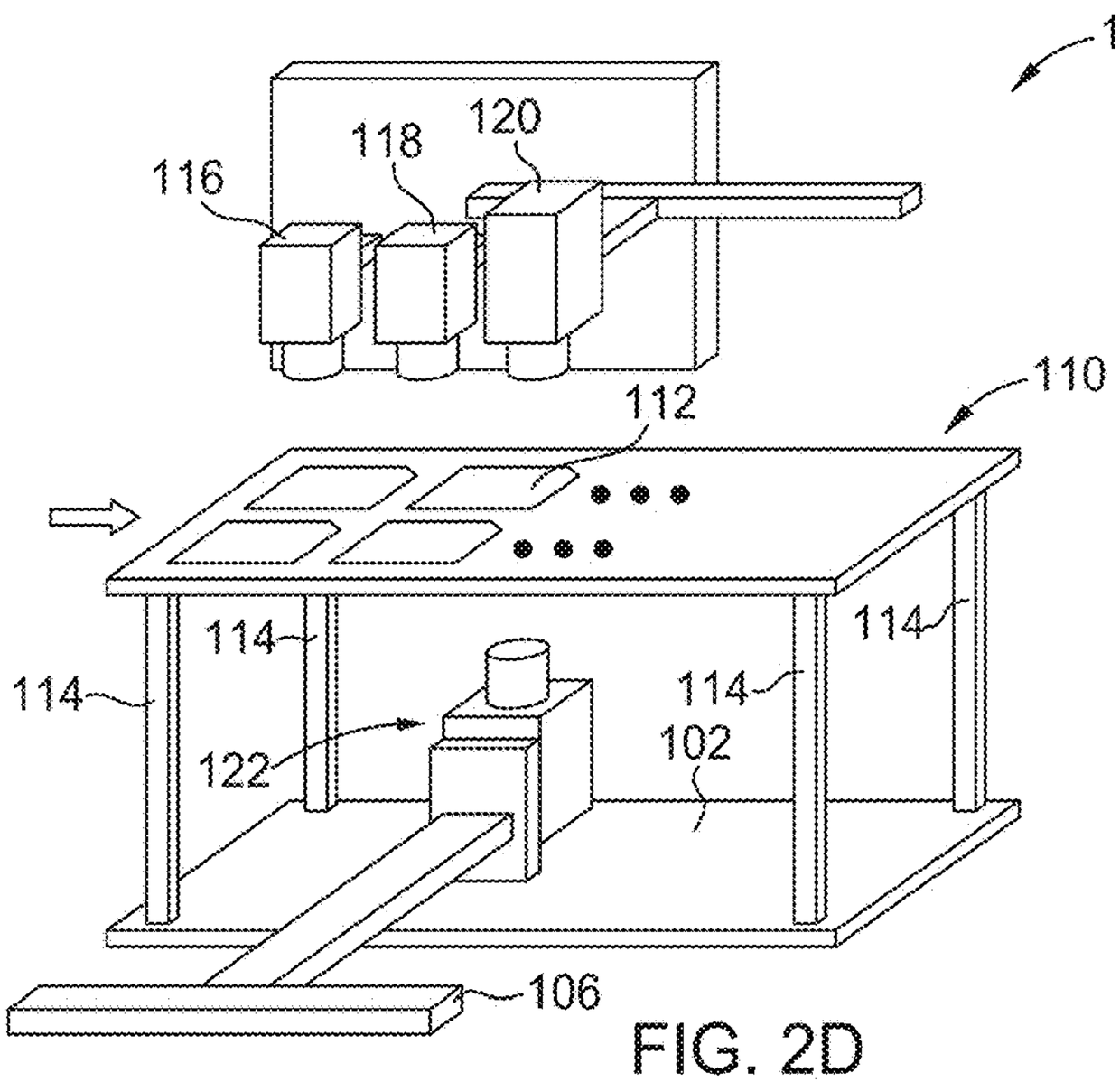

100
118
120
116
110
112
114
114
114
114
122
102
106

FIG. 2D

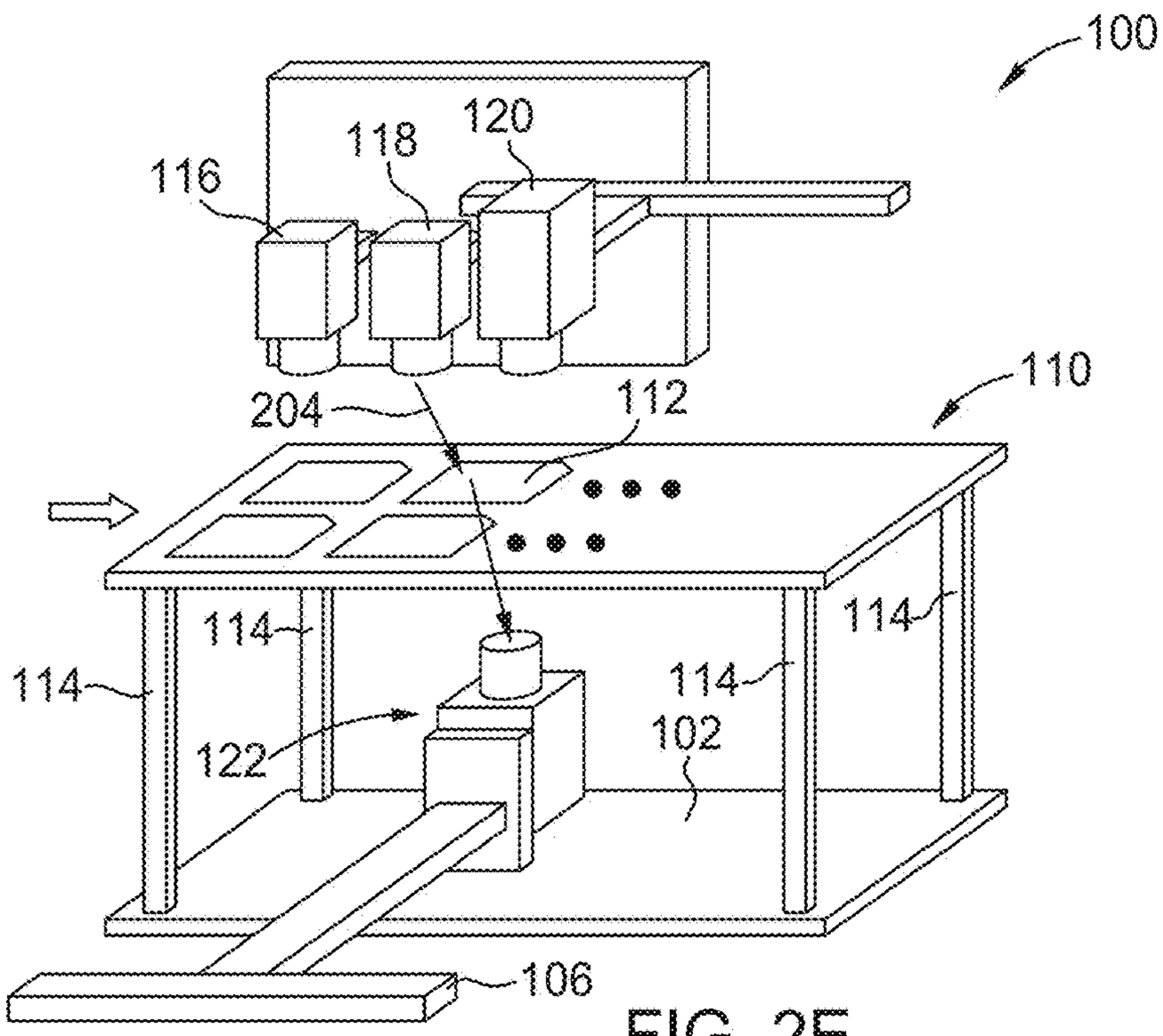

100
116
118
120
110
204
112
114
114
114
114
122
102
106

FIG. 2E

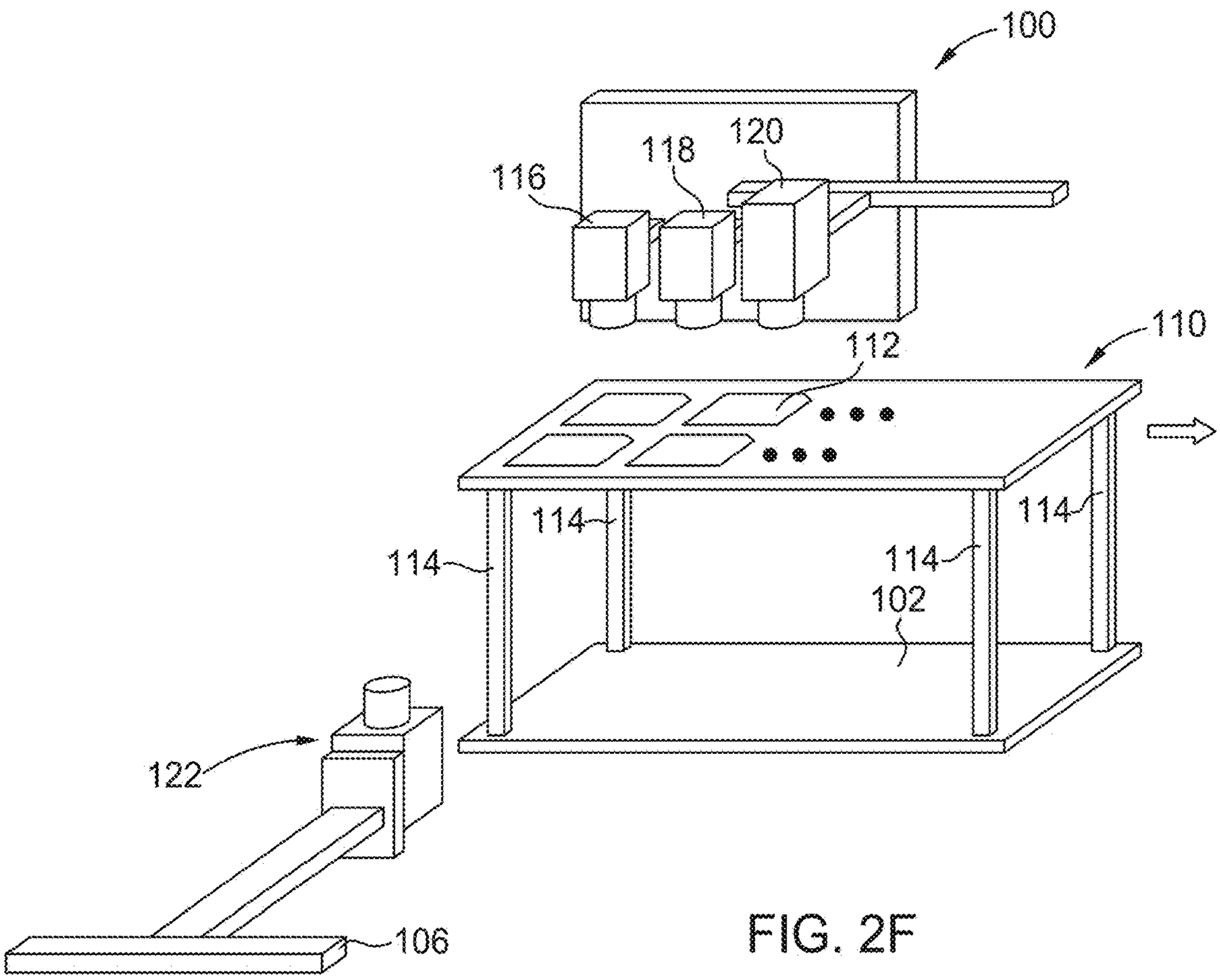

100
116
118
120
110
112
114
114
114
114
102
122
106

FIG. 2F

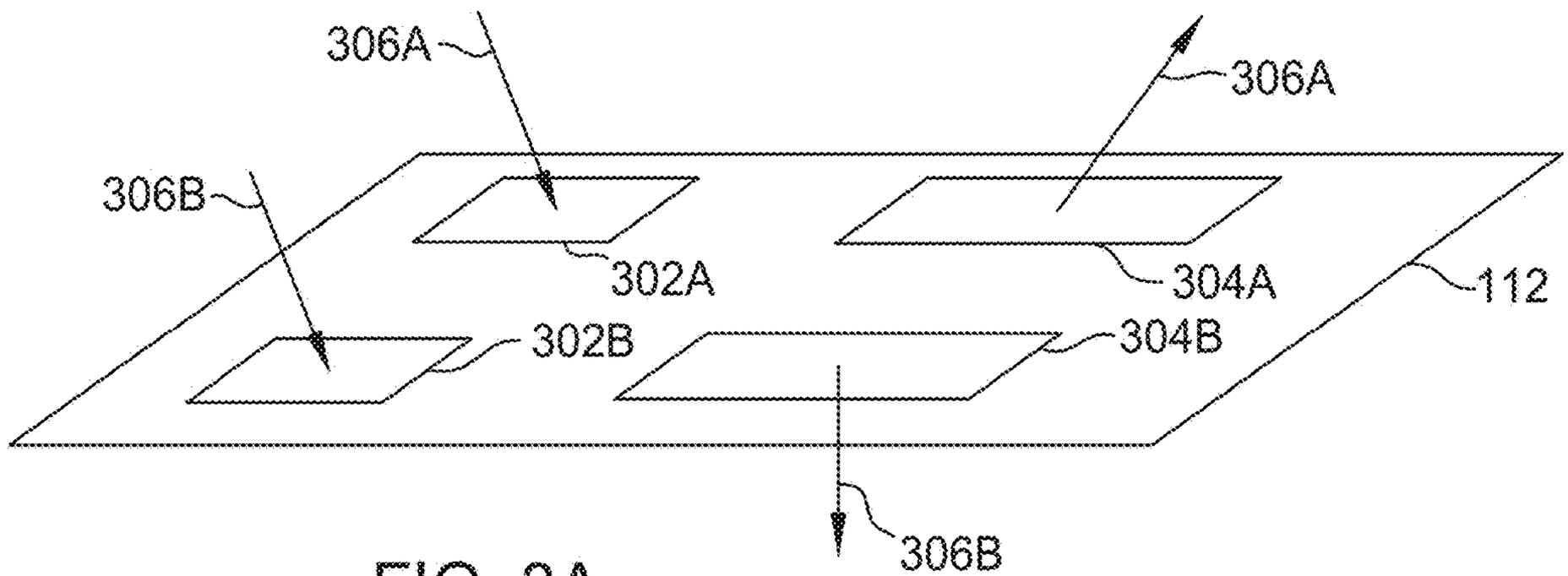

306A
306A
306B
302A
304A
112
302B
304B
306B

FIG. 3A

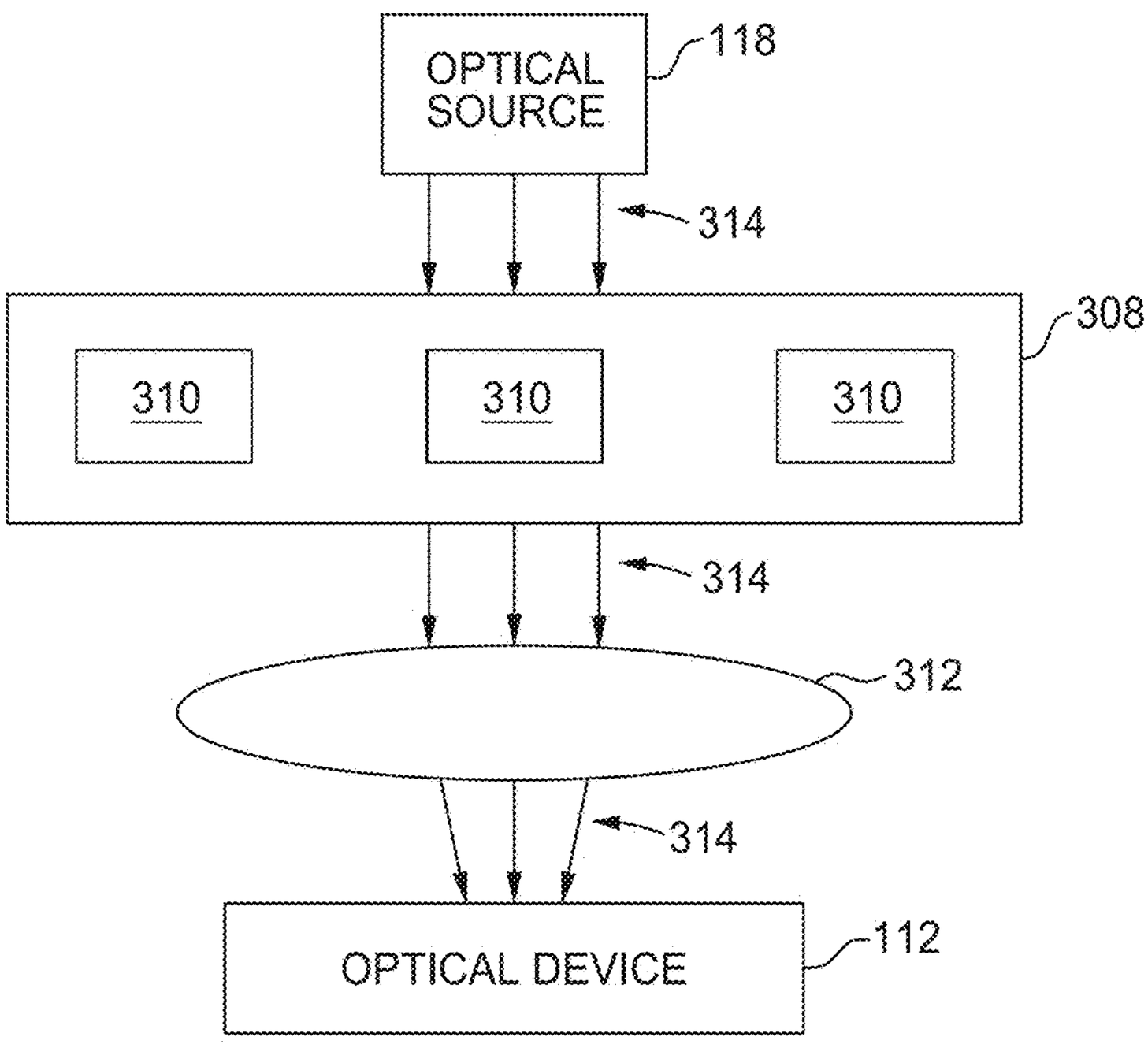

OPTICAL SOURCE
118
314
308
310
310
310
314
312
314
OPTICAL DEVICE
112

FIG. 3B

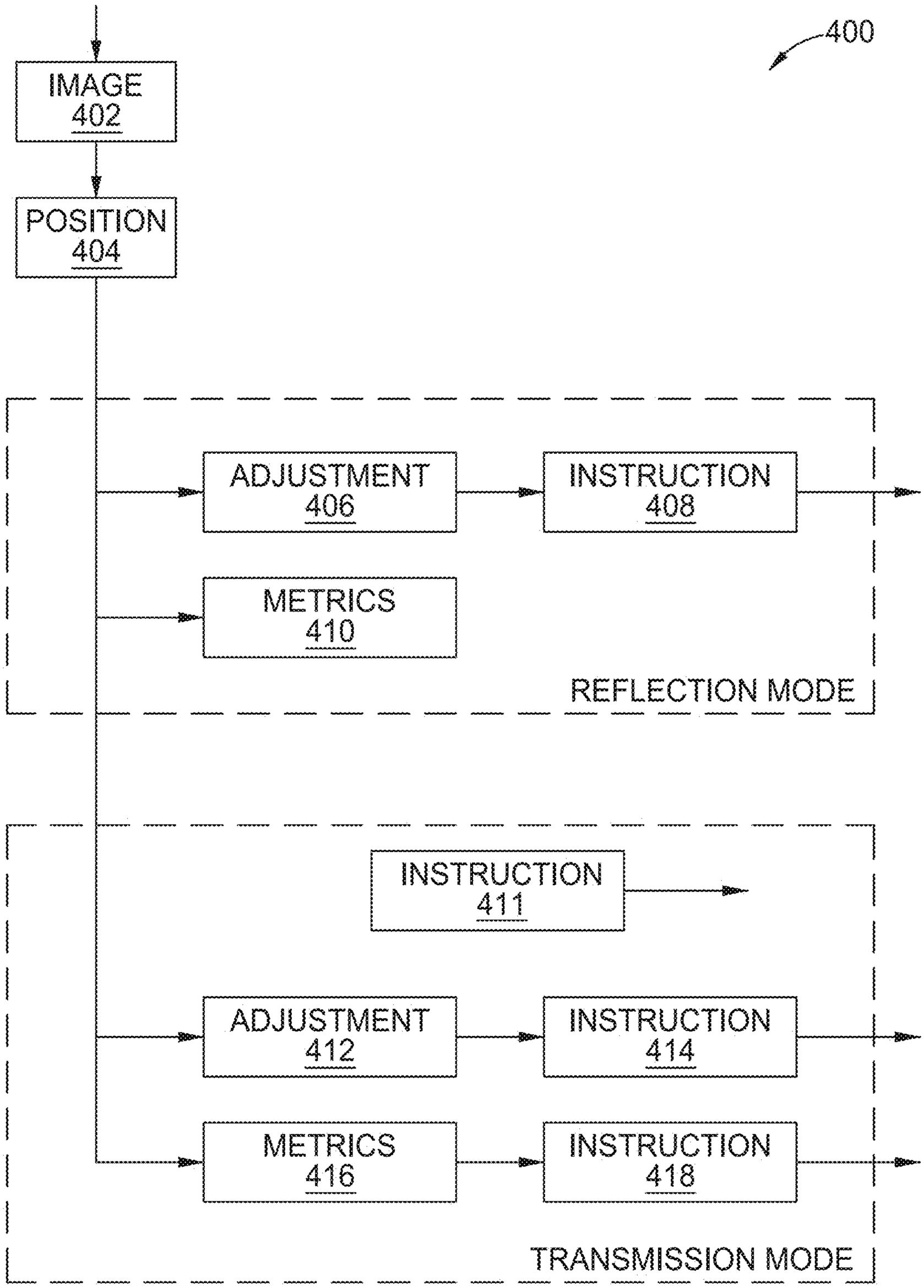

400
IMAGE
402
POSITION
404
ADJUSTMENT
406
INSTRUCTION
408
METRICS
410
REFLECTION MODE
INSTRUCTION
411
ADJUSTMENT
412
INSTRUCTION
414
METRICS
416
INSTRUCTION
418
TRANSMISSION MODE

FIG. 4

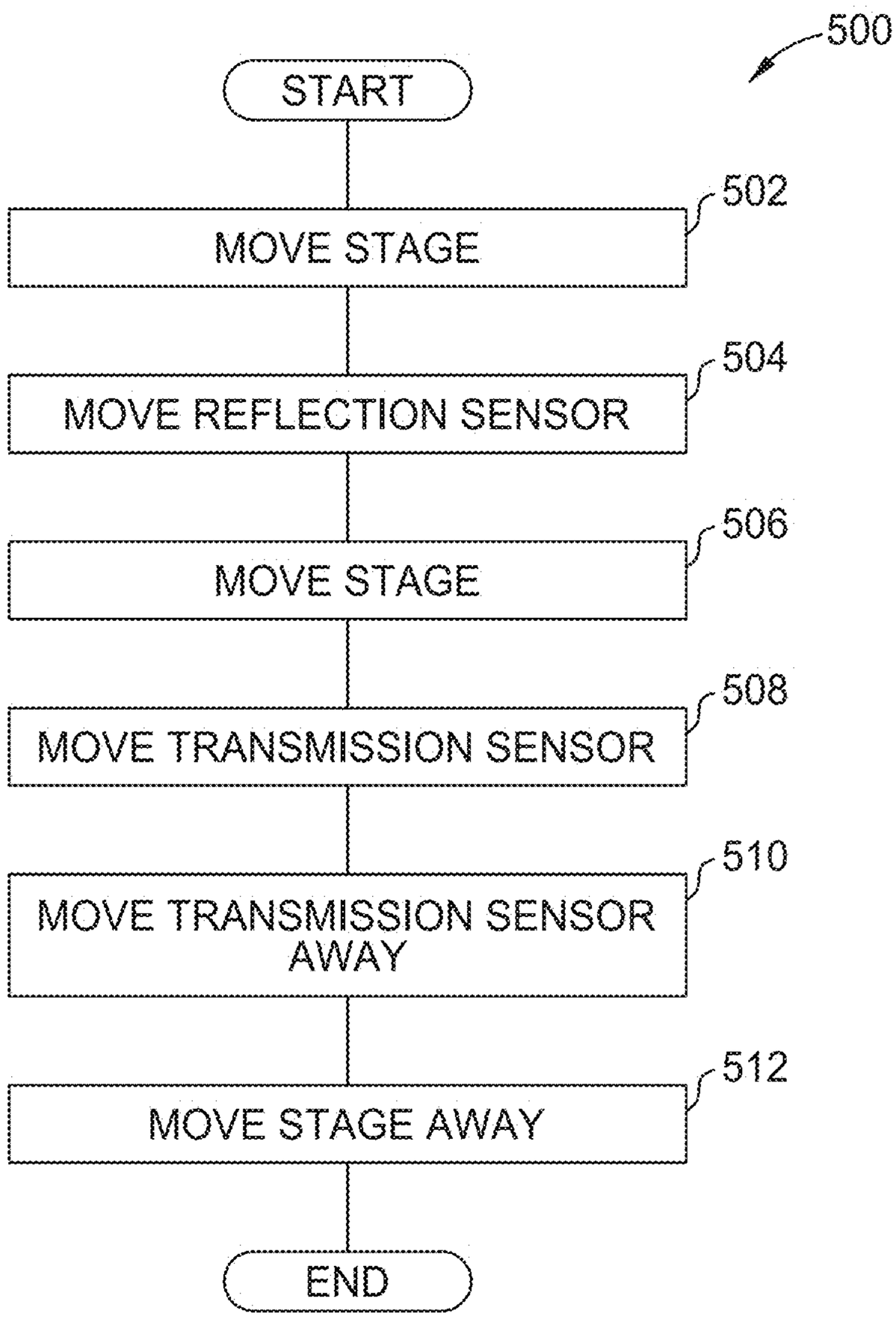

500
START
502
MOVE STAGE
504
MOVE REFLECTION SENSOR
506
MOVE STAGE
508
MOVE TRANSMISSION SENSOR
510
MOVE TRANSMISSION SENSOR AWAY
512
MOVE STAGE AWAY
END

FIG. 5

METROLOGY SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This Application claims the benefit of U.S. Provisional Application 63/706,932 filed on Oct. 14, 2024, which is incorporated by reference in its entirety.

BACKGROUND

Field

[0002] Embodiments of the present disclosure generally relate to optical devices for augmented, virtual, and mixed reality. More specifically, embodiments described herein relate to a metrology system for measuring these optical devices.

Description of the Related Art

[0003] Virtual reality is generally considered to be a computer generated simulated environment in which a user has an apparent physical presence. A virtual reality experience can be generated in 3D and viewed with a head-mounted display (HMD), such as glasses or other wearable display devices that have near-eye display panels as lenses to display a virtual reality environment that replaces an actual environment.

[0004] Augmented reality provides an experience in which a user can still see through the display lenses of the glasses or other HMD device to view the surrounding environment, yet also see images of virtual objects that are generated for display and appear as part of the environment. Augmented reality can include any type of input, such as audio and haptic inputs, as well as virtual images, graphics, and video that enhances or augments the environment that the user experiences. As an emerging technology, there are many challenges and design constraints with augmented reality.

[0005] One such challenge is measuring optical devices (e.g., the display lenses of the glasses) for image quality standards. To determine whether image quality standards are met, metrology metrics of the fabricated optical devices may be measured using a metrology system.

SUMMARY

[0006] The present disclosure describes a metrology system. The system includes a an optical source, a first sensor, and a second sensor. The optical source is positioned on a first side of an optical device held by a stage. The first sensor is positioned on the first side of the optical device. During a first mode, the first sensor detects a first optical signal from the optical source reflected from the optical device. During a second mode, the second sensor moves such that (i) the second sensor is positioned on a second side of the optical device opposite the first side of the optical device and (ii) the second sensor detects a second optical signal from the optical source transmitted through the optical device.

[0007] According to another embodiment, a method includes, during a first mode, directing, by an optical source positioned on a first side of an optical device held by a stage, a first optical signal towards the optical device, and detecting, by the first sensor, the first optical signal from the optical source reflected from the optical device. The method further includes, during a second mode, directing, by the optical source, a second optical signal towards the optical device and moving a second sensor such that (i) the second sensor is positioned on a second side of the optical device opposite the first side of the optical device and (ii) the second sensor detects the second optical signal from the optical source transmitted through the optical device.

[0008] According to another embodiment, a non-transitory computer readable medium stores instructions that, when executed by one or more processors, causes the one or more processors to, individually or collectively, during a first mode, direct, by an optical source positioned on a first side of an optical device held by a stage, a first optical signal towards the optical device, and detect, by the first sensor, the first optical signal from the optical source reflected from the optical device. The instructions further cause the one or more processors to, individually or collectively, during a second mode, direct, by the optical source, a second optical signal towards the optical device and move a second sensor such that (i) the second sensor is positioned on a second side of the optical device opposite the first side of the optical device and (ii) the second sensor detects the second optical signal from the optical source transmitted through the optical device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the disclosure, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only exemplary embodiments and are therefore not to be considered limiting of its scope, and may admit to other equally effective embodiments.

[0010] FIG. **1** illustrates a metrology system;

[0011] FIGS. **2**A through **2**F illustrate an example operation of the metrology system of FIG. **1**.

[0012] FIG. **3**A illustrates an example optical device in the metrology system of FIG. **1**.

[0013] FIG. **3**B illustrates an example portion of the metrology system of FIG. **1**.

[0014] FIG. **4** illustrates an example operation performed by the metrology system of FIG. **1**.

[0015] FIG. **5** is a flowchart of an example method performed by the metrology system of FIG. **1**.

[0016] To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. It is contemplated that elements and features of one embodiment may be beneficially incorporated in other embodiments without further recitation.

DETAILED DESCRIPTION

[0017] A metrology system may be used to measure metrology metrics of optical devices (e.g., glass lenses) to determine whether the optical devices meet image quality standards. In existing implementations, separate metrology systems are used to measure transmission metrics that indicate how optical signals transmit through an optical device and to measure reflection metrics that indicate how optical signals reflect off the optical device. Separate metrology systems, however, occupy a large area and typically,

complex structures are used to move optical devices between the separate metrology systems.

[0018] The present disclosure describes a metrology system that measures both transmission metrics and reflection metrics. The metrology system includes a first sensor that detects optical signals reflected off an optical device. In a first mode (which may be referred to as a reflection mode), the optical device may be moved into position such that the first sensor is positioned on a first side of the optical device (e.g., above the optical device), and an optical source directs an optical signal towards the optical device. The optical signal reflects off the optical device, and the system moves the first sensor to detect the optical signal and to measure reflection metrics. A second mode (which may be referred to as a transmission mode) begins after the first mode. The system moves a second sensor that detects optical signals transmitted through the optical device such that the second sensor is positioned on a second side of the optical device (e.g., beneath the optical device). The optical source directs an optical signal towards the optical device, and the optical signal passes through the optical device. They system moves the second sensor to detect the optical signal and to measure transmission metrics. After the second mode concludes, the system moves the second sensor away from the optical device so that the optical device may be moved away or out of the system.

[0019] In certain embodiments, the system provides several technical advantages. For example, the system measures both reflection metrics and transmission metrics. As a result, the system occupies less area than a set of multiple systems that measure reflection metrics and/or transmission metrics. As another example, the system may reduce the amount of time it takes to measure reflection metrics and transmission metrics by removing the need to shuttle optical devices between multiple systems that measure reflection metrics and/or transmission metrics.

[0020] FIG. **1** illustrates an example metrology system **100**. As seen in FIG. **1**, the metrology system includes a stage **102**, an upper portion **104**, a bottom portion **106**, and a computer system **108**. Generally, the metrology system **100** measures both reflection metrics and transmission metrics of optical devices (e.g., lenses for augmented reality systems). For example, the metrology system **100** may measure or determine angular uniformity, contrast, efficiency, color uniformity, modulation transfer function curve, field of view, ghost images, eye box, display leakage, and/or see through test metrics for an optical device.

[0021] The stage **102** holds or elevates optical devices. As seen in FIG. **1**, the stage **102** supports a tray **110**. In some embodiments, the stage **102** supports a wafer instead of or in addition to the tray **110**. Multiple optical devices **112** are positioned on the tray **110**. These optical devices **112** may be lenses for augmented reality and/or virtual reality systems. The stage **102** includes columns **114** that elevate the tray **110** and that create a space between the tray **110** and a bottom surface of the stage **102**. During operation, the system **100** may move the stage **102** to position the optical devices **112** relative to the upper portion **104** and/or the bottom portion **106**. The system **100** may also move the stage **102** to shuttle the optical devices **112** into and out of the metrology system **100**. In some instances, the stage **102** is considered to hold the optical devices **112** when the optical devices **112** are supported by the tray **110**.

[0022] The upper portion **104** is positioned on a first side of the optical devices **112** (e.g., above the optical devices **112**). As seen in FIG. **1**, the upper portion **104** includes an alignment camera **116**, an optical source **118**, and a sensor **120**. The alignment camera **116** and the optical source **118** may be laterally separated by a distance D. In some embodiments, the distance D between the alignment camera **116** and the optical source **118** is fixed and known by the system **100**.

[0023] The alignment camera **116** captures images of the optical devices **112**, and the system **100** may use these images to position the optical devices **112** relative to the upper portion **104** and/or the bottom portion **106**. For example, these images may be used to position the optical devices **112** so that the optical device **112** directs optical signals towards the optical devices **112**. In some embodiments, the optical devices **112** include fiducials (e.g., markings, slits, etc.). The images of the optical devices **112** show these fiducials, and the metrology system **100** uses the fiducials to determine how to move (e.g., translate, rotate, etc.) the stage **102** to properly position the optical devices **112** for the upper portion **104** and/or the bottom portion **106**.

[0024] In some embodiments, the metrology system **100** uses the distance D between the alignment camera **116** and the optical source **118** to determine how to properly position the optical device **112**. For example, the metrology system **100** may determine the positioning of the optical device **112** relative to the alignment camera **116** using the images from the alignment camera **116**. The metrology system **100** then uses the distance D to determine how to position the optical device **112** relative to the alignment camera **116** such that an optical signal from the optical source **118** reaches the optical device **112**. The metrology system **100** then moves the stage **102** to reposition the optical device **112**.

[0025] The optical source **118** produces and directs optical signals towards the optical devices **112**. By adjusting the position or orientation of an optical device **112** relative to the optical source **118** (e.g., by moving the stage **102**), the metrology system **100** may control whether an optical signal from the optical source **118** reflects off the optical device **112** or transmits through the optical device **112**.

[0026] The sensor **120** may detect optical signals that reflect off the optical device **112**. For example, the metrology system **100** may move the sensor **120** until the sensor **120** detects the optical signal produced by the optical source **118** and reflecting off the optical device **112**. The metrology system **100** may then analyze the signals from the sensor **120** to determine reflection metrics for the optical device **112**.

[0027] The bottom portion **106** includes an arm **121** and a sensor **122** attached to the arm **121**. Generally, after the metrology system **100** measures the reflection metrics using the sensor **120**, the metrology system **100** moves the arm **121** to position the sensor **122** on a second side of the optical device **112** (e.g., beneath the optical device **112**). As seen in FIG. **1**, the metrology system **100** may move the arm **121** such that the sensor **122** is positioned between the stage **102** and the optical device **112**. The metrology system **100** may also move the stage **102** to position or orient the optical device **112** such that the optical device **112** transmits an optical signal produced by the optical source **118** and directed towards the optical device **112**.

[0028] The metrology system **100** then moves the sensor **122** (e.g., by moving the arm **121**) so that the sensor **122** detects the optical signal produced by the optical source **118** and transmitted through the optical device **112**. The metrol-

ogy system **100** may then analyze the signals from the sensor **122** to determine transmission metrics for the optical device **112**. After the metrology system **100** measures the transmission metrics using the sensor **122**, the metrology system **100** moves the arm **121** away from the optical device **112** and the stage **102** such that the bottom portion **106** does not collide with one or more of the columns **114** when the metrology system **100** moves the stage **102** and the optical device **112** away from or out of the metrology system **100**. After the metrology system **100** moves the stage **102** and the optical device **112** away from or out of the metrology system **100**, the metrology system **100** may move another stage elevating additional optical devices into the metrology system **100** for measurement.

[0029] The computer system **108** controls the operation of the metrology system **100**. For example, the computer system **108** may control the movement of the stage **102**, the sensor **120**, and/or the sensor **122**. As seen in FIG. **1**, the computer system **108** includes a processor **124** and a memory **126**, which perform the functions or features of the computer system **108** described herein.

[0030] The processor **124** is any electronic circuitry, including, but not limited to one or a combination of microprocessors, microcontrollers, application specific integrated circuits (ASIC), application specific instruction set processor (ASIP), and/or state machines, that communicatively couples to the memory **126** and controls the operation of the computer system **108**. The processor **124** may be 8-bit, 16-bit, 32-bit, 64-bit or of any other suitable architecture. The processor **124** may include an arithmetic logic unit (ALU) for performing arithmetic and logic operations, processor registers that supply operands to the ALU and store the results of ALU operations, and a control unit that fetches instructions from memory and executes them by directing the coordinated operations of the ALU, registers and other components. The processor **124** may include other hardware that operates software to control and process information. The processor **124** executes software stored on the memory **126** to perform any of the functions described herein. The processor **124** controls the operation and administration of the computer system **108** by processing information (e.g., information received from the alignment camera **116**, sensor **120**, sensor **122**, and memory **126**). The processor **124** is not limited to a single processing device and may encompass multiple processing devices contained in the same device or computer or distributed across multiple devices or computers. The processor **124** is considered to perform a set of functions or actions if the multiple processing devices collectively perform the set of functions or actions, even if different processing devices perform different functions or actions in the set.

[0031] The memory **126** may store, either permanently or temporarily, data, operational software, or other information for the processor **124**. The memory **126** may include any one or a combination of volatile or non-volatile local or remote devices suitable for storing information. For example, the memory **126** may include random access memory (RAM), read only memory (ROM), magnetic storage devices, optical storage devices, or any other suitable information storage device or a combination of these devices. The software represents any suitable set of instructions, logic, or code embodied in a computer-readable storage medium. For example, the software may be embodied in the memory **126**, a disk, a CD, or a flash drive. In particular embodiments, the software may include an application executable by the processor **124** to perform one or more of the functions described herein. The memory **126** is not limited to a single memory and may encompass multiple memories contained in the same device or computer or distributed across multiple devices or computers. The memory **126** is considered to store a set of data, operational software, or information if the multiple memories collectively store the set of data, operational software, or information, even if different memories store different portions of the data, operational software, or information in the set.

[0032] FIGS. **2**A through **2**F illustrate an example operation of the metrology system **100** of FIG. **1**. As seen in FIG. **2**A, the metrology system **100** begins with the bottom portion **106** moved away from the upper portion **104** such that there is a gap into which a stage elevating an optical device may move. As seen in FIG. **2**B, the metrology system **100** moves a stage **102** into the gap. The stage **102** elevates a tray **110** and an optical device **112**, and the upper portion **104** is positioned above the optical device **112**. The alignment camera **116** may capture an image of the optical device **112**. The metrology system **100** may use the image to determine how to position the optical device **112** such that an optical signal from the optical source **118** is directed at the optical device **112** and such that the optical device **112** reflects the optical signal. In some embodiments, the metrology system **100** also uses the distance between the alignment camera **116** and the optical source **118** to determine how to position the optical device **112**. The metrology system **100** then moves (e.g., translates, rotates, etc.) the stage **102** to position the optical device **112**.

[0033] As seen in FIG. **2**C, the optical source **118** directs an optical signal **202** towards the optical device **112**, and the optical signal **202** reflects off the optical device **112**. The metrology system **100** moves the sensor **120** such that the sensor **120** detects the optical signal **202** reflecting off the optical device **112**. The metrology system **100** then analyzes the signals from the sensor **120** to determine reflection metrics for the optical device **112**.

[0034] As seen in FIG. **2**D, after the metrology system **100** finishes sensing reflected signals from the optical device **112**, the metrology system **100** may move the bottom portion **106** towards the stage **102** and/or the optical device **112**. By moving the bottom portion **106**, the metrology system **100** positions the sensor **122** beneath the optical device **112** and between the optical device **112** and the stage **102**. In some embodiments, the metrology system **100** moves the bottom portion **106** and/or the sensor **122** beneath the optical device **112** between the optical device **112** and the stage **102** before the metrology system **100** finishes sensing reflected signals from the optical device **112**.

[0035] The metrology system **100** may determine from the images from the alignment camera **116** of the optical device **112** how to position the optical device **112** such that the optical device **112** transmits optical signals from the optical source **118**. The metrology system **100** then moves (e.g., translates, rotates, etc.) the stage **102** and/or the optical device **112** into that position.

[0036] As seen in FIG. **2**E, the metrology system **100** then directs an optical signal **204** from the optical source **118** to the optical device **112**. The optical signal **204** transmits through the optical device **112** and towards the sensor **122**. The metrology system **100** may move the bottom portion **106** and/or the sensor **122** so that the sensor **122** detects the

optical signal **204** transmitting through the optical device **112**. The metrology system **100** then analyzes the signals from the sensor **122** to determine transmission metrics for the optical device **112**.

[0037] As seen in FIG. **2**F, after the metrology system **100** finishes sensing transmitted signals through the optical device **112**, the metrology system **100** may move the bottom portion **106** and/or the sensor **122** away from the stage **102** and/or the optical device **112**. In this manner, the sensor **122** is no longer positioned between the stage **102** and the optical device **112**. Additionally, the bottom portion **106** is cleared away from the stage **102**. The metrology system **100** then moves the stage **102** away from or out of the metrology system **100**. In the example of FIG. **2**E, the metrology system **100** moves the stage **102** to the right. If the metrology system **100** had not moved the bottom portion **106** away from the stage **102** and/or the optical device **112**, the bottom portion **106** would have collided with one or more of the columns **114**, which would have prevented the metrology system **100** from moving the stage **102** away from or out of the metrology system **100**. By moving the bottom portion **106** towards and away from the stage **102**, the metrology system **100** can measure both reflection metrics and transmission metrics rather than using separate systems to measure reflection metrics and transmission metrics.

[0038] FIG. **3**A illustrates an example optical device **112** in the metrology system **100** of FIG. **1**. As seen in FIG. **3**A, the optical device **112** includes optical couplers **302** (which may be referred to as in-couplers) and optical couplers **304** (which may be referred to as out-couplers). The optical device **112** may include any number of optical couplers **302** and **304**. In the example of FIG. **3**A, the optical device **112** includes the optical couplers **302**A, **302**B, **304**A, and **304**B.

[0039] When an optical signal **306**A is directed at the optical coupler **302**A (which may be referred to as a reflection in-coupler), the optical coupler **302**A directs the optical signal **306**A through the optical device **112** and out the optical coupler **304**A (which may be referred to as a reflection out-coupler). If the optical signal **306**A approaches the optical coupler **302**A from above the optical device **112**, the optical coupler **304**A directs the optical signal **306**A away and above the optical device **112**. In this manner, the optical couplers **302**A and **304**A reflect the optical signal **306**A. For example, when the optical source of the metrology system **100** directs an optical signal to the optical coupler **302**A, the optical device **112** redirects the optical signal out of the optical coupler **304**A and towards the reflection sensor in the upper portion of the metrology system **100**.

[0040] When an optical signal **306**B is directed at the optical coupler **302**B (which may be referred to as a transmission in-coupler), the optical coupler **302**B directs the optical signal **306**B through the optical device **112** and out the optical coupler **304**B (which may be referred to as a transmission out-coupler). If the optical signal **306**B approaches the optical coupler **302**B from above the optical device **112**, the optical coupler **304**B directs the optical signal **306**B away and below the optical device **112**. In this manner, the optical couplers **302**B and **304**B transmit the optical signal **306**B. For example, when the optical source of the metrology system **100** directs an optical signal to the optical coupler **302**B, the optical device **112** redirects the optical signal out of the optical coupler **304**B and towards the transmission sensor in the bottom portion of the metrology system **100**.

[0041] FIG. **3**B illustrates an example portion of the metrology system **100** of FIG. **1**. As seen in FIG. **3**B, the metrology system **100** includes one or more reticle trays **308** with one or more reticles **310**. The metrology system **100** also includes one or more lenses **312**. The metrology system **100** positions a reticle tray **308** and a lens **312** between the optical source **118** and the optical device **112** when measuring certain reflection metrics or transmission metrics. The reticles **310** of the reticle tray **308** project certain reticle patterns or shapes towards the optical device **112** when the optical source **118** directs an optical signal **314** towards the reticle tray **308**, and the lens **312** focuses or redirects optical signals **314** towards the optical device **112**. Generally, different reticle patterns or shapes may make it easier to measure certain reflection metrics or transmission metrics. After the metrology system **100** has finished measuring a certain reflection metric or transmission metric, the metrology system **100** may swap the reticle tray **308** for another reticle tray **308** to project another reticle pattern or swap the lens **312** for another lens **312** to redirect or focus the optical signal **314** differently towards the optical device **112**. The new reticle tray **308** or lens **312** may make it easier to measure a different reflection metric or transmission metric. The metrology system **100** may then measure this reflection metric or transmission metric.

[0042] FIG. **4** illustrates an example operation **400** performed by the metrology system **100** of FIG. **1**. A computer system (e.g., the computer system **108** shown in FIG. **1**) may perform the operation **400**. By performing the operation **400**, the computer system measures reflection metrics and transmission metrics.

[0043] The computer system begins by receiving an image **402** of an optical device. The optical device may be elevated by a stage that the computer system moves into the metrology system. The computer system may use an alignment camera to capture the image **402** of the optical device. In some embodiments, the image **402** may show a fiducial (e.g., a marking, slit, cut, etc.) on the optical device. The fiducial may serve as a reference that the computer system uses to determine the position and/or orientation of the optical device relative to the alignment camera.

[0044] The computer system may operate in two modes: a reflection mode and a transmission mode. During the reflection mode, the computer system may reflect optical signals off the optical device to measure reflection metrics using a reflection sensor. During the transmission mode, the computer system may transmit optical signals through the optical device to measure transmission metrics using a transmission sensor.

[0045] In the example of FIG. **4**, the computer system begins in the reflection mode. The computer system determines an adjustment **406** to the position **404** of the optical device such that an optical signal from an optical source would be directed to an optical coupler on the optical device that would cause the optical signal to be reflected off the optical device. In some embodiments, the computer system uses a known distance between the alignment camera and the optical source to determine the adjustment **406**. The computer system then generates an instruction **408** and communicates the instruction **408** to move the stage elevating the optical device. The instruction **408** makes the adjustment **406** to the positioning of the stage to change the position **404** of the optical device. In this manner, the optical

signal from the optical source is directed to the optical coupler of the optical device for reflecting the optical signal.

[0046] The computer system then uses the reflection sensor to detect the optical signal reflected from the optical device. The reflection sensor may be positioned above the optical device, like the alignment camera and the optical source. In some embodiments, the computer system communicates instructions that move the reflection sensor such that the reflection sensor detects the optical signal reflected from the optical device. The computer system analyzes signals from the reflection sensor to determine the metrics **410**, which may be reflection metrics for the optical device.

[0047] During the transmission mode, the computer system operates the metrology system to determine transmission metrics for the optical device. The computer system may initiate the transmission mode by generating and communicating instructions **411** to move the transmission sensor towards the stage and the optical device. For example, the instructions **411** may move an arm attached to the transmission sensor towards the stage and the optical device. The computer system may move the transmission sensor such that the transmission sensor is positioned beneath the optical device between the stage and the optical device.

[0048] The computer system may initiate the transmission mode at any time after the stage has been moved into the metrology system. For example, the computer system may initiate the transmission mode after the computer system has finished measuring the metrics **410** during the reflection mode. As another example, the computer system may initiate the transmission mode during the reflection mode. As a result, the transmission mode and the reflection mode may not be mutually exclusive of each other and may overlap each other in some instances.

[0049] After positioning the transmission sensor, the computer system determines an adjustment **412** to the position **404** of the optical device. For example, the computer system may determine the adjustment **412** that would cause the optical signal from the optical source to be directed to an optical coupler on the optical device that causes the optical device to transmit the optical signal through the optical device. The computer system generates and communicates an instruction **414** to make the adjustment **412** to the position **404** of the optical device. The instruction **414** may cause the stage to move to adjust the position of the optical device elevated by the stage.

[0050] After positioning the optical device, the optical device transmits the optical signal from the optical source through the optical device and into the transmission sensor positioned beneath the optical device. In some embodiments, the computer system communicates instructions that move the transmission sensor such that the transmission sensor detects the optical signal transmitted through the optical device. The computer system analyzes signals from the transmission sensor to determine metrics **416**, which may be transmission metrics for the optical device.

[0051] After the computer system finishes measuring the metrics **416**, the computer system generates and communications instructions **418** that cause the transmission sensor to move away from the optical device and the stage. For example, the instructions **418** may move an arm attached to the transmission sensor away from the optical device and stage. By moving the transmission sensor away from the optical device and stage, the computer system provides clearance so that the stage does not collide with the transmission sensor and/or arm when the stage is moved away from or out of the metrology system. After moving the transmission sensor away from the optical device and stage, the computer system moves the optical device and stage away from or out of the metrology system. The computer system may then repeat the operation **400** by moving another stage and optical device into the metrology system.

[0052] FIG. **5** is a flowchart of an example method **500** performed by the metrology system **100** of FIG. **1**. In certain embodiments, a computer system (e.g., the computer system **108** shown in FIG. **1**) performs the method **500**. By performing the method **500**, the computer system measures both reflection metrics and transmission metrics for an optical device.

[0053] At block **502**, the computer system moves a stage elevating an optical device to adjust a position of the optical device. The computer system may determine the adjustment to the position of the optical device by analyzing images of the optical device from an alignment camera. The computer system may move the stage and/or the optical device such that an optical signal from an optical source is directed at an optical coupler on the optical device that causes the optical device to reflect the optical signal.

[0054] At block **504**, the computer system moves a reflection sensor above the optical device such that the reflection sensor detects the optical signal reflected from the optical device. The computer system analyzes signals from the reflection sensor to measure reflection metrics for the optical device.

[0055] At block **506**, the computer system moves the stage to adjust a position of the optical device. The computer system may determine the adjustment to the position of the optical device by analyzing images of the optical device from the alignment camera. The computer system may move the stage and/or the optical device such that an optical signal from the optical source is directed at an optical coupler on the optical device that causes the optical device to transmit the optical signal through the optical device.

[0056] At block **508**, the computer system moves a transmission sensor into position beneath the optical device between the stage and the optical device. The transmission sensor may have been positioned away from the stage and optical device previously to provide clearance for the stage to be moved into the metrology system. By moving the transmission sensor beneath the optical device, the transmission sensor may detect the optical signal transmitted through the optical device. The computer system analyzes signals from the transmission sensor to measure transmission metrics for the optical device.

[0057] At block **510**, the computer system move the transmission sensor away from the optical device and/or the stage after the computer system finishes measuring transmission metrics for the optical device. The computer system may move the arm attached to the transmission sensor away from the optical device to move the transmission sensor away from the optical device and out from between the optical device and the stage. By moving the transmission sensor away from the optical device, the computer system creates clearance to move the stage and optical device away from or out of the metrology system.

[0058] At block **512**, the computer system moves the stage away from or out of the metrology system. For example, the computer system may move the stage away from the alignment camera and the optical source. In this manner, the

computer system frees the metrology system to accept or receive another stage and/or optical device.

[0059] While the foregoing is directed to embodiments of the present disclosure, other embodiments of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

What is claimed is:

1. A system comprising:
an optical source positioned on a first side of an optical device held by a stage;
a first sensor positioned on the first side of the optical device; and
a second sensor, wherein:
during a first mode, the first sensor detects a first optical signal from the optical source reflected from the optical device; and
during a second mode, the second sensor moves such that (i) the second sensor is positioned on a second side of the optical device opposite the first side of the optical device and (ii) the second sensor detects a second optical signal from the optical source transmitted through the optical device.

2. The system of claim **1**, wherein:
after the second sensor detects the second optical signal, the second sensor moves out from between the optical device and the stage; and
the stage moves away from the optical source.

3. The system of claim **1**, wherein:
the optical device comprises a reflection in-coupler and a transmission in-coupler;
during the first mode, the stage moves such that the first optical signal from the optical source is directed to the reflection in-coupler; and
during the second mode, the stage moves such that the second optical signal from the optical source is directed to the transmission in-coupler.

4. The system of claim **1**, wherein:
a first reticle moves between the optical source and the optical device to measure a first metric for the optical device based on a signal from at least one of the first sensor or the second sensor;
the first reticle moves away from the optical source; and
a second reticle moves between the optical source and the optical device to measure a second metric for the optical device based on a signal from at least one of the first sensor or the second sensor.

5. The system of claim **1**, wherein:
during the first mode:
the stage moves, based on one or more images of the optical device, to reposition the optical device; and
the first sensor moves such that the first sensor detects the first optical signal; and
the second sensor is positioned between the stage and the optical device when the second sensor is positioned on the second side of the optical device.

6. The system of claim **5**, wherein the stage moving comprises at least one of the stage translating or rotating.

7. The system of claim **5**, wherein the stage moving is based on a fiducial of the optical device appearing in the one or more images.

8. The system of claim **1**, wherein the stage moving is based on a distance between an alignment camera and the optical source.

9. A method comprising:
during a first mode:
directing, by an optical source positioned on a first side of an optical device held by a stage, a first optical signal towards the optical device; and
detecting, by a first sensor positioned on the first side of the optical device, the first optical signal from the optical source reflected from the optical device; and
during a second mode:
directing, by the optical source, a second optical signal towards the optical device; and
moving a second sensor such that (i) the second sensor is positioned on a second side of the optical device opposite the first side of the optical device and (ii) the second sensor detects the second optical signal from the optical source transmitted through the optical device.

10. The method of claim **9**, further comprising:
after the second sensor detects the second optical signal, moving the second sensor out from between the optical device and the stage; and
moving the stage away from the optical source.

11. The method of claim **9**, wherein:
the optical device comprises a reflection in-coupler and a transmission in-coupler;
moving the stage during the first mode comprises moving the stage such that the first optical signal from the optical source is directed to the reflection in-coupler; and
moving the stage during the second mode comprises moving the stage such that the second optical signal from the optical source is directed to the transmission in-coupler.

12. The method of claim **9**, further comprising:
moving a first reticle between the optical source and the optical device;
determining a first metric for the optical device based on a signal from at least one of the first sensor or the second sensor;
moving the first reticle away from the optical source;
moving a second reticle between the optical source and the optical device; and
determining a second metric for the optical device based on a signal from at least one of the first sensor or the second sensor.

13. The method of claim **9**, further comprising:
during the first mode:
moving the stage, based on one or more images of the optical device, to reposition the optical device; and
moving the first sensor such that the first sensor detects the first optical signal; and
the second sensor is positioned between the stage and the optical device when the second sensor is positioned on the second side of the optical device.

14. The method of claim **13**, wherein moving the stage comprises at least one of translating or rotating the stage.

15. The method of claim **13**, wherein moving the stage is based on a fiducial of the optical device appearing in the one or more images.

16. The method of claim **13**, wherein moving the stage is based on a distance between an alignment camera and the optical source.

17. A non-transitory computer readable medium storing instructions that, when executed by one or more processors, causes the one or more processors to, individually or collectively:

during a first mode:

direct, by an optical source positioned on a first side of an optical device held by a stage, a first optical signal towards the optical device; and

detect, by a first sensor positioned on the first side of the optical device, the first optical signal from the optical source reflected from the optical device; and

during a second mode:

direct, by the optical source, a second optical signal towards the optical device; and

move a second sensor such that (i) the second sensor is positioned on a second side of the optical device opposite the first side of the optical device and (ii) the second sensor detects the second optical signal from the optical source transmitted through the optical device.

18. The medium of claim **17**, wherein the instructions further cause the one or processors to, individually or collectively:

after the second sensor detects the second optical signal, move the second sensor out from between the optical device and the stage; and

move the stage away from the optical source.

19. The medium of claim **17**, wherein:

the optical device comprises a reflection in-coupler and a transmission in-coupler;

moving the stage during the first mode comprises moving the stage such that the first optical signal from the optical source is directed to the reflection in-coupler; and

moving the stage during the second mode comprises moving the stage such that the second optical signal from the optical source is directed to the transmission in-coupler.

20. The medium of claim **17**, wherein the instructions further cause the one or processors to, individually or collectively:

move a first reticle between the optical source and the optical device;

determine a first metric for the optical device based on a signal from at least one of the first sensor or the second sensor;

move the first reticle away from the optical source;

move a second reticle between the optical source and the optical device; and

determine a second metric for the optical device based on a signal from at least one of the first sensor or the second sensor.

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