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(54) PRINTING APPARATUS, PRINTING METHOD, AND DATA CARRIER MEANS

DRUCKVORRICHTUNG, DRUCKVERFAHREN UND DATATRÄGERMITTEL

APPAREIL D'IMPRESSION, PROCÉDÉ D'IMPRESSION ET MOYENS DE SUPPORT POUR DONNÉES

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Description

BACKGROUND

Technical Field

[0001] This disclosure relates to a printing apparatus, a printing method, and carrier means.

Background Art

[0002] Some image recording apparatuses employ a laser processing system for processing recording targets, in which laser beams are irradiated onto the recording targets to heat the recording targets to form images on the recording targets. Such image recording apparatuses include, for example, a laser irradiation device arranging a plurality of semiconductor lasers in an array, and the laser beams emitted from each one of the semiconductor lasers are irradiated to different positions in a pre-set direction to perform the image recording on the recording targets.

[0003] JP-H06-183039-A discloses a technique for detecting temperature and humidity of a heat-sensitive recording media and controlling an output power of a laser beam.

[0004] In conventional methods of generating heat by absorbing the laser beam into a recording layer of the heat-sensitive recording media to develop a color in the recording layer of the heat-sensitive recording media, even if the output power of the laser beam is kept constant, due to variations in the color development sensitivity and other properties of the recording layer of the heat-sensitive recording media depending on different manufacturers, lots, and types, consistent print quality has been hard to obtain.

[0005] Further, when the output power of the laser beam is excessively increased and the temperature of the heat-sensitive recording media becomes too high to exceed the heat-resistance limits of the heat-sensitive recording media, foreign matter (e.g., smoke) and/or decomposed products may be generated from the heat-sensitive recording media during the laser irradiation, generating safety and health concerns. Further, the foreign matter and/or decomposed products may adhere to the heat-sensitive recording media, adversely affecting the absorption amount of the laser beam and degrading color development quality.

[0006] International Publication No. WO 2018/102633 A1 discloses a laser marking system comprising at least one controller to control an array of optical devices, between a laser source and a scan head.

SUMMARY

[0007] As one aspect of the present disclosure, a printing apparatus in accordance with claim 1 is provided.

[0008] As another aspect of the present disclosure, a method of printing target information on a recording medium using a laser beam emitted from a laser device in accordance with claim 3 is provided.

[0009] As to the above-described aspects of the present disclosure, the printing apparatus and the printing method can provide consistent print quality.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] A more complete appreciation of the description and many of the attendant advantages and features thereof can be readily acquired and understood from the following detailed description with reference to the accompanying drawings, wherein:

FIG. 1 is a perspective view of an image recording system according to an embodiment of the present disclosure;
FIG. 2 is a perspective view illustrating a configuration of a recording apparatus provided in the image recording system of FIG. 1;
FIG. 3 illustrates an enlarged view of an optical fiber provided in the recording apparatus provided in the image recording system of FIG. 1;
FIG. 4 illustrates an enlarged view near an array head;
FIG. 5 illustrates an example of an arrangement of an array head;
FIG. 6 illustrates another example of an arrangement of an array head;
FIG. 7 illustrates another example of an arrangement of an array head;
FIG. 8 illustrates another example of an arrangement of an array head;
FIG. 9 illustrates another example of an arrangement of an array head;
FIG. 10 illustrates an example block diagram of the image recording system of FIG. 1;
FIGs. 11 and 12 illustrate a modification example of the image recording system of FIG. 1;

FIG. 13 illustrates an example functional block diagram of an image recording system according to an embodiment of the present disclosure;

FIG. 14 is a cross-sectional view illustrating relative positions of a recording apparatus and an irradiation stand according to the embodiment of the present disclosure;

FIG. 15 is a cross-sectional view of a heat-sensitive recording medium according to the embodiment of the present disclosure;

FIG. 16 is a diagram illustrating a relationship between optical properties and absorption rate of a heat-sensitive recording medium according to the embodiment of the present disclosure;

FIG. 17 is a diagram illustrating a laser output control of the image recording system according to the embodiment of the present disclosure;

FIG. 18 illustrates a relationship between a ratio of energy absorbed by heat-sensitive recording media and an image density when a solid image is printed on the heat-sensitive recording media having different configurations of print layers, and using irradiation stands made of different material; and

FIG. 19 is a flowchart illustrating a laser control operation performed by the image recording system according to the embodiment of the present disclosure.

[0011] The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted.

DETAILED DESCRIPTION

[0012] A description is now given of exemplary embodiments of the present disclosures. It should be noted that although such terms as first, second, etc., may be used herein to describe various elements, components, regions, layers and/or units, it should be understood that such elements, components, regions, layers and/or units are not limited thereby because such terms are relative, that is, used only to distinguish one element, component, region, layer or unit from another region, layer or unit. Thus, for example, a first element, component, region, layer or unit discussed below could be termed a second element, component, region, layer or unit without departing from the teachings of the present disclosures.

[0013] In addition, it should be noted that the terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present disclosures. Thus, for example, as used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. Moreover, the terms "includes" and/or "including," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0014] Hereinafter, a description is given of an image recording system, such as a printing apparatus, a printing method and a printing control program of an embodiment.

[0015] The image recording system, such as a printing apparatus, according to the embodiment performs recording of image by irradiating a laser beam onto a recording target. The "image" are visible information, and can be selected appropriately according to the purpose. In other words, the image indicates any target information, such as text, symbol, line, shape, solid image, or a combination of these, and two-dimensional code, such as bar code, quick response (QR) code (registered trademark), or the like.

[0016] The recording target, such as a recording medium, is not particularly limited as long as the recording target can be recorded with the target information using the laser beam, and can be selected appropriately according to the purpose. The recording target can be any object capable of absorbing light and converting the light into heat to form an image, such as stamping on a metal, or the like. The recording target may have a structure having a heat-sensitive recording medium, heat-sensitive recording portion, or the like.

[0017] The heat-sensitive recording medium includes, for example, a support, an image recording layer formed on the support, and other layers as needed. Each of these layers may be a single layer structure, may be a laminated structure, or may be contacted on a surface of the support.

[0018] The image recording layer includes, for example, leuco dye and developer, and further includes other components as needed.

[0019] The leuco dye is not limited to particular type, but can be selected appropriately from dyes used for the heat-sensitive recording material. For example, leuco compounds such as triphenylmethane compounds, fluoran compounds, phenothiazine compounds, auramine compounds, spiropyran compounds, and indolinophthalide compounds are preferably used.

[0020] The developer can be various compounds, such as various electron-accepting compounds or oxidizers that develop the leuco dye when contacting with each other.

[0021] The other components include, for example, binder resins, photothermal conversion materials, heat-fusible substances, antioxidants, light stabilizers, surfactants, lubricants, fillers, or the like.

[0022] The support is not particularly limited as to the shape, structure, size, or the like, and can be selected appropriately according to the purpose. For example, a flat plate may be used as the shape. The structure may be a single layer structure or a laminated structure. The size can be selected appropriately according to the size of the heat-sensitive recording medium.

[0023] The other layer includes, for example, a photothermal conversion layer, protective layer, underlayer, ultraviolet absorption layer, oxygen blocking layer, intermediate layer, back layer, adhesion layer, adhesive layer, or the like.

[0024] The heat-sensitive recording medium can be processed into a desired shape according to the application type. Examples of the shape include card type, tag type, label type, sheet type, roll type, or the like. For example, the card type includes prepaid cards, point cards, credit cards, or the like. The tag type that is processed smaller than the card size can be used as a value tag at stores or the like. Further, the tag type that is processed larger than the card type can be used for process control, shipping instruction, ticket, or the like. Since the label type can be pasted on a product as a label, the label type can be processed into various sizes, and pasted on carts, vessels, boxes, containers, or the like that are repeatedly used for the process control, product management, or the like. Further, the sheet type that is processed larger than the card type can be used for general document sheets, instruction sheets for process control, or the like because the area where the image is recorded becomes wider.

[0025] The heat-sensitive recording portion can be set on a structural object, for example, a part where a label heat-sensitive recording medium is attached to a surface of the structural object, or a part where the heat-sensitive recording material (e.g., liquid) is applied onto the surface of the structural object, or the like. Further, the structural object having the heat-sensitive recording portion is not particularly limited as long as the structural object has the heat-sensitive recording portion on the surface of the structural object, and can be selected appropriately according to the purpose. Examples of the structural object having the heat-sensitive recording portion include a variety of products, such as plastic bags, polyethylene terephthalate (PET) bottles, cans, transport containers, such as cardboards and containers, work in process, industrial products, or the like.

(Configuration of Image Recording System)

[0026] Hereinafter, a description is given of an image recording system that records an image on a transport container attached with a heat-sensitive recording label, which is an example of the structural object having the heat-sensitive recording portion (recording target).

[0027] FIG. 1 is a perspective view of an image recording system 100 according to an embodiment of the present disclosure. In the following description, a direction of conveying a transport container C is set as the X-axis direction, a direction vertical to the conveying direction of the transport container C is set as the Z-axis direction, and a direction orthogonal to the X-axis direction and the Z-axis direction is set as the Y-axis direction.

[0028] As described below, the image recording system 100 emits a laser beam onto a heat-sensitive recording label RL (recording target) attached to the transport container C.

[0029] As illustrated in FIG. 1, the image recording system 100 includes, for example, a conveyor apparatus 10, a recording apparatus 14, a system control apparatus 18, a scanner 15, and a shield cover 11.

[0030] The recording apparatus 14 is, for example, a laser device, and emits a laser beam onto the heat-sensitive recording label RL (recording target) to record an image, such as a visible image on the heat-sensitive recording label RL. The recording apparatus 14 is disposed on the -Y side of the conveyor apparatus 10, that is, the -Y side of the conveying path.

[0031] The shield cover 11 is subjected to an anodic oxidation process to form a black-colored and porous surface, and shields the laser beam irradiated from the recording apparatus 14 to reduce the diffusion of the laser beam. The shield cover 11 has an opening 11a for passing the laser beam at a portion facing to the recording apparatus 14. In the embodiment, the conveyor apparatus 10 is a roller conveyor, but can be a belt conveyor.

[0032] The system control apparatus 18 is connected to the conveyor apparatus 10, the recording apparatus 14 and the scanner 15 to control the image recording system 100 entirely. To be described later, the scanner 15 reads or scans a coded image information, such as bar code or quick response (QR) code (registered trademark), recorded on the recording target. The system control apparatus 18 verifies whether or not the image is properly recorded based on the information read by the scanner 15.

(Composition of Heat-sensitive Recording Label)

[0033] Hereinafter, a description is given of the heat-sensitive recording label RL attached to the transport container C. As to the heat-sensitive recording label RL (heat-sensitive recording medium), the image recording is performed by changing a color using generated heat. As to the heat-sensitive recording label RL, a heat-sensitive recording medium capable of recording image one time only may be used, or a heat reversible recording medium capable of recording image multiple times may be used.

[0034] The heat-sensitive recording label RL is formed by material such as photothermal conversion material that absorbs the laser beam and converts the laser beam into heat, and also includes one or more materials that generate a change in hue and reflectance by generated heat.

[0035] The photothermal conversion material includes, for example, inorganic materials and organic materials. The inorganic materials include, for example, particles of at least one of carbon black, metal boride, or metal oxides of Ge, Bi, In, Te, Se, Cr or the like. As to the inorganic materials, a material having a larger absorption of light in the near infrared wavelength range and a smaller absorption of light in the visible wavelength range is preferable, and for example, a metal boride and a metal oxide can be used. As to the inorganic materials, at least one selected from, for example, hexaboride, tungsten oxide compounds, antimony tin oxide (ATO), indium tin oxide (ITO), and zinc antimonate is suitable.

[0036] The hexaboride includes, for example, LaB_6, CeB_6, PrB_6, NdB_6, GdB_6, TbB_6, DyB6, HoB6, YB6, SmB6, EuB6, ErB6, TmB6, YbB6, LuB6, SrB6, CaB6, and (La,Ce)B6.

[0037] The tungsten oxide compounds, include, for example, fine particles of tungsten oxide represented by the general formula of "WyOz" (W is tungsten; O is oxygen; $2.2 \leq z/y \leq 2.999$) or fine particles of complex tungsten oxide represented by the general formula of "MxWyOz" (M is selected from one or more elements of H, He, alkali metal, alkaline earth metal, rare earth element, Mg, Zr, Cr, Mn, Fe, Ru, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Al, Ga, In, Tl, Si, Ge, Sn, Pb, Sb, B, F, P, S, Se, Br, Te, Ti, Nb, V, Mo, Ta, Re, Be, Hf, Os, Bi, and I; W is tungsten; O is oxygen; $0.001 \leq x/y \leq 1$, $2.2 \leq z/y \leq 3.0$), described in the International Publication No. WO/2005/037932 and Japanese Laid-Open Publication No. 2005-187323-A,

[0038] Among these, cesium-containing tungsten oxide is preferable as the tungsten oxide compound because the cesium-containing tungsten oxide has a larger absorption in the near infrared wavelength range and a smaller absorption in the visible wavelength range.

[0039] As to the tungsten oxide compounds, among antimony tin oxide (ATO), indium tin oxide (ITO) and zinc antimonate, ITO is preferable because of a larger absorption in the near infrared wavelength range and a smaller absorption in the visible wavelength range. These compounds can be formed into a layer by bonding particulate materials using a vacuum evaporation method or a resin bonding method.

[0040] As to the organic materials, various dyes can be appropriately used depending on the optical wavelength to be absorbed. When a semiconductor laser is used as a light source, a near infrared absorbing dye having an absorption peak in a range of 600 nm to 1,200 nm is used. Specifically, the organic materials include cyanine dyes, quinone dyes, quinoline derivatives of indole naphthol, phenylenediamine nickel complexes, phthalocyanine dyes, or the like.

[0041] The photothermal conversion material may use one type alone or two or more types in combination. Further, the photothermal conversion material may be provided in the image recording layer, or may be provided in a layer other than the image recording layer. When the photothermal conversion material is used in the layer other than the image recording layer, it is preferable to provide a photothermal conversion layer adjacent to a heat-reversible recording layer.

[0042] The photothermal conversion layer includes at least the photothermal conversion material and binder resin.

[0043] As to the material that changes hue and reflectance due to the generated heat, for example, known products, such as a combination of an electron-donating dye precursor and an electron-accepting developer, can be used. Further, the materials that change hue and reflectance due to the generated heat include materials that cause a complex reaction by heat and light, such as a color change reaction accompanying solid-state polymerization of diacetylene compounds under the effect of the generated heat and ultraviolet light irradiation.

[0044] Configuration of Recording Apparatus:

FIG. 2 is a perspective view of a configuration of the recording apparatus 14.

[0045] The recording apparatus 14 includes, for example, an array of laser emitting units of a plurality of optical fibers (fiber array), which are arrayed in a main scanning direction (Z-axis direction) orthogonal to the sub-scanning direction (X-axis direction), which is a conveying or moving direction of the transport container C attached with the recording target. The recording apparatus 14 emits a laser beam emitted from laser beam emitting elements to the recording target via the fiber array to record an image on the recording target, in which the recorded image consists of segments of drawn image.

[0046] Specifically, the recording apparatus 14 includes, for example, a laser array unit 14a, a fiber array unit 14b, and an optical unit 43. The laser array unit 14a includes, for example, a plurality of laser beam emitting elements 41 arranged in an array, a cooling unit 50 for cooling the laser beam emitting elements 41, a plurality of driving drivers 45, disposed for the corresponding laser beam emitting elements 41, for driving the corresponding laser beam emitting elements 41, and a controller 46 for controlling the plurality of driving drivers 45. Hereinafter, the laser beam emitting element 41 may mean one or more laser beam emitting elements 41 and the driving driver 45 may mean one or more driving drivers 45 for the simplicity of the description.

[0047] Further, as indicated in FIG. 2, the controller 46 is connected to an image information output unit 47 and a power supply 48. The image information output unit 47 (e.g., personal computer) outputs image information to the laser beam emitting element 41, and the power supply 48 supplies power to the laser beam emitting element 41.

[0048] The laser beam emitting element 41 can be selected appropriately depending on the purpose. For example, a semiconductor laser, a solid-state laser, a dye laser, or the like can be used as the laser beam emitting element 41. The laser beam emitting element 41 is preferably the semiconductor laser diode because the semiconductor laser diode has wider wavelength selectivity, smaller size enabling reduction of the device size, and lower cost.

[0049] The wavelength of the laser beam emitted from the laser beam emitting element 41 is not particularly limited, and can be selected appropriately according to the purpose. For example, the wavelength of the laser beam emitted from the laser beam emitting element 41 is, preferably in a range from 700 nm to 2000 nm, and more preferably in a range from 780 nm to 1600 nm.

[0050] In the laser beam emitting element 41, all of the applied energy is not converted into the laser beam. Typically, in the laser beam emitting element 41, some energy, not converted into the laser beam, is converted into heat, thus generating the heat. Therefore, the laser beam emitting element 41 is cooled by the cooling unit 50.

[0051] Further, the recording apparatus 14 can separately dispose the laser beam emitting elements 41 by using the fiber array unit 14b. With this configuration, the influence of heat from the adjacent laser beam emitting element 41 can be reduced, and the cooling of the laser beam emitting element 41 can be performed efficiently. Therefore, the temperature rise and the fluctuation of the laser beam emitting element 41 can be reduced or avoided, the fluctuation of output power of the laser beam can be reduced, and thereby the density unevenness and unintended blank portion in a printed image can be reduced or avoided.

[0052] The output power of laser beam means the average output power measured by a power meter. The output power of laser beam can be controlled using two types of methods such as a method of controlling the peak power and a method of controlling the light emission ratio of pulse light (i.e., duty such as laser emission time per cycle time).

[0053] The cooling unit 50 employs, for example, a liquid cooling system, in which cooling liquid is circulated to cool the laser beam emitting element 41. As illustrated in FIG. 2, the cooling unit 50 includes, for example, a heat receiving unit 51 that receives heat from each laser beam emitting element 41, and a heat radiating unit 52 that dissipates heat received from the cooling liquid. The heat receiving unit 51 and the heat radiating unit 52 are connected using cooling pipes 53a and 53b. The heat receiving unit 51 includes, for example, a casing and a cooling pipe, disposed inside the casing, for flowing the cooling liquid. The casing and the cooling pipe are made of material having a higher thermal conductivity. The plurality of laser beam emitting elements 41 are arranged, for example, in an array on the heat receiving unit 51.

[0054] The heat radiating unit 52 includes a radiator and a pump for circulating the cooling liquid. The cooling liquid supplied by the pump of the heat radiating unit 52 flows through the cooling pipe 53a and the heat receiving unit 51. Then, the laser beam emitting element 41 is cooled by removing the heat from the laser beam emitting element 41 arranged on the heat receiving unit 51 by flowing the cooling liquid in the cooling pipe disposed inside the heat receiving unit 51. The cooling liquid that has increased the temperature by depriving the heat of the laser beam emitting element 41 flows through the cooling pipe 53b, and then flows into the radiator of the heat radiating unit 52 and is cooled by the radiator. The cooling liquid cooled by the radiator is supplied again to the heat receiving unit 51 by the pump.

[0055] The fiber array unit 14b includes a plurality of optical fibers 42 and an array head 44. The optical fibers 42 are disposed for the corresponding laser beam emitting elements 41. The array head 44 holds a laser exit end 42a (see FIG. 4) of each of the optical fibers 42 in an array in the vertical direction (Z-axis direction). The laser incidence end of each of the optical fibers 42 is attached to a laser exit end of the laser beam emitting element 41.

(Configuration of Optical Fiber)

[0056] FIG. 3 is an enlarged view of the optical fiber 42, and FIG. 4 is an enlarged view near the array head 44.

[0057] The optical fiber 42 is an optical waveguide of the laser beam emitted from the laser beam emitting element 41. The shape, size (diameter), material and structure of the optical fiber 42 are not particularly limited and can be selected appropriately according to the purpose.

[0058] The size of the optical fiber 42 (i.e., diameter d1 in FIG. 3) is preferably 15 μm or more to 1000 μm or less. When the diameter d1 of the optical fiber 42 is 15 μm or more to 1000 μm or less, it is advantageous in terms of the fineness of image. In one example case, the image recording system 100 uses an optical fiber having the diameter d1 of 125 μm as the optical fiber 42.

[0059] The material of the optical fiber 42 is not particularly limited, and can be selected appropriately according to the purpose, and the material of the optical fiber 42 is, for example, glass, resin, and quartz.

[0060] The structure of the optical fiber 42 preferably consists of a core portion (i.e., central portion) that passes through the laser beam and a cladding layer provided on the outer periphery of the core portion.

[0061] The diameter d2 (FIG. 3) of the core portion is not particularly limited, and can be selected appropriately according to the purpose. The diameter d2 of the core portion is preferably 10 μm or more to 500 μm or less. For example, the image recording system 100 uses the optical fiber having the diameter d2 of 105 μm for the core portion.

The material of the core portion is not particularly limited, and can be selected appropriately according to the purpose, and the material of the core portion is, for example, such as glass doped with germanium or phosphorus.

[0062] The average thickness of the cladding layer is not particularly limited, and can be selected appropriately according to the purpose, and preferably 10 μm or more to 250 μm or less. The material of the cladding layer is not particularly limited, and can be selected appropriately according to the purpose. Examples of material of the cladding layer are glass doped with boron or fluorine.

[0063] As illustrated in FIG. 4, the vicinity of the laser exit ends 42a of the plurality of optical fibers 42 are held by the array head 44 as an array to set the pitch of the laser exit ends 42a of each optical fiber 42 to 127 μm. In the recording apparatus 14, the pitch of the laser exit ends 42a is set to 127 μm so that an image having a resolution of 200 dpi (dot per inch) can be recorded.

[0064] If all of the optical fibers 42 are to be held by one array head 44 alone, the array head 44 becomes longer and tends to be deformed. As a result, it becomes difficult to keep the linearity of the beam array and the uniformity of the beam pitch if the one array head 44 is employed. Therefore, it can be configured that the one array head 44 holds 100 to 200 optical fibers 42. Then, it is preferable to construct the recording apparatus 14 by arranging the plurality of array heads 44, each holding the 100 to 200 optical fibers 42, in the direction orthogonal to the conveying or moving direction of the transport container C (Z-axis direction). For example, in the image recording system 100, 200 array heads 44 are arranged in the Z-axis direction.

(Configuration of Array Head)

[0065] FIGs. 5 to 9 illustrate examples of an arrangement of the array head 44.

[0066] FIG. 5 is an example of arraying a plurality of array heads 44 of the fiber array unit 14b in the recording apparatus 14 in the Z-axis direction with a linear arrangement pattern. FIG. 6 is another example of arraying a plurality of array heads 44 of the fiber array unit 14b in the recording apparatus 14 in the Z-axis direction with a staggered arrangement pattern.

[0067] The staggered arrangement pattern of the plurality of array heads 44 illustrated in FIG. 6 is preferable compared to the linear arrangement pattern of the plurality of array heads 44 illustrated in FIG. 5 from the viewpoint of assembly work.

[0068] FIG. 7 is another example of arraying a plurality of array heads 44 of the fiber array unit 14b in the recording apparatus 14 with an inclined arrangement pattern with respect to the X-axis direction. By arraying the plurality of array heads 44 as illustrated in FIG. 7, the pitch P in the Z-axis direction of the optical fibers 42 can be narrowed compared to the arrangement patterns illustrated in FIGs. 5 and 6, thereby achieving a higher resolution.

[0069] FIG. 8 is another example of arraying a plurality of array heads 44 of the fiber array unit 14b in the recording apparatus 14 with a staggered arrangement pattern in two array head group (two rows) in the sub-scanning direction (X-axis direction), in which one row of the array head group is disposed by displacing the one row of the array head group with respect to the other array head group for a half of the alignment pitch P of the optical fibers 42 in the main scanning direction (Z-axis direction). By arraying the plurality of array heads 44 as illustrated in FIG. 8, the pitch P of the optical fibers 42 in the Z-axis direction can be set narrower compared to the arrangement patterns illustrated in FIGs. 5 and 6, thereby achieving a higher resolution.

[0070] The recording apparatus 14 of the image recording system 100 transmits image information in a direction orthogonal to the scanning direction of the heat-sensitive recording label RL (recording target) attached to the transport container C in accordance with the control of the system control apparatus 18, to be described later in FIG. 10, in which the image information is used for recording an image corresponding to the image information. Therefore, as to the recording apparatus 14, if there is a difference between the scan timing of the heat-sensitive recording label RL and the transmission timing of image information in the direction orthogonal to the scanning direction, the image information is stored in the memory, so that the image storage amount increases. In such a case, compared to the arrangement pattern of the plurality of array heads 44 illustrated in FIG. 7, the arrangement pattern of the plural array heads 44 illustrated in FIG. 8 can reduce the amount of information stored in the memory of the system control apparatus 18.

[0071] Further, FIG. 9 is another example of arraying a plurality of array heads 44 of the fiber array unit 14b with a staggered arrangement pattern, in which two rows of the optical fibers 42 are arranged in a laminated and staggered manner in one array head 44, and then the plurality of array heads 44 are arranged in the staggered arrangement pattern, which is different from arrangement pattern of the plurality of array heads 44 illustrated in FIG. 8. The array head 44 including the two rows of the optical fibers 42 arranged with the laminated and staggered manner in the one array head 44 can be manufactured easily, and a higher resolution can be achieved. In addition, compared to the arrangement pattern of the plurality of array heads 44 illustrated in FIG. 8, the arrangement pattern of the array head 44 illustrated in FIG. 9 can reduce the amount of information stored in the memory of the system control apparatus 18.

[0072] Further, as illustrated in FIG. 2, the optical unit 43 includes a collimator lens 43a and a condenser lens 43b. The collimator lens 43a converts the laser beams of the divergent luminous flux emitted from each optical fiber 42 into parallel light beams, the condenser lens 43b condenses the laser beams onto a surface of the heat-sensitive recording label RL, which is a laser irradiation surface. Whether the optical unit 43 is provided or not can be selected appropriately according to the purpose.

[0073] The image information output unit 47, such as the personal computer, inputs the image data to the controller 46. Then, the controller 46 generates drive signals for driving each driving driver 45 based on the input image data. Then, the controller 46 transmits the generated drive signals to each driving driver 45. Specifically, the controller 46 is equipped with a clock generator. When the clock number that the clock generator oscillates becomes a specific clock number, the controller 46 transmits the drive signals for driving each driving driver 45 to each driving driver 45.

[0074] In response receiving the drive signals, each driving driver 45 drives the corresponding laser beam emitting element 41. Then, the laser beam emitting element 41 emits the laser beam in accordance with the drive signals received from the driving driver 45. Then, the laser beam emitted from the laser beam emitting element 41 enters the corresponding optical fiber 42, and then the laser beam is emitted from the laser exit end 42a of the optical fiber 42. Then, the laser beam emitted from the laser exit end 42a of the optical fiber 42 passes through the collimator lens 43a and the condenser lens 43b of the optical unit 43, and then irradiated onto the surface of the heat-sensitive recording label RL (recording target) attached to the transport container C. Then, an image is recorded on the surface of the heat-sensitive recording label RL by being heated by the laser beam irradiated onto the surface of the heat-sensitive recording label RL.

[0075] If the recording apparatus 14 is, for example, a recording apparatus that uses a galvanometer mirror to deflect a laser beam, an image such as text is recorded as one stroke image by irradiating the laser beam using a rotation of the galvanometer mirror. Therefore, when a certain amount of information is to be recorded on the recording target, the recording cannot be performed correctly if the conveyance of the recording target is not stopped.

[0076] By contrast, as to the recording apparatus 14 of the image recording system 100 according to the embodiment, by using the laser array arranging the plurality of laser beam emitting elements 41 in the array, an image can be recorded on the recording target by performing ON-OFF control of each laser beam emitting element 41 corresponding to each pixel. As a result, even if the amount of information (e.g., data size) increases, the image can be recorded on the recording target without stopping the conveyance of the transport container C. Therefore, even if a larger amount of information is to be recorded on the recording target, the image recording system 100 can record the images without sacrificing the productivity.

[0077] As to be described later, the recording apparatus 14 of the image recording system 100 records the image on the recording target by heating the recording target by irradiating the laser beam onto the recording target. Since conventional laser-use recording apparatuses does not have the fiber array unit 14b, it is necessary to arrange the laser beam emitting elements 41 in an array with an interval according to the resolution. Therefore, in the conventional laser-use recording apparatuses, it is necessary to arrange the laser beam emitting elements 41 with a very narrow pitch to attain the resolution of 200 dpi. As a result, in the conventional laser-use recording apparatuses, the heat occurred in the laser beam emitting element 41 is difficult to dissipate, and the temperature of the laser beam emitting element 41 becomes higher.

[0078] In the conventional laser-use recording apparatuses, the temperature of the laser beam emitting element 41 becomes higher, the wavelength and the output power of laser beam of the laser beam emitting element 41 fluctuate, and thereby heating the recording target at a pre-set temperature becomes difficult, and a good quality image is difficult to obtain. Further, in the conventional laser-use recording apparatuses, to reduce or prevent the temperature rise of the laser beam emitting element 41, it is necessary to decrease the conveying speed of the recording target to set the laser beam emission interval of the laser beam emitting element 41 longer, causing difficultly of increasing the productivity sufficiently.

[0079] Typically, the cooling unit uses the chiller method, and the cooling is performed without heating in the chiller method. Therefore, the temperature of the light source does not become higher than the temperature set for the chiller, but the temperature of the laser beam emitting element 41, which is a laser beam source that is brought into contact with the cooling unit 50, fluctuates depending on the ambient temperature.

[0080] Further, when a semiconductor laser is used as the laser beam emitting element 41, the output power of laser beam changes in accordance with the temperature of the laser beam emitting element 41, such as the laser output power becomes higher when the temperature of the laser beam emitting element 41 becomes lower. In order to control the laser output power, it is preferable to measure the temperature of the laser beam emitting element 41 and/or the temperature of the cooling unit 50 and to control the input signals to the driving driver 45 that controls the laser output power so that the laser output power becomes constant in accordance with the measurement result and to perform normal image forming operation.

[0081] The recording apparatus 14 of the image recording system 100 is a fiber-array-using recording apparatus that uses the fiber array unit 14b. As to the fiber-array-using recording apparatus, the laser exit end 42a of the fiber array unit 14b can be arranged with a pitch in accordance with the image resolution, and it is not necessary to set the pitch between the laser beam emitting elements 41 of the laser array unit 14a in accordance with the pitch corresponding to the image resolution. With this configuration, the pitch between the laser beam emitting elements 41 can be sufficiently increased so that the heat occurring in the laser beam emitting elements 41 can be sufficiently dissipated, and the laser beam emitting elements 41 can be prevented from becoming too high temperature. Therefore, the fluctuation of the wavelength and the output power of laser beam emitted from the laser beam emitting element 41 can be reduced or prevented, and thereby a good quality image can be recorded on the recording target. Further, even if the laser beam emission interval of the laser beam emitting elements 41 is set shorter, the temperature increase of the laser beam emitting elements 41 can be reduced, the conveying speed of the transport container C can be increased, and thereby the productivity can be increased.

(Hardware Configuration of Recording Apparatus)

[0082] Further, in the recording apparatus 14, the cooling unit 50 is provided to cool the laser beam emitting element 41 using the cooling liquid, and thereby the temperature rise of the laser beam emitting element 41 can be further reduced. Therefore, the laser beam emission interval of the laser beam emitting element 41 can be further set shorter, and the conveying speed of the transport container C can be increased, and thereby the productivity can be increased.

[0083] Further, although the laser beam emitting element 41 is cooled by the cooling liquid, the laser beam emitting element 41 can be air-cooled by using a cooling fan or the like. The cooling efficiency of the liquid cooling is higher, and the laser beam emitting element 41 can be cooled efficiently. The cooling efficiency of the air cooling is lower compared to the liquid cooling, but the laser beam emitting element 41 can be cooled at lower cost.

[0084] Hereinafter, a description is given of a block diagram of an image recording system 100 according to the embodiment with reference to FIG. 10. As illustrated in FIG. 10, the system control apparatus 18 includes, for example, a central processing unit (CPU), a read only memory (ROM), a random access memory (RAM), a non-volatile memory, or the like. The system control apparatus 18 controls driving of each unit and various computation operations of the image recording system 100. The system control apparatus 18 is connected to, for example, the conveyor apparatus 10, the recording apparatus 14, the scanner 15, a timer 16, a storage 17, an operation panel 181, and the image information output unit 47.

[0085] The operation panel 181 is equipped with a touch panel display and various keys to display images and receive various information input by an operator's key operation.

[0086] The system control apparatus 18 controls the recording apparatus 14 by operating the CPU in accordance with the program stored in the storage unit such as the ROM, and irradiates, via the optical fiber array, the laser beam onto the recording target moving in a given direction with respect to a laser irradiation direction of the recording apparatus 14 used as the laser irradiation apparatus to heat the recording target to record the image on the recording target.

[0087] Further, the CPU of the system control apparatus 18 operates based on an image recording program (an example of print control program) stored in a storage unit such as the ROM, and performs a laser output control of the recording apparatus 14 based on the optical properties of the heat-sensitive recording label RL and an irradiation stand. Further, even if the heat-sensitive recording labels RL having different optical properties are used, consistent print quality can be obtained. The details are to be described later.

(Recording Operation of Image Recording System)

[0088] Hereinafter, a description is given of a recording operation of the image recording system 100 with reference to FIG. 1.

[0089] At first, an operator places the transport container C containing a baggage on the conveyor apparatus 10. The number of the transport container C can be one or more. Hereinafter, the transport container C indicates one or more transport containers C. Specifically, the operator places the transport container C on the conveyor apparatus 10 so that a side face of the transport container C (e.g., a side face of a body of the transport container C) attached with the heat-sensitive recording label RL faces the -Y side of the conveyor apparatus 10 (i.e., the side face of the recording apparatus 14).

[0090] When the operator operates the operation panel 181 and instructs a start of conveyance of the transport container C on the conveyor apparatus 10, a conveyance start signal is transmitted from the operation panel 181 to the system control apparatus 18. In response to receiving the conveyance start signal, the system control apparatus 18 controls the conveyor apparatus 10 to start the conveyance of the transport container C on the conveyor apparatus 10. Then, the transport container C mounted on the conveyor apparatus 10 is conveyed toward the recording apparatus 14 by the conveyor apparatus 10. The conveying speed of the transport container C on the conveyor apparatus 10 is, for example, 2 ms^{-1}.

[0091] As indicated in FIG. 1, a sensor D for detecting the transport container C being conveyed on the conveyor apparatus 10 is disposed at a upstream of the conveyance direction of the transport container C with respect to the recording apparatus 14. When the transport container C is detected by the sensor D, a detection signal is transmitted from the sensor D to the system control apparatus 18. The system control apparatus 18 is being supplied with time information indicating the time counted by the timer 16. The system control apparatus 18 starts the time measurement based on the time information received from the timer 16 at the timing when the detection signal is received from the sensor D. Then, based on the time elapsed from the reception timing of the detection signal, the system control apparatus 18 recognizes the timing when the transport container C is to reach the recording apparatus 14.

[0092] When the time elapsed from the reception timing of the detection signal becomes given time T1, and the transport container C is facing the recording apparatus 14, the system control apparatus 18 outputs a recording start signal to the recording apparatus 14 to record an image on the heat-sensitive recording label RL attached to the transport container C that is passing through the recording apparatus 14.

[0093] In response to receiving the recording start signal, the recording apparatus 14 emits a laser beam of a preset intensity power onto the heat-sensitive recording label RL attached to the transport container C based on the image information received from the image information output unit 47. With this configuration, the image is recorded on the heat-sensitive recording label RL without contacting the heat-sensitive recording label RL.

[0094] The image (image information transmitted from the image information output unit 47) recorded on the heat-sensitive recording label RL is, for example, text information indicating the content of package contained in the transport container C, and information of transport destination, or a code image such as a bar code or a two-dimensional code, which encodes the content of package contained in the transport container C and the information of transport destination.

[0095] After the transport container C is recorded with the image by passing through the recording apparatus 14, the transport container C passes through the scanner 15.

[0096] At this timing, the scanner 15 reads the code image such as the bar code, the two-dimensional code, or the like recorded on the heat-sensitive recording label RL to acquire information, such as the content of package, the information of transport destination of the transport container C. The system control apparatus 18 compares the information acquired from the code image and the image information transmitted from the image information output unit 47 to check whether the image is properly or correctly recorded on the heat-sensitive recording label RL. If the image is properly or correctly recorded on the heat-sensitive recording label RL, the system control apparatus 18 sends the transport container C to the next step (e.g., transport preparation process) using the conveyor apparatus 10.

[0097] On the other hand, if the image is not properly or correctly recorded on the heat-sensitive recording label RL, the system control apparatus 18 temporarily stops the conveyor apparatus 10 and displays, on the operation panel 181, a message (error message) indicating the image is not properly or correctly recorded on the heat-sensitive recording label RL. Further, if the image is not properly or correctly recorded on the heat-sensitive recording label RL, the system control apparatus 18 may convey the transport container C to a pre-set conveyance destination.

(Vibration Reducing Operation)

[0098] In a case where the recording apparatus 14 performs the recording processing on the transport container C that is vibrating on the conveyor apparatus 10, the vibration may affect the quality of image recorded on the heat-sensitive recording label RL.

[0099] For example, the vibration of the transport container C may disturb the text image recorded on the heat-sensitive recording label RL, causing the text to lose its aesthetic appeal, and causing the information to be read by persons or devices to be difficult to read. Further, as to the two-dimensional code, the image may collapse due to vibration, and causing difficultly to read the information.

[0100] Therefore, when the two-dimensional code is not recorded on the transport container C, the image recording system 100 sets the amplitude of the vibration of the conveyor apparatus 10 to, for example, 6 mm or less. Further, when the two-dimensional code having a line width of 0.375 mm is recorded on the transport container C, the image recording system 100 sets the amplitude of vibration of the conveyor apparatus 10 to, for example, 2 mm less by using a damping device. Further, when the two-dimensional code having a line width of 0.5 mm is recorded on the transport container C, the image recording system 100 sets the amplitude of vibration of the conveyor apparatus 10 to, for example, 3 mm or less by using a damping device.

[0101] By setting the amplitude of vibration of the conveyor apparatus 10 to, for example, 2 mm or less, both the two-dimensional code and the text image can be recorded on the recording target with higher image quality. The vibration of the conveyor apparatus 10 can be reduced by providing, for example, the damping device to the conveyor apparatus 10.

[0102] The image recording system 100 used for recording the bar code on the recording target transmits the image information indicating each bar constituting the bar code in a direction orthogonal to the conveyance direction of the transport container C, from the image information output unit 47. With this configuration, when the bar code is recorded on the transport container C, even if the vibration occurs to the transport container C during the conveyance by the conveyor apparatus 10, the influence of vibration on the quality of image, which is recorded on the heat-sensitive recording label RL, can be reduced.

[0103] Further, if the recording apparatus 14 and the conveyor apparatus 10 vibrate simultaneously with the same pattern, the influence of vibration does not appear on the image recorded on the heat-sensitive recording label RL attached on the transport container C. Therefore, the recording apparatus 14 can be attached to the conveyor apparatus

10, or the resonant frequency of the recording apparatus 14 and the conveyor apparatus 10 can be matched. Further, if the conveyor apparatus 10 is a roller conveyor, since each roller moves up and down and the cross-shape of each roller is not a true circle, vibration may likely to occur. By making the conveyor apparatus 10 as a belt conveyor, the vibration can be reduced.

[0104] When the transport container C attached with the recording target is light weight and has a larger volume, the transport container C may be affected and moved by airflow while the image is being recorded on the recording target (heat-sensitive recording label RL). Therefore, the image recording system 100 may be provided with a rectifying (wind-proof) device.

[0105] Further, if the cycle period of the vibration of the transport container C is sufficiently longer than the time period for recording the image on the heat-sensitive recording label RL, the movement of the transport container C in the vertical direction (Z-axis direction) becomes smaller during the image recording operation even if the amplitude of vibration of the transport container C is slightly large, and thereby the influence of vibration to the image quality can be reduced. Therefore, for example, in a case where the amplitude of vibration of the transport container C is difficult to be reduced sufficiently, the conveyor apparatus 10 may be designed so that the eigen frequency of the conveyor apparatus 10 becomes a lower frequency.

[0106] Further, when the image is recorded on the heat-sensitive recording label RL (recording target) attached on the transport container C, a sudden or abrupt vibration may occur due to colliding of an object with the conveyor apparatus 10. In this case, the transport container C is vibrated greatly, and thereby the higher quality image cannot be recorded on the recording target. In such a case, the conveyor apparatus 10 is provided with a vibration detection sensor, and when the vibration detection sensor detects that the conveyor apparatus 10 vibrates at a given vibration level or more, the conveyor apparatus 10 can be stopped.

(Modification Example)

[0107] FIGs. 11 and 12 illustrate a modification example of the image recording system 100 according to the embodiment. As illustrated in FIGs. 11 and 12, the image recording system 100 can be configured to record an image on the heat-sensitive recording label RL (recording target) attached on the transport container C by moving the recording apparatus 14 instead of moving the transport container C. In the modification example of the image recording system 100, a mounting table 150 is provided to mount the transport container C on the mounting table 150. The recording apparatus 14 is supported by a guide rail 141 so as to be movable along the left and right directions along the guide rail 141.

[0108] As to the modification example of the image recording system 100, at first, an operator sets the transport container C on the mounting table 150 so that a surface of the transport container C attached with the heat-sensitive recording label RL (recording target) becomes a surface facing the recording apparatus 14. After setting the transport container C on the mounting table 150, the operation panel 181 is operated to start the image recording process. When the image recording process has started, the recording apparatus 14 set on the left side of the guide rail 141 (see FIG. 11) moves toward the right side of the guide rail 141 as indicated by an arrow illustrated in FIG. 11. While moving toward the right side of the guide rail 141 as indicated by an arrow illustrated in FIG. 11, the recording apparatus 14 records an image on the recording target (the heat-sensitive recording label RL of the transport container C) by irradiating the laser beam. After recording the image on the recording target, the recording apparatus 14 located at the right side end of the guide rail 141 (see FIG. 12) moves to the left side of the guide rail 141 as indicated by an arrow in FIG. 12, and then returns to the position illustrated in FIG. 11.

(Deterioration of Print Quality Due to Differences in Optical Properties)

[0109] As to the image recording system 100 according to the embodiment, the heat-sensitive recording medium that generates color when the recording layer absorbs the laser beam and is heated by the absorbed laser beam, may use different colors, materials, and thicknesses for a print layer depending on the manufacturer. Therefore, the optical properties (the reflection and absorption of the laser beam) of the print layer may be different for each manufacturer, in which even if the same image is to be formed by controlling the laser output power at the same level, the color density in the print layer may become different for the heat-sensitive recording medium provided by each manufacturer. Further, since each irradiation stand facing the laser beam light source via the heat-sensitive recording medium has different optical properties, the color density of the print layer becomes different for each irradiation stand. Due to the difference in the optical properties, there is a concern that a difference occurs in the print quality of the printed heat-sensitive recording medium.

[0110] As to the image recording system 100 of the embodiment using the laser printing system, based on the optical properties of the print layer of the medium, such as heat-sensitive recording medium, and the optical properties of the irradiation stand, the image recording system 100 sets the energy absorbed by the recording medium at the time of laser irradiation at a constant level to set a substantially constant temperature of the recording layer of the recording medium.

With this configuration, the color density of the recording layer can be set to the same level for each recording medium to obtain consistent print quality.

[0111] Specifically, as illustrated in FIG. 10, the storage 17 stores, for example, a laser control program executed by the CPU of the system control apparatus 18. The storage 17 further stores, for example, medium optical properties data and irradiation stand optical properties data used for the computation operation for the laser control based on the laser control program. The medium optical properties data represent optical properties including the reflectance and the absorption rate of light for each medium, such as heat-sensitive recording medium. Similarly, the irradiation stand optical properties data represent data indicating optical properties including the reflectance and the absorption rate of each manufacturer's irradiation stand.

[0112] An administrator of the image recording system 100 designates a medium, such as heat-sensitive recording medium, and an irradiation stand used for printing by operating the operation panel 181. The CPU of the system control apparatus 18 reads out the medium optical properties data corresponding to the medium designated by the administrator and the irradiation stand optical properties data corresponding to the to-be-used (mounted) irradiation stand from the storage 17, and uses the read-out optical properties data for the laser control to be described later.

[0113] In this example case, the medium optical properties data and the irradiation stand optical properties data, which correspond to the medium and the irradiation stand designated by the administrator, are read out from the storage 17 and used for the computation operation. However, the medium optical properties data and the irradiation stand optical properties data input by the administrator via the operation panel 181 can be used for the computation operation, or the medium optical properties data and the irradiation stand optical properties data can be downloaded from a database on a network and used for the computation operation.

(Functional Configuration of Image Recording System)

[0114] FIG. 13 is an example functional block diagram of each functional unit implemented by the CPU of the system control apparatus 18 by executing the laser control program stored in the storage 17. As illustrated in FIG. 13, the CPU of the system control apparatus 18 executes the laser control program to implement, for example, a data acquisition unit 61, a time information acquisition unit 62, an adjustment unit 63, a laser control unit 64 (an example of an irradiation control unit), and a laser output acquisition unit 65.

[0115] The data acquisition unit 61 acquires the medium optical properties data and the irradiation stand optical properties data corresponding to the medium and the irradiation stand designated by the administrator from the storage 17.

[0116] The time information acquisition unit 62 acquires time information from the timer 16 and counts the irradiation time of laser beam.

[0117] The adjustment unit 63 performs the computation operation for performing a laser control for obtaining consistent print quality in accordance with the optical properties of the medium and the irradiation stand based on the acquired medium optical properties data and the irradiation stand optical properties data.

[0118] The laser control unit 64 performs the laser control of the recording apparatus 14 based on the computation operation result.

[0119] The laser output acquisition unit 65 acquires laser output information indicating the current laser output power fed back from the recording apparatus 14. The laser output information is used by the laser control unit 64 to adjust the laser output power.

(Relative Positions of Recording Apparatus and Irradiation Stand)

[0120] FIG. 14 is a cross-sectional view illustrating relative positions of the recording apparatus 14 and an irradiation stand 70. The irradiation stand 70 is made of, for example, aluminum, and a surface of the irradiation stand 70 is blackened by anodic oxidation processing. With this configuration, scattering of the irradiated laser beam can be reduced. Further, as illustrated in FIG. 14, the irradiation stand 70 is provided opposite the recording apparatus 14 via the heat-sensitive recording medium RL. Hereinafter, the heat-sensitive recording medium RL corresponds to the above-described heat-sensitive recording label RL. The irradiation stand 70 supports the heat-sensitive recording medium RL during conveyance of the heat-sensitive recording medium RL, and can reduce the fluctuation of the heat-sensitive recording medium RL in the conveying path (e.g., fluctuation of position of the heat-sensitive recording medium RL). This enables the laser irradiation to be performed at the appropriate position by the recording apparatus 14 and stabilizes the density and dot size of print image.

[0121] The irradiation stand 70 also serves to cut off the laser beam to prevent the laser beam passing to the opposite side. With this configuration, an abnormal temperature increase in the recording apparatus 14 due to the energy of the laser beam can be prevented.

(Configuration of Heat-sensitive Recording Medium)

[0122] FIG. 15 is a cross-sectional view of the heat-sensitive recording medium RL. As illustrated in FIG. 15, the heat-sensitive recording medium RL includes, for example, a substrate RL1, a recording layer RL2, a print layer RL3, and also a protective layer as needed.

[0123] The substrate RL1, formed of, for example, polyethylene terephthalate (PET), supports the recording layer RL2.

[0124] The recording layer RL2 is formed of, for example, a coloring agent such as leuco dye, developer, and photo-thermal conversion material. The recording layer RL2 emits heat by absorbing an incident laser beam with the photo-thermal conversion material, and the color develops by reacting the developer with the coloring agent as the temperature rises. With this configuration, an image is formed in the recording medium RL. As above-described, the image is formed in the recording layer RL2 by a chemical reaction, but a method of forming the image is not limited thereto.

[0125] The print layer RL3 forms a background image for the image recorded in the recording layer RL2. The print layer RL3 is formed of color, material, and thickness selected by each manufacturer of the heat-sensitive recording medium RL. Therefore, the color, material and thickness of the print layer RL3 vary depending on the manufacturer. Further, the print layer RL3 is an optional layer provided when the user uses the image recording system 100.

[0126] In addition, the protective layer may be also provided as needed. By providing the protective layer, infiltration of water, chemicals, or the like, and rubbing and abrasion of image can be prevented to preserve the image. In addition, a protective layer that absorbs ultraviolet light may be provided to prevent discoloration of the coloring agent (colorant) by ultraviolet rays. It should be noted that the stacking order of the layers of the substrate RL1 to the print layer RL3 can be changed from the stacking order illustrated in FIG. 15.

(Relation between Optical Properties and Absorption Rate during Laser Irradiation of Heat-Sensitive Recording Medium)

[0127] FIG. 16 is a diagram illustrating a relationship between the optical properties and the absorption rate of the heat-sensitive recording medium RL and the opposing irradiation stand 70. In FIG. 16, a thick arrow indicates a path of a laser beam that enters the heat-sensitive recording medium RL, and a hatched area in the recording layer RL2 indicates a heat absorption area in the recording layer RL2.

[0128] The laser beam incident from the substrate RL1 is partially reflected at one surface of the substrate RL1, and at an interface between the substrate RL1 and the substrate RL2. The laser beam passing through the interface between the substrate RL1 and the recording layer RL2 is partially absorbed in the recording layer RL2 as heat, partially reflected at an interface between the recording layer RL2 and the print layer RL3, and the remaining laser beam passes through the heat-sensitive recording medium RL.

[0129] Thereafter, a part of the laser beam incident on the irradiation stand 70 is reflected at one surface of the irradiation stand 70 and enters the heat-sensitive recording medium RL again, and then the reflection, absorption, and passing of laser beam occur within the heat-sensitive recording medium RL in the same manner as described above. The remaining laser beam not reflected at the one surface of the irradiation stand 70 passes through the one surface of the irradiation stand 70.

[0130] In this configuration, a ratio of energy of the laser beam reflected by the heat-sensitive recording medium RL with respect to the energy of the initial incident laser beam entering the heat-sensitive recording medium RL is referred to as "R1," in which the energy of laser beam reflected by the heat-sensitive recording medium RL is the sum of the energy of laser beam reflected at the surface of the substrate RL1, the interface between the substrate RL1 and the recording layer RL2, and the interface between the recording layer RL2 and the print layer RL3.

[0131] Further, a ratio of energy of the laser beam passing through the heat-sensitive recording medium RL, reflected at the irradiation stand 70, and passing through the heat-sensitive recording medium RL again is referred to as "R2."

[0132] Further, a ratio of energy of the laser beam passing through the heat-sensitive recording medium RL and passing through the surface of the irradiation stand 70 is referred to as "T."

[0133] Further, a ratio of energy of the initial incident laser beam entering and absorbed by the heat-sensitive recording medium RL and a ratio of energy of the laser beam passing through the heat-sensitive recording medium RL, reflected at the surface of the irradiation stand 70 and then absorbed by the heat-sensitive recording medium RL again are summed as absorption rate "A."

[0134] Since the laser beam other than "R1," "R2" and "T" is absorbed by the heat-sensitive recording medium RL, an equation of "R1+R2+T+A = 1" can be set. Then, "A = 1-(R2+R1+T)" is obtained. Since the parameters "R1," "R2," "T" and "A" are considered to be wavelength dependent, the parameters are set using the central wavelength of the laser beam used for the recording apparatus 14. Further, the effect of the laser beam that is reflected two times or more can be neglected because a ratio of laser beam reflected two times or more is small. However, the absorption rate "A" can be determined more correctly or strictly by considering the two times or more reflection.

[0135] Based on the above concept, the ratio of energy absorbed by the recording layer R2 of the heat-sensitive recording medium RL can be determined by considering the optical properties related to reflection and passing for the heat-sensitive recording medium RL (particularly, the print layer RL3) and the irradiation stand 70. With this configuration, even if a user changes at least any one of the heat-sensitive recording medium RL and the irradiation stand 70, the absorption rate "A" can be determined in view of the influence of changing the heat-sensitive recording medium RL and/or the irradiation stand 70, so that the image quality can be stabilized by controlling the output power of laser beam optimally, as to be described later

(Measurement Method and Input Method of Optical Properties)

[0136] Hereinafter, a description is given of a measurement method and an input method of the parameters "R1," "R2" and "T" that are necessary for obtaining the above-mentioned absorption rate "A."

[0137] "R1" measures the reflectance of the heat-sensitive recording medium RL at the wavelength of the laser beam using a spectrophotometer or the like.

[0138] Since "R2" is the ratio of the laser beam passing through the heat recording medium RL two times and reflected at the irradiation stand 70, "R2" is calculated as a product obtained by multiplying a squared value of the transmittance rate of the heat-sensitive recording medium RL and the reflectance rate of the irradiation stand 70. Alternatively, as to the arrangement of FIG. 16, the energy of the laser beam reflected by the heat-sensitive recording medium RL and the energy of the laser beam reflected by the irradiation stand 70 for the incident laser beam can be calculated respectively, and added together as the sum of "R1" and "R2."

[0139] "T" is calculated as a product obtained by multiplying the transmittance rate of the heat-sensitive recording medium RL and the transmittance rate on the surface of the irradiation stand 70 (i.e., 1 - reflectance). Since the diffusion reflection caused by roughness may occur at the surface of the heat-sensitive recording medium RL and the interface between the layers, the reflected laser beam may be collected using the integrating sphere or the like and measured.

[0140] The medium optical properties data ("R1" and "R2") of the heat-sensitive recording medium RL and the irradiation stand optical properties data ("T") can be measured in advance by an administrator and stored in the storage 17. As described above, the parameters "R1," "R2" and "T" can be input by the administrator via the operation panel 181. Further, instead of inputting "R1" and "R2" separately, the sum of "R1" and "R2" can be used.

[0141] Based on the parameters "R1," "R2" and "T," the absorption rate "A" indicating an absorption level by the heat-sensitive recording medium RL can be calculated using the above-described computation equation. Further, the laser irradiation time t [s] per unit area is set as follows. That is, when the pitch of one dot is set to 200 dpi, the pitch of 127 μm is obtained. Further, the conveying speed of the medium is set to 5 [ms^{-1}]. In this example case, the laser irradiation time t [s] per unit area is set to "t = 127/5 = 25.4 [μs]. In addition to the laser irradiation time, for example, the resolution or the reverse number of the conveying speed of the medium (heat-sensitive recording medium RL) may be used.

(Laser Output Control)

[0142] FIG. 17 illustrates a relationship between the absorption rate "A" indicating energy level absorbed by the heat-sensitive recording medium RL calculated by the system control apparatus 18 based on the above-described computation equation and the laser output power of the recording apparatus 14. The system control apparatus 18 controls the recording apparatus 14 such that the laser output power P [W] satisfies the following equation.

$$A \times P \times t = 5.0 \times 10^3 \text{ [J]}$$

[0143] The left side of this equation indicates Joule heat absorbed by the heat-sensitive recording medium RL per unit area (for example, one pitch, 127 μm square). The left side of this equation is a value obtained by multiplying the laser output power P [W] and the irradiation time t [s] of the irradiated laser and the absorption rate A of the energy absorbed by the heat-sensitive recording medium RL.

[0144] The system control apparatus 18 controls the recording apparatus 14 such that the value of "A×P×t" becomes a constant value set by the right side of this equation. With this configuration, even if the material of the print layer RL3 of the heat-sensitive recording medium RL and/or the irradiation stand 70 is changed by a user and thereby different optical properties are set, and thereby a value of the absorption rate "A" changes, the energy to be absorbed by the heat-sensitive recording medium RL can be set at a constant value.

[0145] With this configuration, a risk that the chemical reaction between the coloring layer and the developer layer of the recording layer RL2 becomes insufficient due to too-low absorbed energy, and thereby producing insufficient image density, can be reduced or prevented. Further, a risk that the image quality fluctuates and deteriorates by reaching the melting point or the deterioration temperature of any material in the heat-sensitive recording medium RL due to excessive absorbed energy can be reduced, with which the image density can be stabilized.

[0146] In the above described configuration, the system control apparatus 18 controls the value of "A×P×t" to become the constant value, in which thermal properties such as the heat capacity of the heat-sensitive recording medium RL and thermal conductivity of the heat-sensitive recording medium RL may also affect the image density. Therefore, the left side of this equation may be adjusted to ± 20% depending on the materials having given heat properties. Thus, the image density can be stabilized even further.

[0147] Further, in this example case, the system control apparatus 18 changes the laser output power P of the laser beam to satisfy "$A \times P \times t = 5.0 \times 10^3$ [J]," but the irradiation time t can be changed instead of the laser output power P. In this case, the system control apparatus 18 changes, for example, the conveying speed depending on the heat-sensitive recording medium RL.

[0148] In the above described configuration, the wavelength of the laser beam used for the recording apparatus 14 is, for example, 950 nm. As indicated in Table 1, the parameters "R1," "R2," "T" and "A" are set in accordance with the color of the print layer RL3. Specifically, when the color of the print layer RL3 is transparent color, the parameter R1 is set to "0.04," the parameter R2 is set to "0.48," the parameter T is set to "0.30," the parameter A is set to "0.18," and stored in the storage 17 as the medium optical properties data or the irradiation stand optical properties data. Similarly, when the color of the print layer RL 3 is red, the parameter R1 is set to "0.04," the parameter R2 is set to "0.47," the parameter T is set to "0.29," and the parameter A is set to "0.20," and stored in the storage 17 as the medium optical properties data or the irradiation stand optical properties data.

Table 1

Color of Print Layer RL3	R1	R2	T	A
Transparent	0.04	0.48	0.30	0.18
White	0.35	0.19	0.14	0.32
Red	0.04	0.47	0.29	0.20
Blue	0.05	0.45	0.28	0.22

[0149] As to the print layer RL3 having the transparent color, the parameter R1, which is the ratio reflected by the heat-sensitive recording medium RL, is set to "0.04." This value indicates that substantially all of the reflection of laser beam occurs at the one surface of the substrate RL1. On the other hand, in a case of the print layer RL3 having white color, as to the parameter R1 of "0.35," "0.04" is reflected at the surface of the substrate RL1, and the remaining "0.31" is the ratio reflected at the interface between the recording layer RL2 and the print layer RL3. Thus, it can be understood that the reflectance ratio of laser beam varies greatly depending on the color of the print layer.

(Laser Output Control)

[0150] FIG. 19 is a flowchart illustrating a laser control operation performed by the system control apparatus 18 based on the laser control program. In the flowchart illustrated in FIG. 19, an operator of the image recording system 100 performs an information/instruction input operation to designate or select the heat-sensitive recording medium RL used for printing via the operation panel 181, and then instructs a start operation of the printing to start the sequence from step S1.

[0151] In step S1, the data acquisition unit 61 of the system control apparatus 18 (FIG. 13) acquires the parameter R1, parameter R2, and parameter T corresponding to the heat-sensitive recording medium RL designated by the operator (user) from the storage 17.

[0152] In step S2, the adjustment unit 63 performs the calculation represented by the following formula by setting "R1" as a ratio of energy of laser beam reflected by the laser-beam-irradiated surface of the heat-sensitive recording medium RL, "R2" as a ratio of energy of laser beam that passes through the heat-sensitive recording medium RL, reflects at the irradiation stand 70, and again passes through the heat-sensitive recording medium RL, "T" as a ratio of energy of laser beam that passes through the surface of the heat-sensitive recording medium RL and the irradiation stand 70, "P [W]" as the output power of laser beam, and "t [s]" as the irradiation time of laser beam per unit area of the recording medium.

$$C = [1-(R1+R2+T)]\times(P\times t)$$

[0153] Then, in step S3, the time information acquisition unit 62 starts to acquire time information that has been counted by the timer 16.

[0154] Then, in step S4, the laser control unit 64 controls the recording apparatus 14 to start the irradiation of laser beam.

[0155] Then, in step S5, the laser output acquisition unit 65 acquires a current value of laser output power fed back from the recording apparatus 14. The laser control unit 64 controls the laser output power by adjusting a value of "P×t" of the above equation while checking or counting the time information to set a substantially constant value for "C."

[0156] In step S6, while performing the laser output control, the laser control unit 64 determines whether or not the value of C is substantially constant, for example, within ± 20% or less of a target value.

[0157] If the laser control unit 64 determines that the value of C is substantially constant (step S6: YES), the sequence proceeds to step S7, in which the laser control unit 64 determines whether or not the printing has completed.

[0158] If the laser control unit 64 determines that the printing has not yet completed (step S7: NO), the laser control unit 64 returns the sequence to step S4 and continues the laser control operation.

[0159] On the other hand, if the laser control unit 64 determines that the printing has completed (step S7: YES), the laser control unit 64 terminates the sequence of FIG. 19.

[0160] Further, if the laser control unit 64 determines that the value of C is not substantially constant (step 6: NO), the sequence proceeds to step S8, in which the adjustment unit 63 changes the value of "P×t" of the above equation, and then returns the sequence to step S2. Then, the adjustment unit 63 performs the above-described computation operation again based on the changed value of "P×t." Then, the laser control unit 64 performs the laser output control based on a computation result of the computation operation, which is performed again. Thus, the laser output control can be performed so that the value of C becomes substantially constant.

[0161] As above described, the image recording system 100 can perform the laser output control by changing the value of "P×t" so that the value C becomes the substantially constant. With this configuration, even if the optical properties of the heat-sensitive recording medium RL and/or the irradiation stand 70 change, the printed image density on the heat-sensitive recording medium RL can be made constant, and the printing quality can be improved.

[0162] As indicated in the above description of the embodiment, the image recording system 100 can stabilize the printed image density of the recording medium RL by performing the laser control based on the optical properties of the recording medium RL and/or the irradiation stand 70 depending on various optical properties of the heat-sensitive recording medium RL and the irradiation stand 70. Therefore, the print quality can be improved.

(Stabilization of Laser Output Depending on Optical Properties of Heat-Sensitive Recording Medium and Irradiation Stand)

[0163] Specifically, FIG. 18 is a graph illustrating a relationship between the absorption rate "A" (parameter A) indicating the energy absorbed by the heat-sensitive recording medium RL, and the image density (OD) obtained by changing the color and thickness of the print layer RL 3 of the heat-sensitive recording medium RL and by changing the material of irradiation stand 70 based on the measured absorption rate "A" (parameter A) and the image density (OD).

[0164] In FIG. 18, each black dot represents a comparative example obtained by setting the irradiated laser output power to a constant value (e.g., P = 3.9 [W]). In this comparative example, as indicated in the graph represented by black dots, the image density increases in accordance with the ratio of the energy absorbed by the heat-sensitive recording medium RL. As indicated by the black dots, the change in the image density (OD) occurs when the user arbitrarily changes the recording medium RL and/or the irradiation stand 70. In particular, when the image density (OD) becomes highest, burns occurred on the heat-sensitive recording medium RL due to the deterioration of the heat-sensitive recording medium RL and image degradation occurred.

[0165] On the other hand, each white circle represents the result of the image recording system 100 according to the present embodiment. As indicated by the white circles, the image density (OD) becomes substantially constant in a range of 1.0 to 1.2 regardless of the change of the recording medium RL and/or the irradiation stand 70 used for the image recording system 100. Thus, the temperature generated on the recording layer RL2 of the heat-sensitive recording medium RL can be substantially set constant, and the color density of the recording layer RL2 is set at the same level for each medium, such as the heat-sensitive recording medium RL, thereby achieving consistent print quality.

(Gradation Expression)

[0166] The image recording system 100 can maintain the image density at a constant level regardless of the print layer RL3, and can reduce degradation of the image, and can provide stable image quality even if the image gradation or tone is changed in the same manner. The image density is dependent on the output power level of laser beam, and a darker image is obtained as the output power level of laser beam increases. Therefore, the system control apparatus 18 changes the energy amount of the right side of the computation equation of "$A \times P \times t = 5.0 \times 10^3$ [J]" in view of the gradation. With this configuration, a stable image quality (print quality) can be obtained constantly regardless of the material of the heat-sensitive recording medium RL and/or the irradiation stand 70, at each gradation.

(Stabilization of Image Density for Print Layer of White)

[0167] As described with reference to Table 1, when all or a part of the print layer RL3 is white in the heat-sensitive recording medium RL, a part of the laser beam is reflected at the interface between the recording layer RL2 and the print layer RL3, and again passing through the recording layer RL2. This increases the absorbed energy and then increases a value of the above described parameter "A." As the value of the parameter "A" increases, the energy absorbed by the heat-sensitive recording medium RL increases, and thereby the developed color density of the heat-sensitive recording medium RL having the print layer RL3 of white becomes different compared to the heat-sensitive recording medium RL having the print layer RL3 of a color other than white.

[0168] As described above, the image recording system 100 can stabilize the energy absorbed by the heat-sensitive recording medium RL and thereby stabilize the image density. This effect can be obtained significantly for the heat-sensitive recording medium RL having the print layer RL3 of white having a reflection ratio of 0.10 or more for the heat-sensitive recording medium RL.

[0169] In the above-described embodiment, the values of the parameters R1, R2 and T are measured in advance and then used. However, all or a part of the parameters R1, R2 and T can be measured just before the printing or during the printing and then used. In this configuration, the laser control can be performed based on the parameters acquired in real time, so that a more stable print quality can be obtained without being affected by the changing condition of the apparatus over time.

(Reducing of Generation of Foreign Matter from Heat-Sensitive Recording Medium)

[0170] A description is given of a case when too strong laser beam is directed onto the heat-sensitive recording medium, in particular, the recording layer of the heat-sensitive recording medium. In this case, the temperature of the heat-sensitive recording medium rises to a temperature higher than the heat resistance temperature limit of the heat-sensitive recording medium, with which the material forming the recording layer may be thermally decomposed, and thereby foreign matter (e.g., smoke) may be generated. Trial experiments conducted using the image recording system 100 has confirmed that the image recording system 100 of the embodiment can reduce the generation of foreign matter and/or decomposed product.

[0171] Therefore, the image recording system 100 can reduce handling work for the heat-sensitive recording medium adhered with the foreign matter by an operator, who is present near the recording apparatus 14 that performs the laser irradiation, and thereby improve the safety operation of the image recording system 100 (e.g., safety of operator). Further, the adhesion of foreign matter and/or decomposed product onto the conveyance system conveying the heat-sensitive recording medium and adversely affecting the absorption amount of laser beam by the heat-sensitive recording medium can be prevented, thereby preventing the deterioration of the print image. Further, the generation of foreign matter and/or decomposed product can be prevented.

[0172] As to the above described embodiment, the printing apparatus, the printing method and the carrier means can be used to attain consistent print quality. Specifically, the intensity of the laser beam (e.g., output power of laser beam) can be controlled based on the optical properties of the recording medium and/or the irradiation stand, and the print density of the recording medium can be stabilized to a constant level even if various kinds of the recording media and the irradiation stands having various optical properties are used.

Claims

1. A printing apparatus (100) comprising:

a laser device (14) configured to direct a laser beam onto a recording medium for printing target information on the recording medium;

an adjustment unit (63) configured to calculate a power of the laser beam to be directed onto the recording medium based on optical properties of the recording medium (RL) and optical properties of an irradiation stand (70) provided opposite the laser device (14) across the recording medium (RL), and adjust the power of the laser beam or an irradiation time of the laser beam,

wherein the adjustment unit (63) calculates an equation of

$$C = [1-(R1+R2+T)]\times(P\times t)$$

and adjusts a value of (P×t) to set a constant value for C,

wherein R1 is a ratio of energy of the laser beam reflected from the recording medium (RL),
wherein R2 is a ratio of energy of the laser beam that passes through the recording medium (RL) and is reflected by the irradiation stand (70), and passes through the recording medium (RL) again,
wherein T is a ratio of energy of the laser beam that passes through the recording medium (RL) and the irradiation stand (70),
wherein P is the power of the laser beam irradiated onto the recording medium (RL), and
wherein t is the irradiation time of the laser beam per unit area of the recording medium (RL); and
an irradiation control unit (64) configured to control the laser device (14) to direct the laser beam onto the recording medium (RL) based on the power and irradiation time as adjusted by the adjustment unit (63).

2. The printing apparatus (100) according to claim 1,
wherein a value of R1, which is the ratio of energy of the laser beam reflected by the recording medium (RL), is set at 0.10 or more.

3. A method of printing target information on a recording medium (RL) using a laser beam emitted from a laser device (14), the method comprising:

calculating a power of the laser beam to be directed onto the recording medium (RL) based on optical properties of the recording medium (RL) and optical properties of an irradiation stand (70) provided opposite the laser device (14) across the recording medium (RL);
adjusting, by an adjustment unit (63), the power of the laser beam or an irradiation time of the laser beam,

wherein the adjustment unit (63) calculates an equation of

$$C = [1 - (R1+R2+T)]\times(P\times t)$$

and adjusts a value of (P×t) to set a constant value for C,

wherein R1 is a ratio of energy of the laser beam reflected from the recording medium (RL),
wherein R2 is a ratio of energy of the laser beam that passes through the recording medium (RL) and is reflected by the irradiation stand (70), and passes through the recording medium (RL) again,
wherein T is a ratio of energy of the laser beam that passes through the recording medium (RL) and the irradiation stand (70),
wherein P is the power of the laser beam irradiated onto the recording medium (RL), and
wherein t is the irradiation time of the laser beam per unit area of the recording medium (RL); and
controlling the laser device (14) to direct the laser beam onto the recording medium (RL) based on the power and irradiation time as adjusted by the adjustment unit (63).

Patentansprüche

1. Druckgerät (100), umfassend:

eine Laservorrichtung (14), konfiguriert zum Richten eines Laserstrahls auf ein Aufzeichnungsmedium, um Zielinformationen auf das Aufzeichnungsmedium zu drucken;
eine Anpassungseinheit (63), konfiguriert zum Berechnen einer Leistung des Laserstrahls, der auf das Aufzeichnungsmedium zu richten ist, basierend auf optischen Eigenschaften des Aufzeichnungsmediums (RL) und optischen Eigenschaften eines Bestrahlungsständers (70), bereitgestellt gegenüber der Laservorrichtung (14), über das Aufzeichnungsmedium (RL), und Anpassen der Leistung des Laserstrahls oder einer Bestrahlungszeit des Laserstrahls,
wobei die Anpassungseinheit (63) eine folgende Gleichung berechnet

$$C = [1-(R1+R2+T)]\times(P\times t)$$

und einen Wert von (Pxt) anpasst, um einen konstanten Wert für C einzustellen,
wobei R1 ein Verhältnis von Energie des von dem Aufzeichnungsmedium (RL) reflektierten Laserstrahls ist,
wobei R2 ein Verhältnis von Energie des Laserstrahls ist, der durch das Aufzeichnungsmedium (RL) verläuft und von dem Bestrahlungsständer (70) reflektiert wird und erneut durch das Aufzeichnungsmedium (RL) verläuft,
wobei T ein Verhältnis von Energie des Laserstrahls ist, der durch das Aufzeichnungsmedium (RL) und den Bestrahlungsständer (70) verläuft,
wobei P die Leistung des auf das Aufzeichnungsmedium (RL) bestrahlten Laserstrahls ist und
wobei t die Bestrahlungszeit des Laserstrahls pro Einheitsfläche auf das Aufzeichnungsmedium (RL) ist; und
eine Bestrahlungssteuereinheit (64), konfiguriert zum Steuern der Laservorrichtung (14) zum Richten des Laserstrahls auf das Aufzeichnungsmedium (RL) basierend auf der Leistung und Bestrahlungszeit, wie durch die Anpassungseinheit (63) angepasst.

2. Druckgerät (100) nach Anspruch 1,
wobei ein Wert von R1, das das Verhältnis von Energie des durch das Aufzeichnungsmedium (RL) reflektierten Laserstrahls ist, auf 0,10 oder mehr eingestellt wird.

3. Verfahren zum Drucken von Zielinformationen auf ein Aufzeichnungsmedium (RL) unter Verwendung eines von einer Laservorrichtung (14) abgegebenen Laserstrahls, das Verfahren umfassend:

Berechnen einer Leistung des Laserstrahls, der auf das Aufzeichnungsmedium (RL) zu richten ist, basierend auf optischen Eigenschaften des Aufzeichnungsmediums (RL) und optischen Eigenschaften eines Bestrahlungsständers (70), bereitgestellt gegenüber der Laservorrichtung (14), über das Aufzeichnungsmedium (RL);
Anpassen, durch eine Anpassungseinheit (63), der Leistung des Laserstrahls oder einer Bestrahlungszeit des Laserstrahls,
wobei die Anpassungseinheit (63) eine folgende Gleichung berechnet

$$C = [1-(R1+R2+T)]\times(P\times t)$$

und einen Wert von (Pxt) anpasst, um einen konstanten Wert für C einzustellen,
wobei R1 ein Verhältnis von Energie des von dem Aufzeichnungsmedium (RL) reflektierten Laserstrahls ist,
wobei R2 ein Verhältnis von Energie des Laserstrahls ist, der durch das Aufzeichnungsmedium (RL) verläuft und von dem Bestrahlungsständer (70) reflektiert wird und erneut durch das Aufzeichnungsmedium (RL) verläuft,
wobei T ein Verhältnis von Energie des Laserstrahls ist, der durch das Aufzeichnungsmedium (RL) und den Bestrahlungsständer (70) verläuft,
wobei P die Leistung des auf das Aufzeichnungsmedium (RL) gestrahlten Laserstrahls ist und
wobei t die Bestrahlungszeit des Laserstrahls pro Einheitsfläche auf das Aufzeichnungsmedium (RL) ist; und
Steuern der Laservorrichtung (14) zum Richten des Laserstrahls auf das Aufzeichnungsmedium (RL) basierend auf der Leistung und Bestrahlungszeit, wie durch die Anpassungseinheit (63) angepasst.

Revendications

1. Appareil d'impression (100) comprenant :

un dispositif laser (14) configuré afin de diriger un faisceau laser sur un support d'enregistrement pour imprimer des informations cibles sur le support d'enregistrement ;
une unité d'ajustement (63) configurée afin de calculer une puissance du faisceau laser à diriger sur le support d'enregistrement sur la base de propriétés optiques du support d'enregistrement (RL) et de propriétés optiques d'un support d'irradiation (70) ménagé à l'opposé du dispositif laser (14) à travers le support d'enregistrement (RL), et ajuster la puissance du faisceau laser ou un temps d'irradiation du faisceau laser,
dans lequel l'unité d'ajustement (63) calcule une équation de :

$$C = [1-(R1+R2+T)]\times(P\times t)$$

et ajuste une valeur de (Pxt) permettant de régler une valeur constante pour C,
dans lequel R1 est un rapport de l'énergie du faisceau laser réfléchi par le support d'enregistrement (RL),

dans lequel R2 est un rapport de l'énergie du faisceau laser qui passe à travers le support d'enregistrement (RL) et est réfléchi par le support d'irradiation (70), et repasse à travers le support d'enregistrement (RL),
dans lequel T est un rapport de l'énergie du faisceau laser qui passe à travers le support d'enregistrement (RL) et le support d'irradiation (70),
dans lequel P est la puissance du faisceau laser irradié sur le support d'enregistrement (RL), et
dans lequel t est le temps d'irradiation du faisceau laser par zone unitaire du support d'enregistrement (RL) ; et
une unité de commande d'irradiation (64) configurée afin de commander le dispositif laser (14) permettant de diriger le faisceau laser sur le support d'enregistrement (RL) sur la base de la puissance et du temps d'irradiation tel qu'ajusté par l'unité d'ajustement (63).

2. Appareil d'impression (100) selon la revendication 1,
dans lequel une valeur de R1, qui est le rapport d'énergie du faisceau laser réfléchi par le support d'enregistrement (RL), est réglée à 0,10 ou plus.

3. Procédé d'impression d'informations cibles sur un support d'enregistrement (RL) en utilisant un faisceau laser émis par un dispositif laser (14), le procédé comprenant :

le calcul d'une puissance du faisceau laser à diriger sur le support d'enregistrement (RL) sur la base de propriétés optiques du support d'enregistrement (RL) et des propriétés optiques d'un support d'irradiation (70) ménagé à l'opposé du dispositif laser (14) à travers le support d'enregistrement (RL) ;
l'ajustement, par une unité d'ajustement (63), de la puissance du faisceau laser ou d'un temps d'irradiation du faisceau laser,
dans lequel l'unité d'ajustement (63) calcule une équation de :

$$C = [1-(R1+R2+T)]\times(P\times t)$$

et ajuste une valeur de (Pxt) permettant de régler une valeur constante pour C,
dans lequel R1 est un rapport de l'énergie du faisceau laser réfléchie par le support d'enregistrement (RL),
dans lequel R2 est un rapport de l'énergie du faisceau laser qui passe à travers le support d'enregistrement (RL) et est réfléchi par le support d'irradiation (70), et repasse à travers le support d'enregistrement (RL),
dans lequel T est un rapport de l'énergie du faisceau laser qui passe à travers le support d'enregistrement (RL) et le support d'irradiation (70),
dans lequel P est la puissance du faisceau laser irradié sur le support d'enregistrement (RL), et
dans lequel t est le temps d'irradiation du faisceau laser par zone unitaire du support d'enregistrement (RL) ; et
la commande du dispositif laser (14) permettant de diriger le faisceau laser sur le support d'enregistrement (RL) sur la base de la puissance et du temps d'irradiation tel qu'ajusté par l'unité d'ajustement (63).

FIG. 1

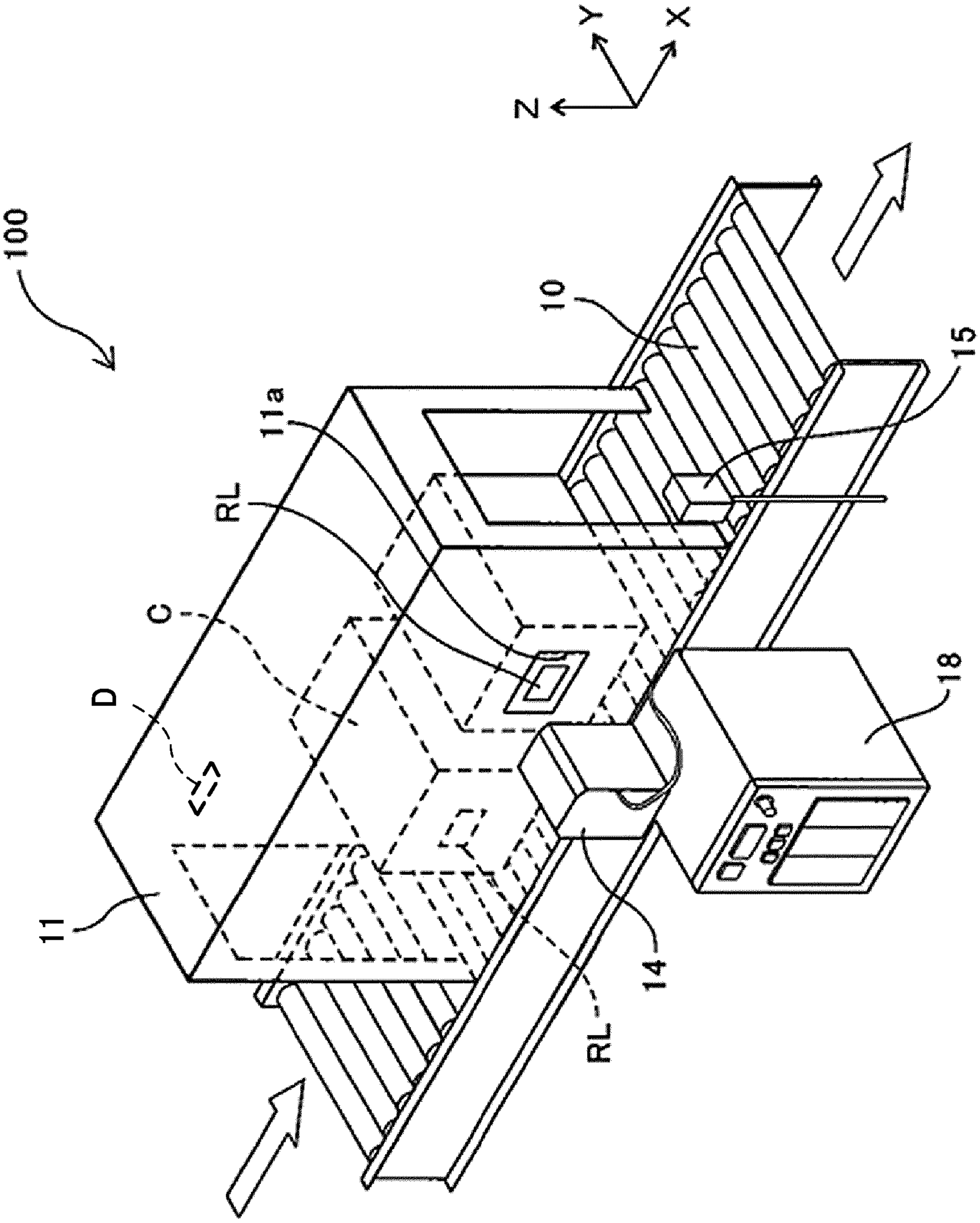


FIG. 2

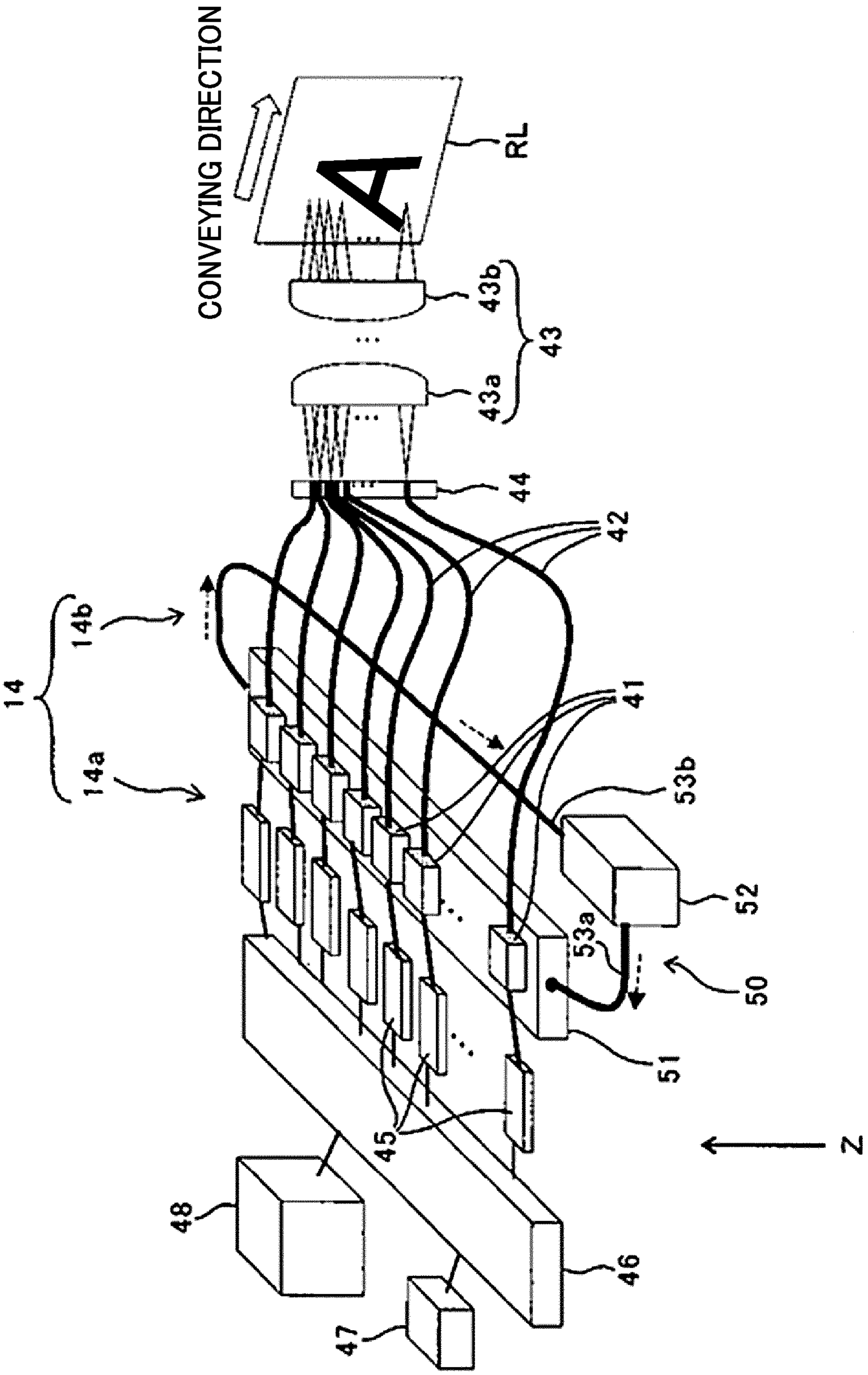

CONVEYING DIRECTION
RL
43b
43
43a
44
42
14b
14
14a
41
53b
52
53a
50
51
45
48
46
47
Z

FIG. 3

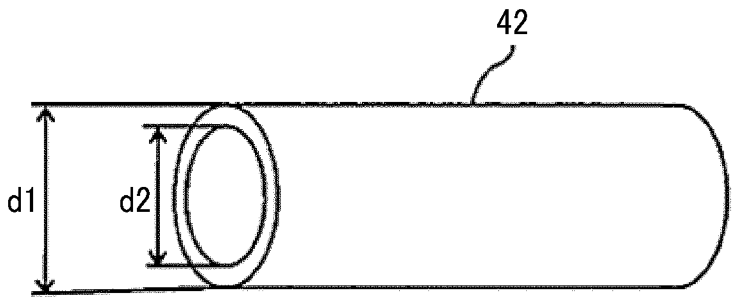


FIG. 4

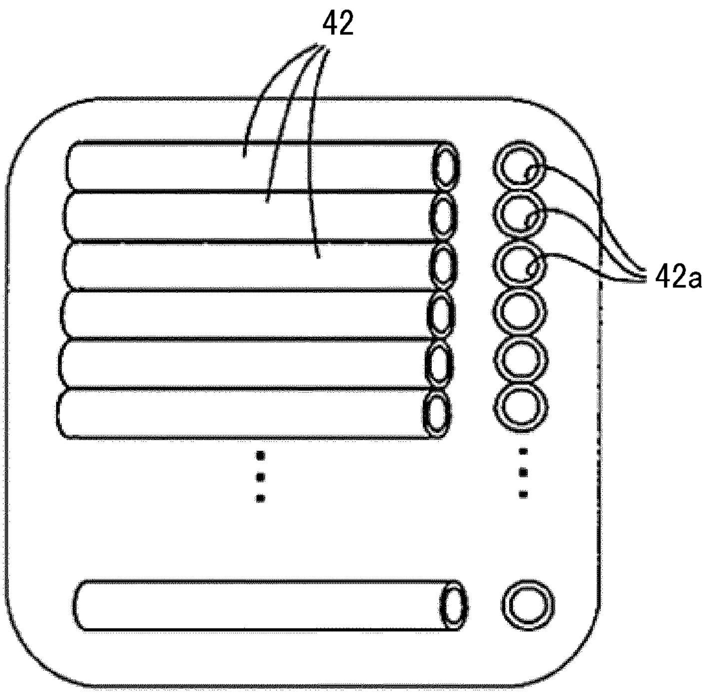


FIG. 5

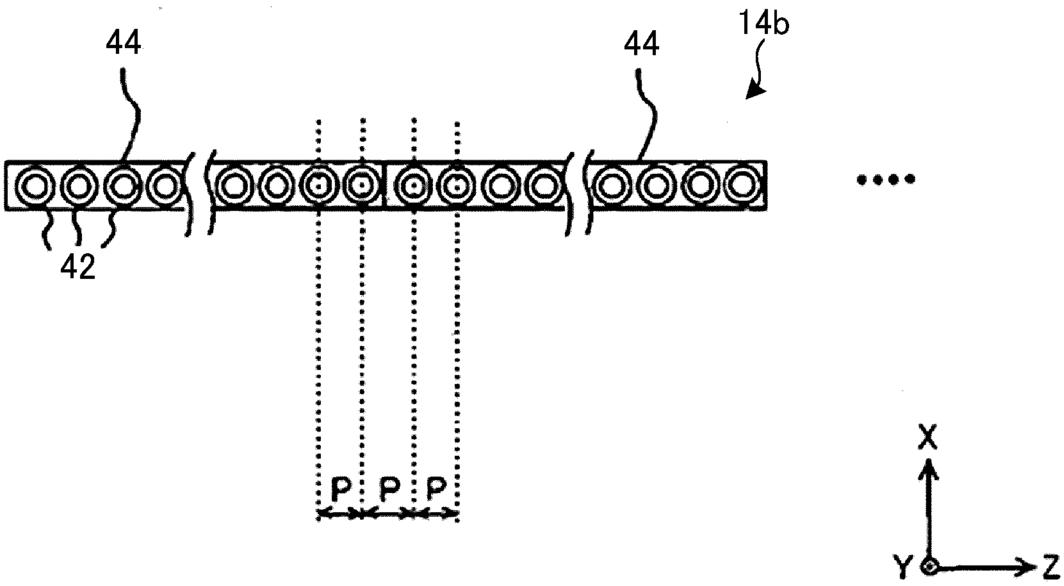


FIG. 6

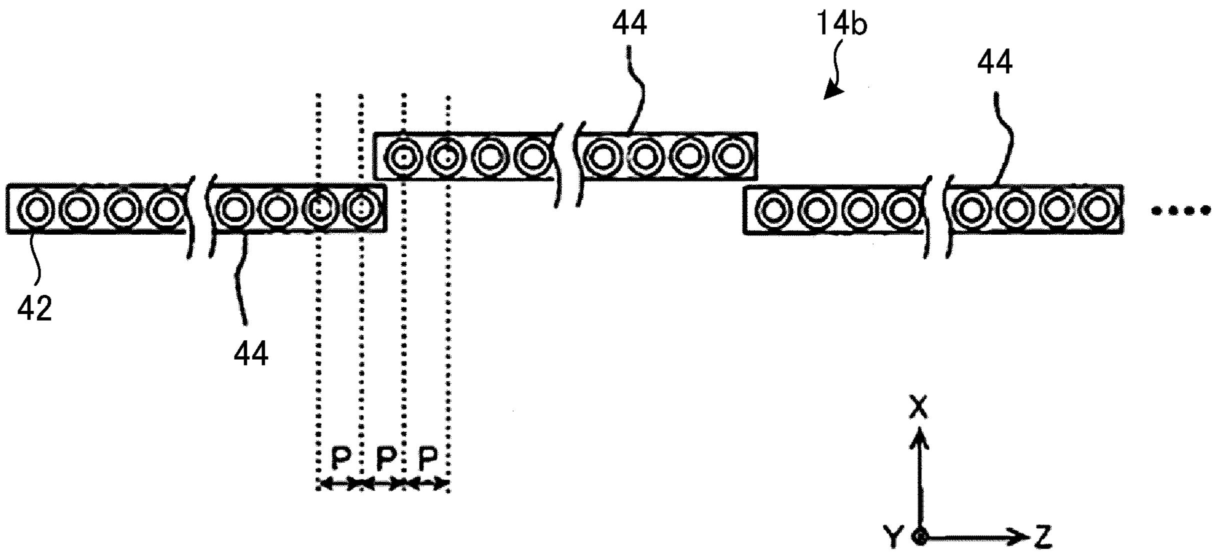


FIG. 7

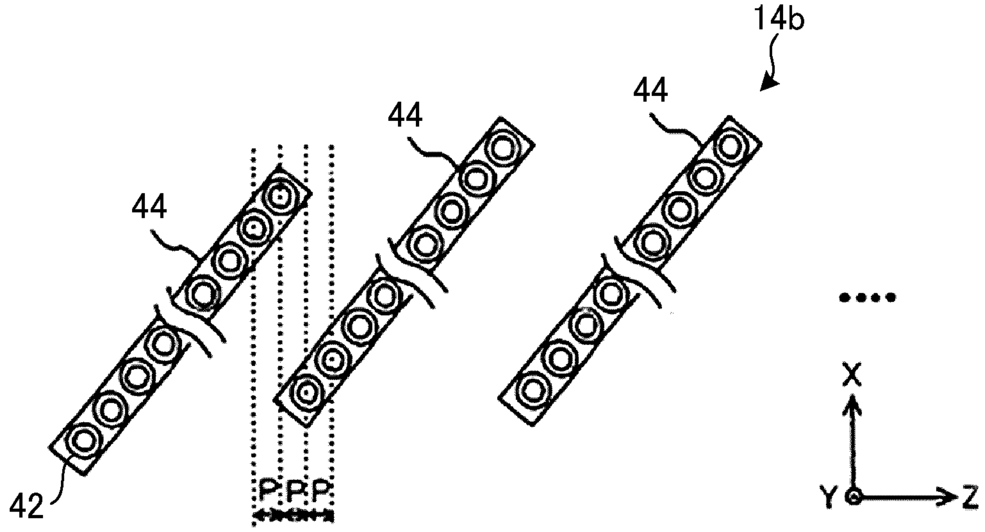


FIG. 8

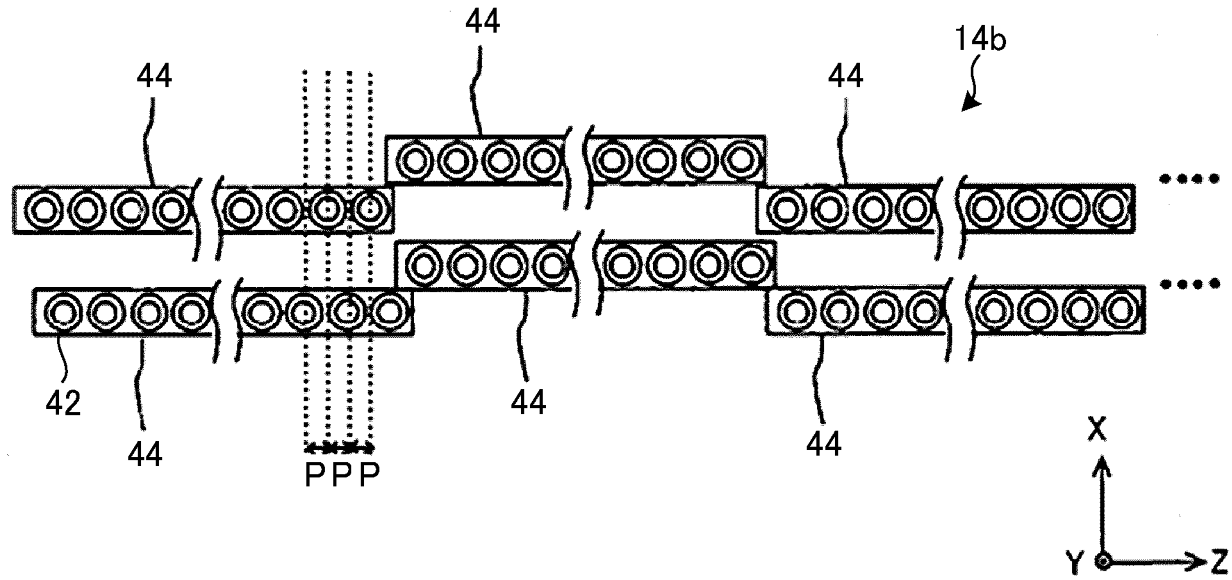


FIG. 9

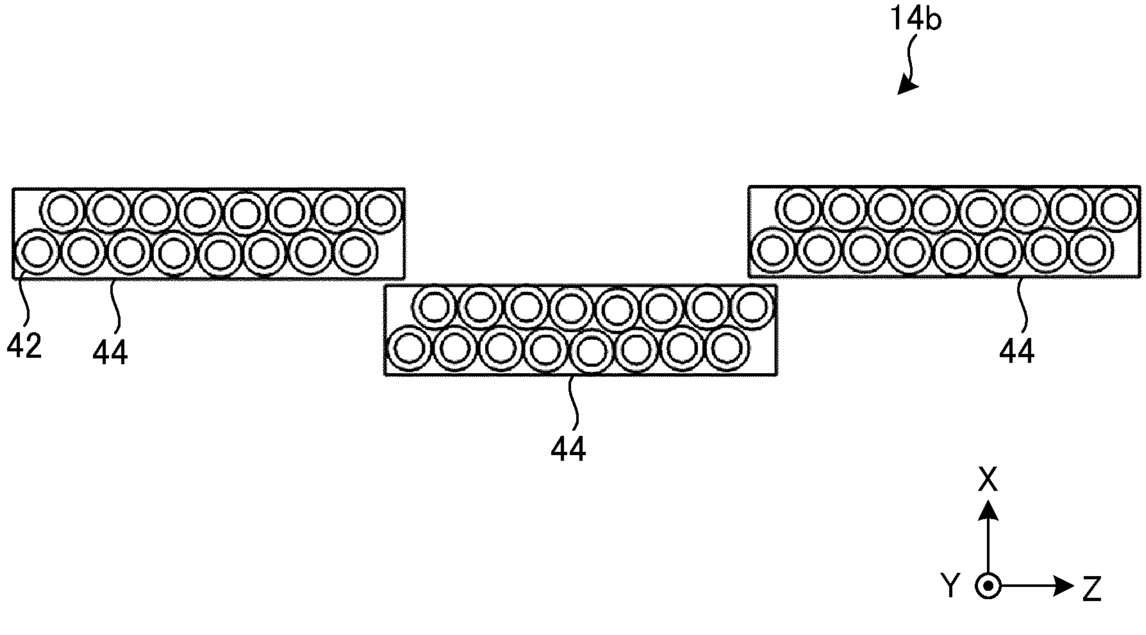


FIG. 10

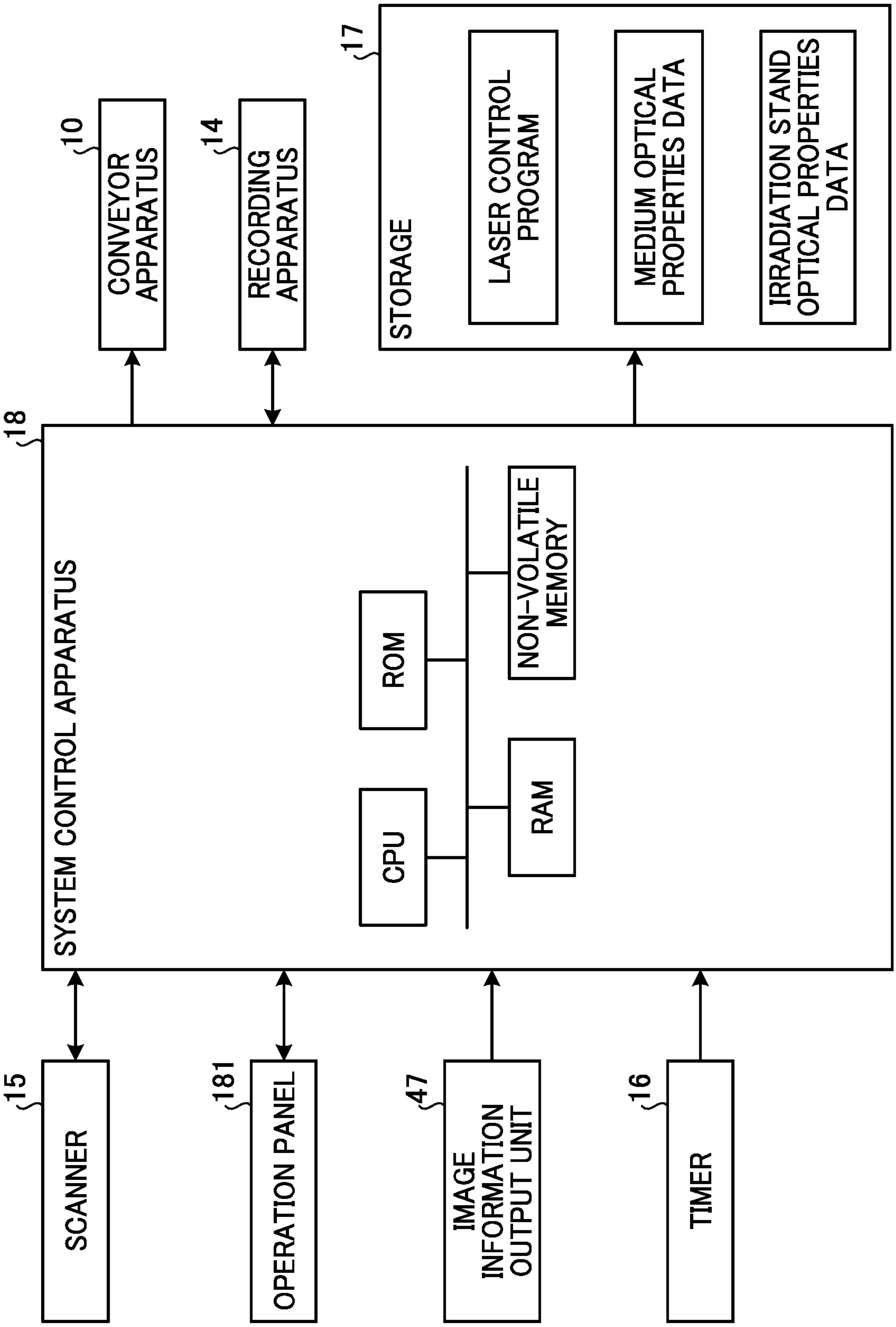

SYSTEM CONTROL APPARATUS
18
CPU
ROM
RAM
NON-VOLATILE MEMORY
10
CONVEYOR APPARATUS
14
RECORDING APPARATUS
17
STORAGE
LASER CONTROL PROGRAM
MEDIUM OPTICAL PROPERTIES DATA
IRRADIATION STAND OPTICAL PROPERTIES DATA
15
SCANNER
181
OPERATION PANEL
47
IMAGE INFORMATION OUTPUT UNIT
16
TIMER

FIG. 11

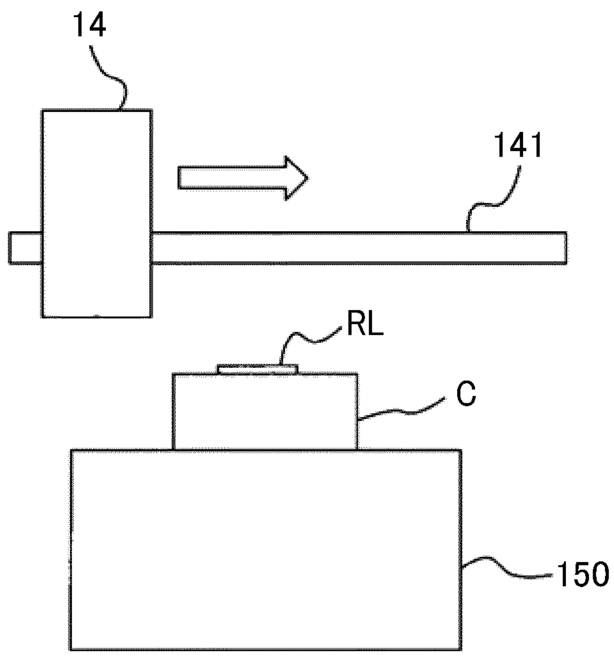


FIG. 12

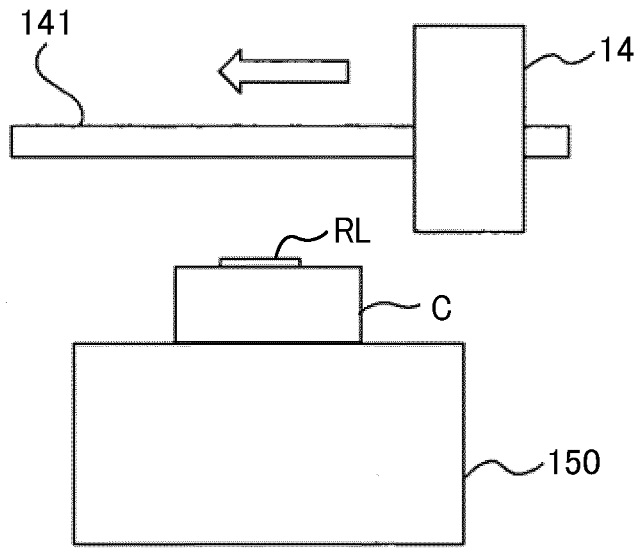


FIG. 13

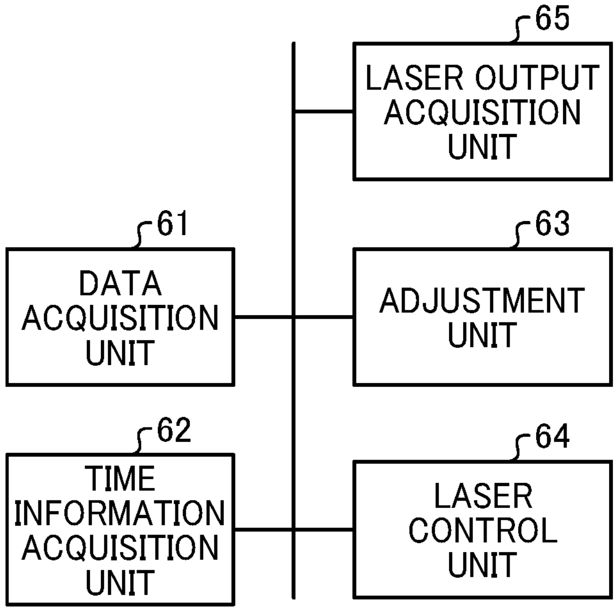

65
LASER OUTPUT ACQUISITION UNIT
61
DATA ACQUISITION UNIT
63
ADJUSTMENT UNIT
62
TIME INFORMATION ACQUISITION UNIT
64
LASER CONTROL UNIT

FIG. 14

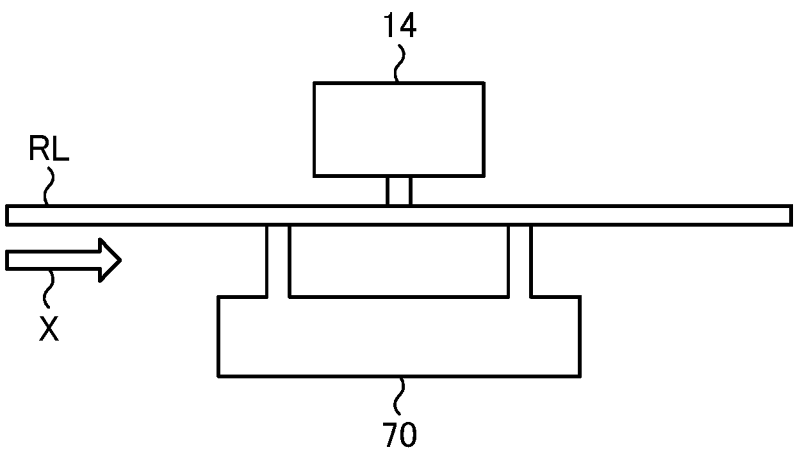

14
RL
X
70

FIG. 15

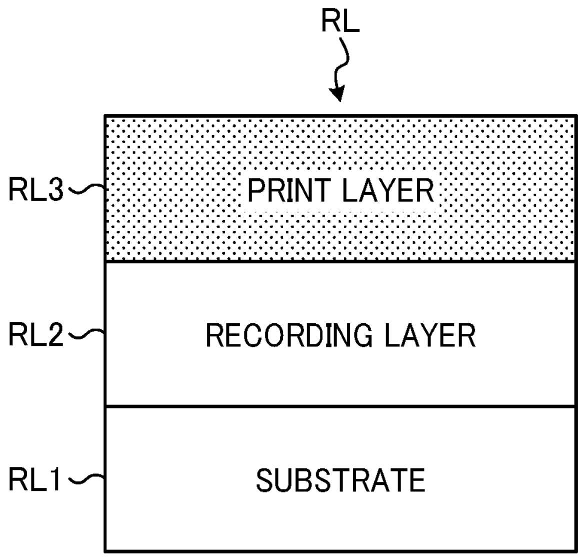

RL
RL3
PRINT LAYER
RL2
RECORDING LAYER
RL1
SUBSTRATE

FIG. 16

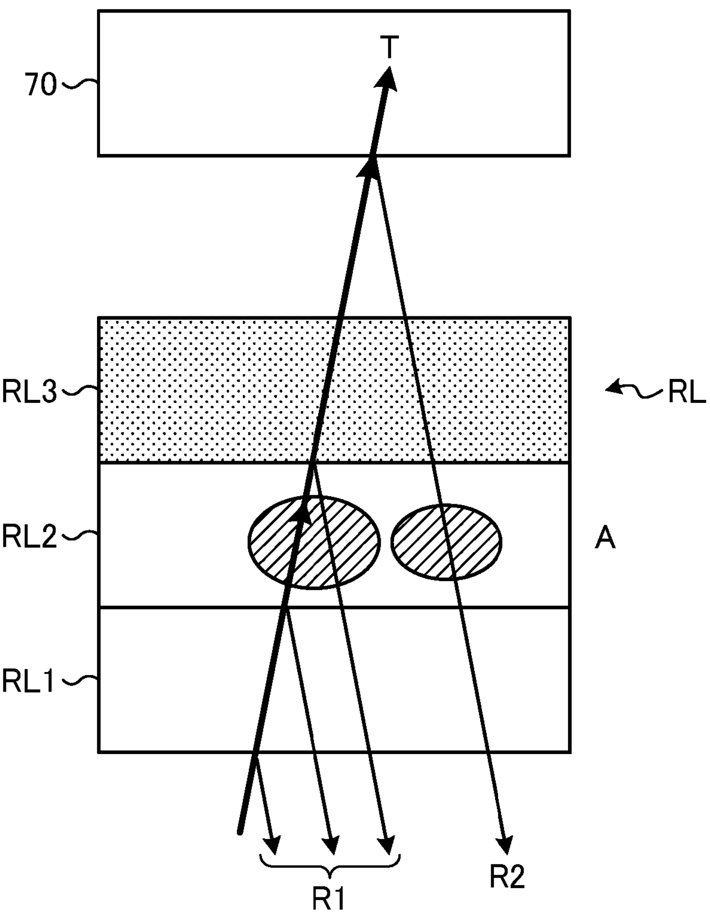

T
70
RL3
RL
RL2
A
RL1
R1
R2

FIG. 17

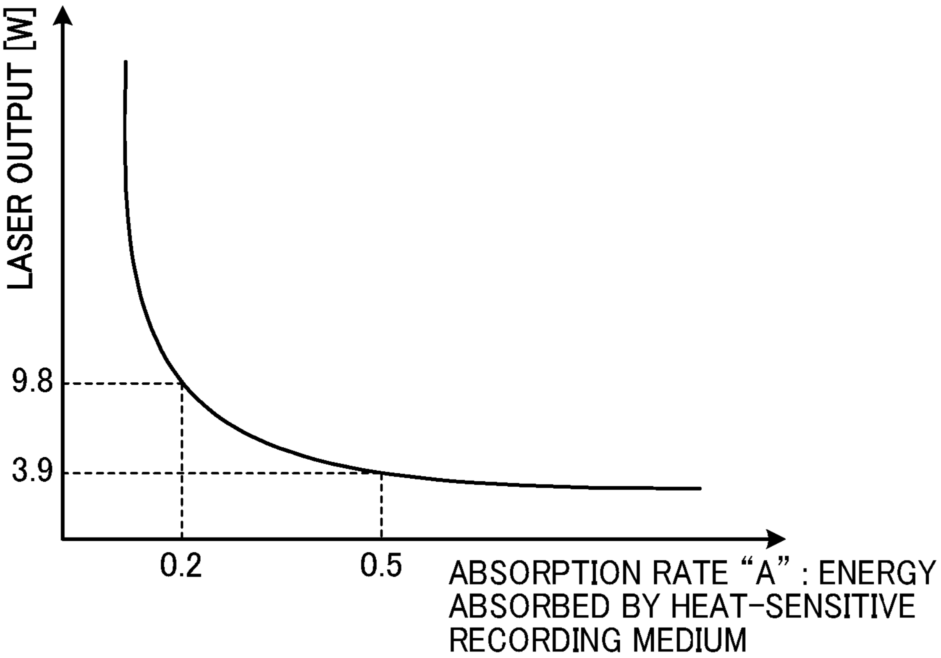

LASER OUTPUT [W]
9.8
3.9
0.2
0.5
ABSORPTION RATE "A" : ENERGY ABSORBED BY HEAT-SENSITIVE RECORDING MEDIUM

FIG. 18

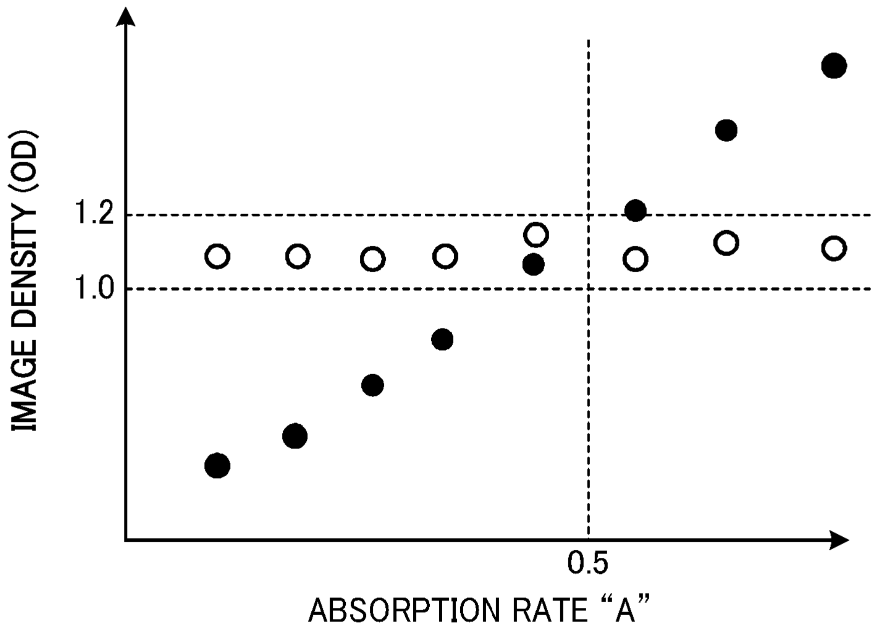
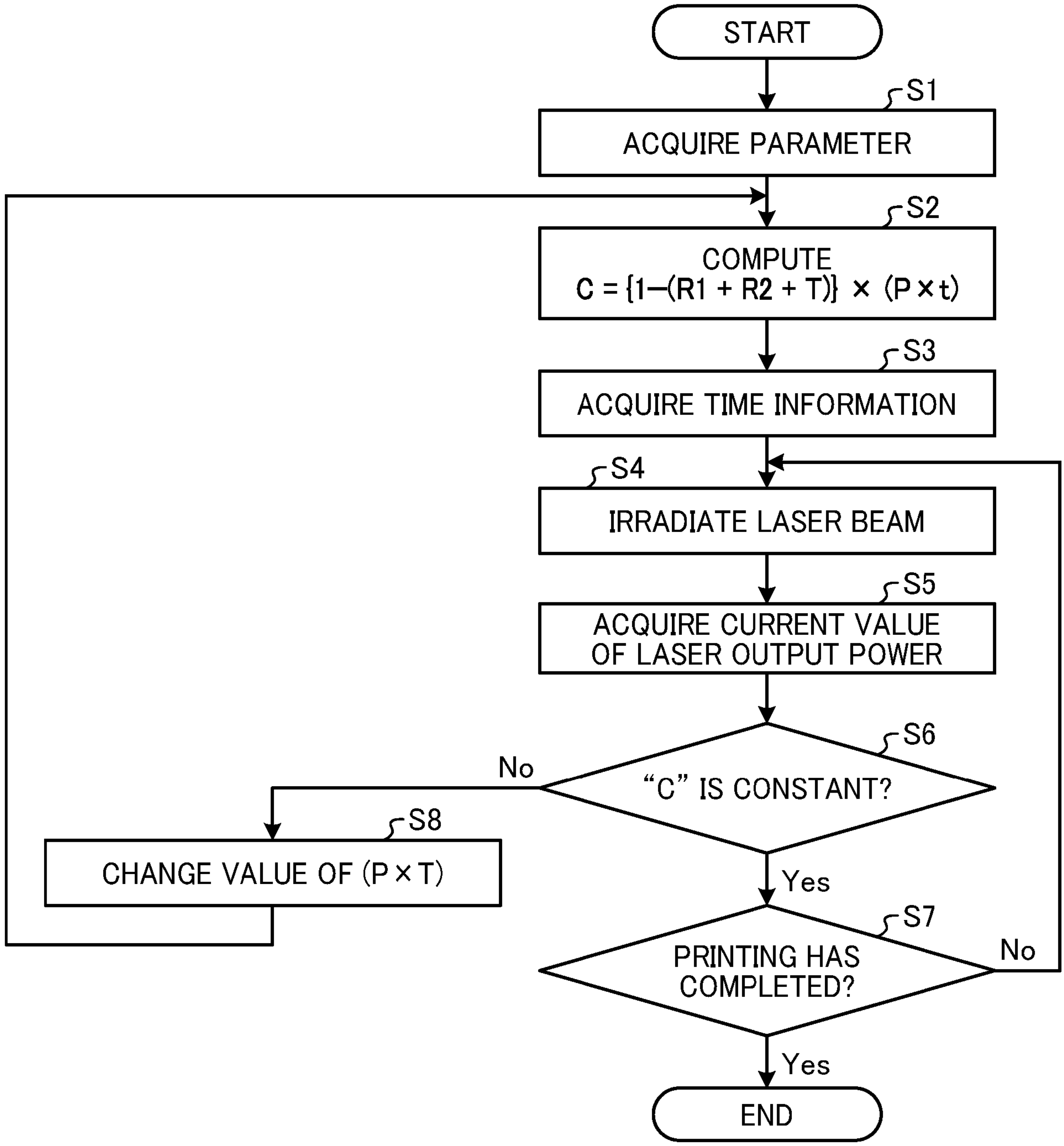


IMAGE DENSITY (OD)
1.2
1.0
0.5
ABSORPTION RATE "A"

FIG. 19


START
S1
ACQUIRE PARAMETER
S2
COMPUTE
C = {1−(R1 + R2 + T)} × (P×t)
S3
ACQUIRE TIME INFORMATION
S4
IRRADIATE LASER BEAM
S5
ACQUIRE CURRENT VALUE
OF LASER OUTPUT POWER
S6
"C" IS CONSTANT?
No
S8
CHANGE VALUE OF (P×T)
Yes
S7
PRINTING HAS
COMPLETED?
No
Yes
END

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H06183039 A **[0003]**
- WO 2018102633 A1 **[0006]**
- WO 2005037932 A **[0037]**
- JP 2005187323 A **[0037]**