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(54) Title: INTELLIGENT ELECTROMECHANICAL DEVICE FOR THE TREATMENT OF OCULAR DOUBLE VISION AND EYE DEFLECTION USING THE PENCIL PUSH UP METHOD

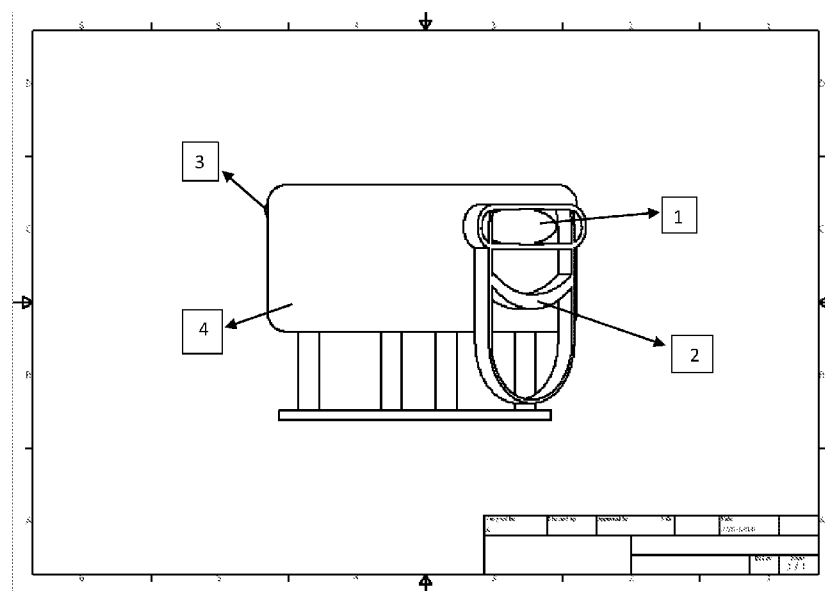


Figure 1-1

(57) Abstract: This invention is a device used to treat eye mismatches and aberrations and by practicing repetition of the eye muscles, it strengthens the eye muscle and in the long run, eliminates eye defects. The device consists of a sign and a series of electronic components and equipment that they are used to control and move the mark toward the user's eyes and by adjusting the light of the training environment and the speed of movement of the sign, it enhances the effect of this method on the user's eyes. This sign is in line with the patient's vision, and the reciprocal movements in the horizontal direction stimulate the eye muscles and improve the patient's vision. In addition, it monitors and processes all feedback and eye movements with a micro-camera.



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- *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

**1- Title:**

Intelligent electromechanical device for the treatment of ocular double vision and eye deflection using the pencil push up method

**2- Technical and practical field:** Mechanics and Electronics / Ophthalmology**3- Background and Summary of Invention:**

**Project Summary:** This device is titled Intelligent electromechanical device for the treatment of ocular double vision and eye deflection using the pencil push up method, It is a device used to treat double vision and ocular deviation and by doing repetitive eye muscle training with the pencil push up method, it strengthens the muscle and in the long run eliminates eye defects. Its function is to stimulate the muscles of the eye with the help of a cue that is aligned with the patient's vision and by moving horizontally and vertically it improves the patient's vision.

**Background:** According to the studies on vision therapy and the use of the pencil push up method in the treatment of ocular diseases There are several methods and programs according to the pencil push up method, including:

1) US Patent No. US20170007450A1, which is a virtual reality system and is only a disease detection system which uses the pencil pushup method to detect visual problems and it has no therapeutic aspect. Moreover, it is not as intelligent as my invention and does not have the capability of physical and mechanical therapy.

2) US Patent No. US20150125838A1, which is a handheld device that treats eye diseases and problems using the pencil push up method; and it is not like my invention is a smart device and does not have the capabilities of automatic rehearsal, control, and recovery.

3) Patent No. WO2017015603A1 which is a type of computer game and program that uses a pencil push up method and by moving the images, it can improve people's vision and this app is not a smart device like my invention and cannot detect eye movements, recovery and feedback.

**4- Description:**

Given the ever-advancing technology and its impact on various disciplines including medicine And the importance of medical equipment in this field, the importance of medical engineering science in enhancing process quality Prevention, diagnosis and treatment of diseases is essential and inevitable. Regarding to the importance of eye health in the community and the importance of medical equipment in the field, Ophthalmology is one of the disciplines that a medical engineer needs to succeed in the field of equipment Must have specialized information in the field of

ophthalmology. According to the investigations in the ophthalmology field is one of the most common diseases in the field of medicine, Strabismus, as well as amblyopia (lazy eye). This problem can occur in all age groups and in both genders. In ophthalmology, any deviation from the correct alignment of the eyes is called strabismus. Deviation is the lack of coordination of the muscles of the eye or the inability to concentrate between the two eyes, which causes the eyes differences in directions. It is one of the most common ophthalmic problems which occurs in 2% of children and adults. The disease has many different types which includes:

- 1) One or both eyes rotate inward (isotropic eyes)
- 2) One or both eyes rotate outward. (Exotropia)
- 3) Eye's deviation of up and down are rarely seen but some kind of the deviation of the eye is concealed and is characterized by the elimination of binocular vision (closure of one eye), which is known as hidden strabismus or Heterophoria.
- 4) Also known as strabismus which is being called heterotropia or isotropy, which is the most common type of strabismus.

In normal binocular vision, both eyes look at one point. The visual field of the brain combines the two images into a three-dimensional image. In strabismus, when one eye is diverted, two different images are sent to the brain. For a young child, the brain learns to ignore the image of the distracted eye and accepts only the image of the direct or better-sighted eye. This eliminates the depth of vision and binocular vision. Adults are prone to strabismus, since the brain has the ability to receive images from both eyes that they develop double vision Strabismus in children (monocular vision), If it will not be treated, it can lead to amblyopia in some cases. The alignment of the eyes at birth is not fully developed. True development of the eye at 1–2 months of age but it may occurs at an early age or later. It is therefore possible to begin strabismus examination after this age. The movement of the eye around is controlled by six muscles around the eye and ordered by the brain. Eye disorganization is due to:

- 1- Imbalances of the two eye muscles
- 2- Lack of equal focus in the eyes. The brain cannot accept different focus images, so it does not take into account messages from one eye. Eventually the weaker eye becomes useless and an ambulatory eye.
- 3- Brain injury or head injury, for example in accidents
- 4- Hereditary incidence of eye deviation, MS, Down Syndrome, Thyroid disease (hypertension), eye or brain tumor, stroke, Hypertension, diabetes, fetal brain injury such as cerebral palsy, Injury to the eye, surgical complications of the eye such as cataracts may cause eye deviation.

Treatment for this disease involves the administration of single-vision glasses and, in some cases, double-vision, to close the stronger eye for correcting focusing deficits (causing the weaker eye to work more), Charter prescription, Vision therapy, Eye muscle training, Botulinum toxin (only for adults) or surgery to correct eye muscles. Among these therapies, eye training is an effective and inexpensive method that is the simplest way to do it using a pencil or pen, or any similar device, by moving it away along the line of sight of the two eyes along the arm, it enhances the vision and treatment of the disease. At this time, it is recommended to the patient that try to follow a single image when the pencil appears as a binary image, the pencil should be separated again from the nose line and the exercise should be resumed. This method is very effective but because of the difficulty in doing it alone at home, most patients avoid it, so we decided to use the new technology and build a machine in this field.

As mentioned in the introduction, according to the ophthalmic examinations Two-eye mismatch disease is very common in all age groups and in both sexes, male and female. There are many ways to treat it, but either these are expensive or painful for the patient. But among these methods for the treatment of eye deviation is the method of training the eyes using a pencil or pen (pencil push up) Or a similar device to correct two-eye mismatch, An uncomplicated, low-cost, simple procedure However, it is effective but is not used by patients because of the difficulty in using this vision therapy. For this reason, we decided to revive this capability by building a device with a similar mechanism, but more accurately, with ease of use. To build this device from a token and a series of electronic elements and equipment are used to control the movement of the mark toward the users' eyes and by adjusting the light of the training environment and the speed of movement of the cue, it enhances the effect of this method on the users' eyes. Also, with its ease of use and light weight, it increases the user's desire and thus the number of exercises and speeding up will improve the disease. The parts list and how it works is as follows:

This machine uses a closed plate that contains two mechanical jacks (bolt system) Horizontal (Fig. 1-4, Part 3) and Vertical (Fig. 1-4, Part 2) and also having a mark (Fig. 1-4, Part 1) It is driven by a stepper motor (horizontally) and a servomotor (vertical). This page contains two double-walled frames on either side to limit user visibility into the practice space. The exterior of this double-walled frame is of a dark colored layer and the inside of the Plexiglas is white and light. And between these two walls, there are a number of LEDs (Figure 1-7) that provide light to the environment. This light can be adjusted by a potentiometer (Fig. 2-1, Part 2), which has been put in place so that it can be treated properly under different lighting conditions. Also using a light-emitting diode with the aid of a micro-camera (Figure 1-1, Part 3) through a series of analysis and calculations, we can examine the performance of the eyes during training under different lighting conditions. The need to put the camera in front of the patients' eyes is to use the pencil push up method The practice of repeating and practicing the symptom continues until the symptom appears as a binary image in front of the patient's eye and the patient's eye is not able to separate a single image, and at this moment the cue should be removed from the nose again, and the camera and image processing system on this device will record the patient's eye-sight momentum and better cue control for automatic sweep. And in addition to the calculations made by the microcontroller, it can intelligently detect the process of recovery and change in the patient's eye state.

The next element is the step motor (Fig. 2-1, part 1) and the step motor must move the desired mark across the horizon by means of two parallel bolts (mechanical jack) (Fig. 1-4, part 3). The token is also attached to a servomotor (Fig. 2-1, part 5), which renders the token vertically exposed to the user's vision and then exits. There are two relays at the beginning and the end of the horizontal path, which when attached to the relay, mark the beginning and end of the path, and this feature allows the step motor not to over-operate. When the symptom moves to the eye at a distance from the eyes, the matching of the patient's vision is impaired, Here, the camera uses the software built into it, analyzing the state of the eyes at this moment (ie, the moment of blinking of sight) to command the device to return to its original state and to begin the exercise from scratch.

All valve tools in this machine are controlled by a microcontroller (Figure 2-1, Part 3). And a switching power supply is used to power the device, which performs the entire power supply.

There are also two potentiometers (Figure 2-1, Part 2), one for manual adjustment of motor step's speed and the other for manual adjustment of light intensity. After the device is switched on, the LEDs (Figure 2-1, Part 7) on the dual-wall screen of the training area are lit. and the microcontroller

instructs the motor step to start and start at the beginning of the path, at this time the start relay is activated indicating that the step motor is at the beginning of the path or not. At this time, before moving the step motor, the servo motor first places the signal in the field of view. By the potentiometer for the LEDs, the light of the plate and by the potentiometer determine the speed of the step motor's speed and the step motor counts the number of pulses after the motor starts. Each pulse indicates the rate of progression of the cue so that we can detect the rate of improvement. When the step motor starts to move, the horizontal movement of the sign by the step motor by means of the mechanical jack (bolt system) sign moves towards the user in line of sight and the user looks at the sign, As stated, the patient should try to follow a single image and as close as possible to the eye as long as he or she is able to project a single image along the nasal line.

When looking at the cue, it disrupts eyes matching and double image appearance. The micro-camera instructs the device to move the servo motor and remove the mark (vertical movement of the mark using mechanical jacks (spindle system) at the moment), the LEDs go off to rest the users' eyes. At the same time, the step motor starts to move towards the beginning of the path and approaches the relay and then repeats the steps that mentioned above.

This is repeated over and over to increase the number of pulses received from the step motor, which means that the cue is closer to the users' eyes and the muscles of the eye are more capable of trying to see a single image and to separate duplicate images. It Indicates improvement and strengthening of the eye muscles and correction of the user's vision. (Because the cue goes so far as to match the vision, and the greater number of pulses indicates an increased ability of the eyes to practice and approach the cue.)

The device is highly commercialized and will not cost much for the consumer. It can also guarantee a quick refund within a short time.

This device is used to correct vision and treat mismatches and is one of the most useful methods in optometric centers and even home treatments.

## **5- Explain the figures, diagrams, maps and ...**

### **• Figure 1-1: Mechanical and technical map of the device including:**

- 1) The location of the user's eye whereby the patient's viewing space is restricted to the chamber inside the device.
- 2) Location of the patient's chin to fix and prevent the patient's head from moving (adjustable for each patient)
- 3) Micro-camera intended for the device that controls the state of the eye during training.
- 4) The double layer enclosure of the device that restricts the patient's eye training environment.

### **• Figure 1-2: Technical overview of the device (top view) including body and related equipment:**

- 1) The location of the user's eye whereby the patient's viewing space is restricted to the chamber inside the device.
- 2) Location of the patient's chin to fix and prevent the patient's head from moving (adjustable for each patient)
- 3) Micro-camera intended for the device that controls the state of the eye during training.
- 4) The double layer enclosure of the device that restricts the patient's eye training environment.

• **Figure 1-3: View of the user in the training environment, which includes:**

- 1) Closed enclosure inside the machine
- 2) Movable cues for eye training
- 3) Location of the patient's chin

• **Figure 1-4: the internal elements of the device, including:**

- 1) A mark fixed on a piece to prevent excessive vibration movements
- 2) A mechanical jack system (bolts) for the vertical movement of the mark attached to a servo motor.
- 3) A mechanical jack system (two parallel bolts) for horizontal movement of the mark attached to a step motor.
- 4) The fixing element of the cue for horizontal movement in the patient's vision, including a cavity for vertical movement and the cue being withdrawn from the user's eye
- 5) The cavity facilitates vertical movement of the cue

• **Figure 1-5: the inner elements of the closer view, which include:**

- 1) The mechanical jack system (bolts) for moving the mark in the vertical Direction
- 2) The mechanical jack system (two parallel bolts) in the horizontal direction at the beginning of the movement path consisting of two relays.

• **Figure 1-6: the bottom elements of the device are the following:**

- 1) Signs
- 2) Mechanical jack (bolt system) for vertical movement of the mark
- 3) Mechanical jack (two parallel bolt systems) for horizontal mark movement
- 4) Signal retention element and bolts for horizontal and vertical movement
- 5) The underlying cavity moves the cue vertically

• **Figure 2-1) the electronic circuit board of the machine includes the electrical elements used, including:**

- 1- Step motor for horizontal movement (in line with user's view)
2. Potentiometer to manually adjust the speed of movement and the intensity of backlight
3. Microcontroller for controlling different parts and communication
- 4 - Reed relay to determine the beginning and end of the route (preventing excessive motor movement)
- 5- Servo motor for moving the signal (visualizing and removing the signal)
- 6- Press key (record the moment of mismatch)
- 7- LED for backlight (indoor environment of the machine)
8. SC motor control step motor
- 9- Power supply input

## **6. Expressing original innovations and claims**

The advantages of using this device are as follows:

- 1) This device and this method of engaging the muscles of the eye so that after doing 30 to 50 times of movement (which varies for different people and the average is 20 times a day), the eyes begin to shed tears. And its effect can be seen several times. It also improves the convergence of the two eyes so that they even treat eye deviation to a great extent, which of course requires at least 12 weeks of continuous use of this device, but its severity affects rapidly after 1 month of training which is visible.
- 2) Using a step motor with a minimum rotation of 15 degrees and high accuracy of measuring the movement of the mark in the range of 1 to 2 mm (Figure 6-8)
- 3) Advanced programming to observe and detect the patient's recovery process during the course of treatment
- 4) Limit user space by a double wall to increase focus in the training environment



5) Manual and automatic light adjustment for using the device in all locations with different optical positions and the use of an optical diode to evaluate and measure patient performance in different optical positions

6) Ability to automatically control the device and the sweep motion of the signal at the moment of disturbance of vision by a micro camera (Figure 6-8)

7) Manually control the speed of the step motor by a potentiometer (Figure 6-8)

8) The use of ESP-type microcontroller, which has Wi-Fi capability that can be connected to the device via Wi-Fi and controlled by the device via web. It can also be connected to a computer via USB and transfer the data to it (Figure 6-8).

9) Pulse counting of the device by the step motor, which, given that each pulse determines the rate of progression to the eye, can identify the point of intersection of the matching of eyes by the number of pulses counted, and It examined the rate of eye healing. (Figure 6-8)

**Claim 1:** An electromechanical device for the elimination of double vision and eye deviation

Vertical and horizontal movement of the cue along the vision of the user, the ability to narrow the visual field and increase patient focus during training, the ability to adjust the light of the training environment and fine-tune the movement speed of the cue, Automatic bookmark control by a smart micro-camera

**Claim 2:** According to claim 1, wherein the horizontal movement of the mark is carried by a step motor and its vertical movement by a servo motor.

**Claim 3:** According to claim 2, in which to move the mark horizontally by the step motor, two parallel guide posts are provided by the mechanical jack method (bolt) as well as its vertical movement using a servo motor another mechanical jack (bolt) was used in the vertical position.

**Claim 4:** According to claim 3, in which the length of the parallel guide rods with the electric elements and the chin is provided 60 cm.

**Claim 5:** According to claim 1 wherein to increase patient concentration and limit the exercise environment an enclosed space consists of a double-walled plate on either side, the inner layer is Plexiglas white and light, and the outer layer is a dark, opaque plate.

**Claim 6:** The method of claim 5, wherein three to four LEDs are used to create a cursor movement environment between two parallel sides of the wall that the power of these LEDs is 10 watts.

**Claim 7:** According to claim 1, two potentiometers are used to adjust the light of the double-wall plate and to adjust the step motor's speed.

**Claim 8:** According to claim 1, wherein an automatic microdorb is provided for automatic control of the device.

**Claim 9:** An ESP microcontroller is used to control the device elements for wireless control and communication with the computer.

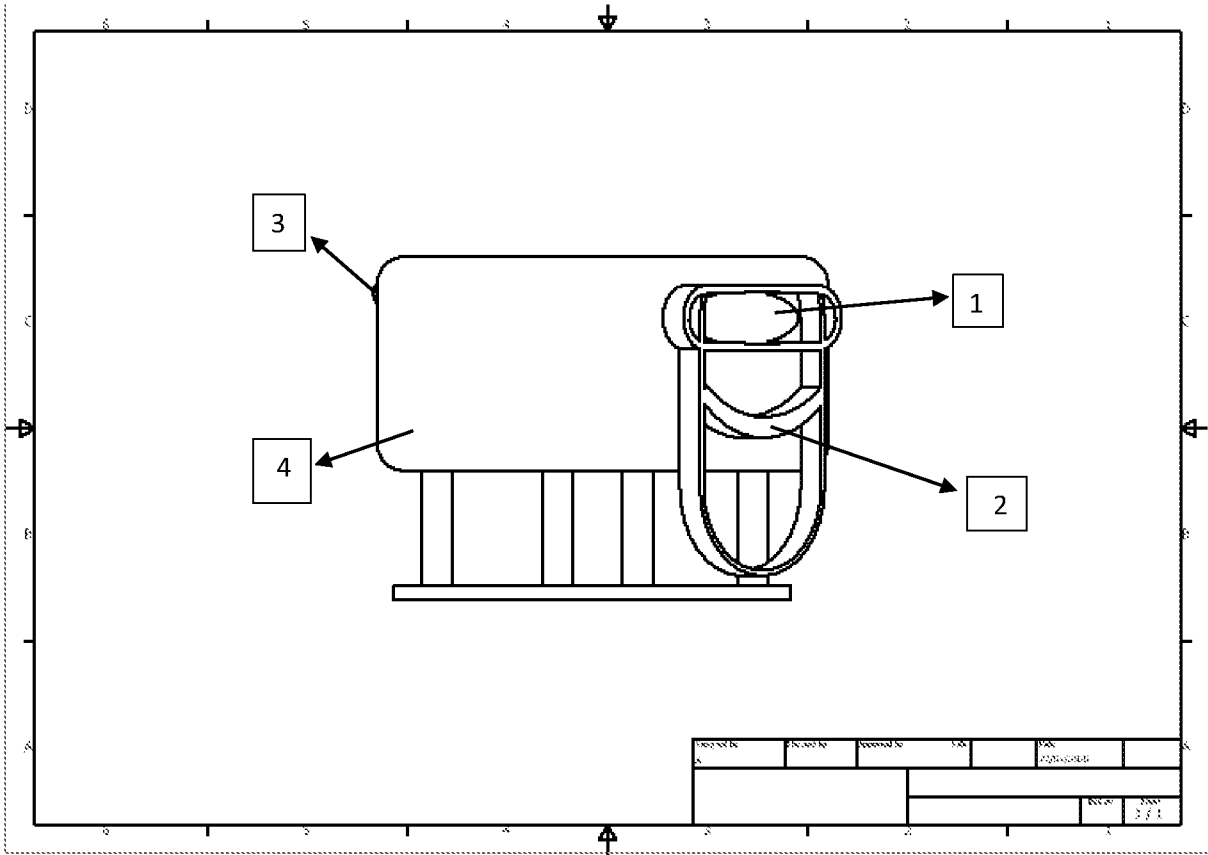


Figure 1-1

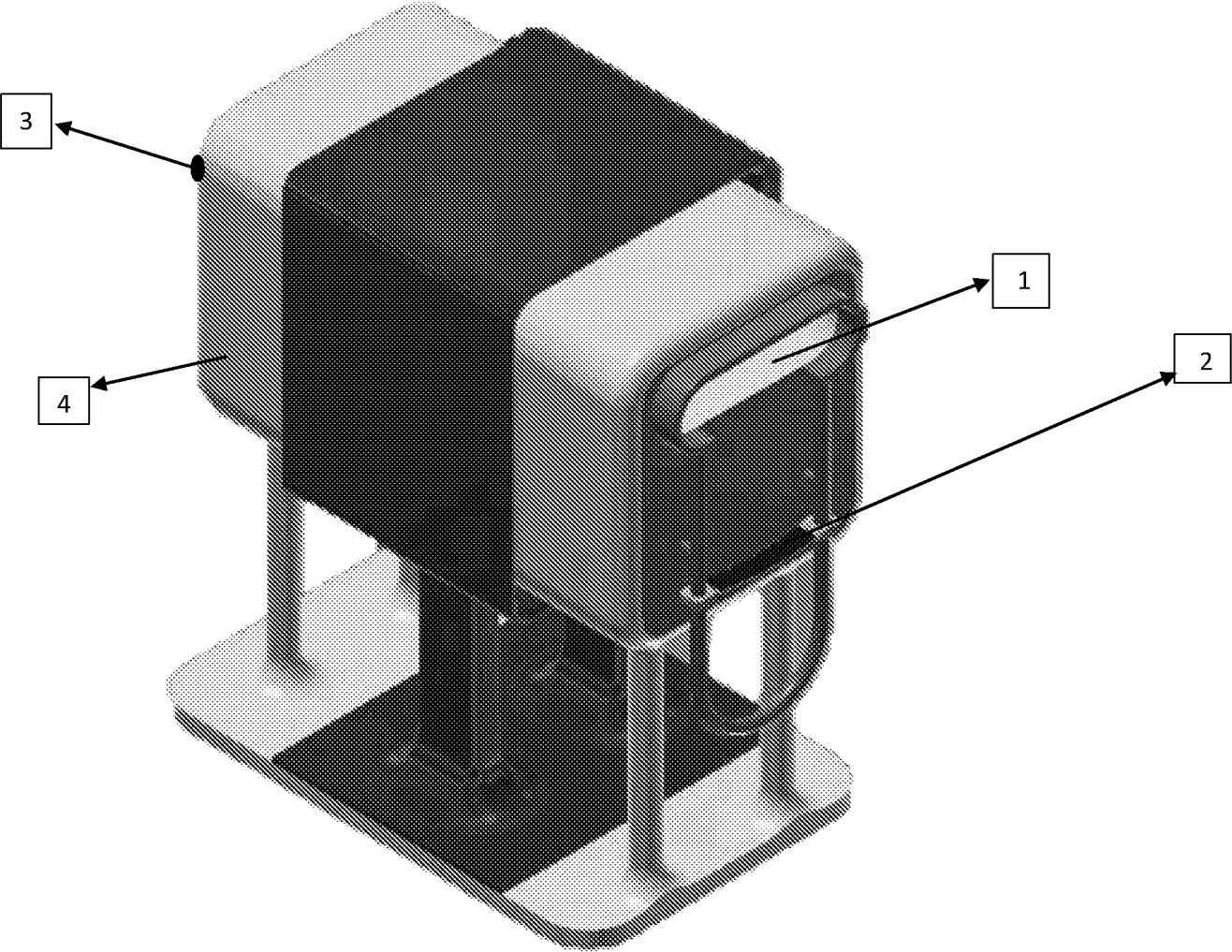
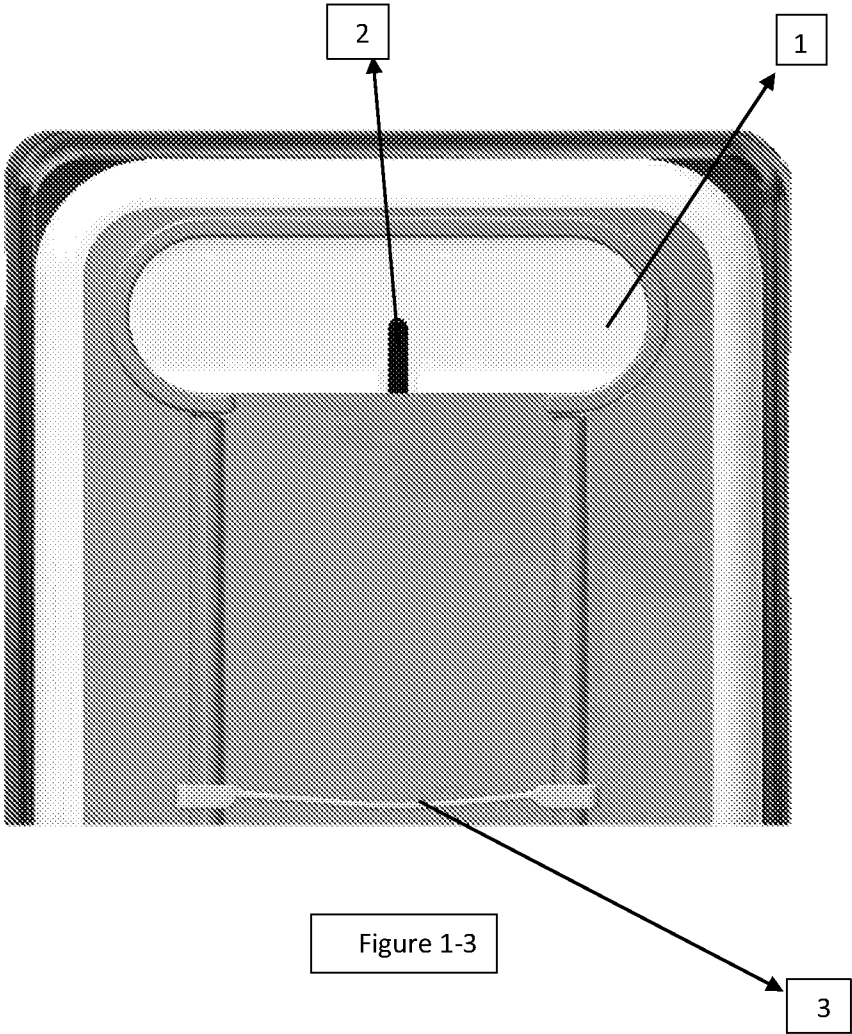


Figure 1-2



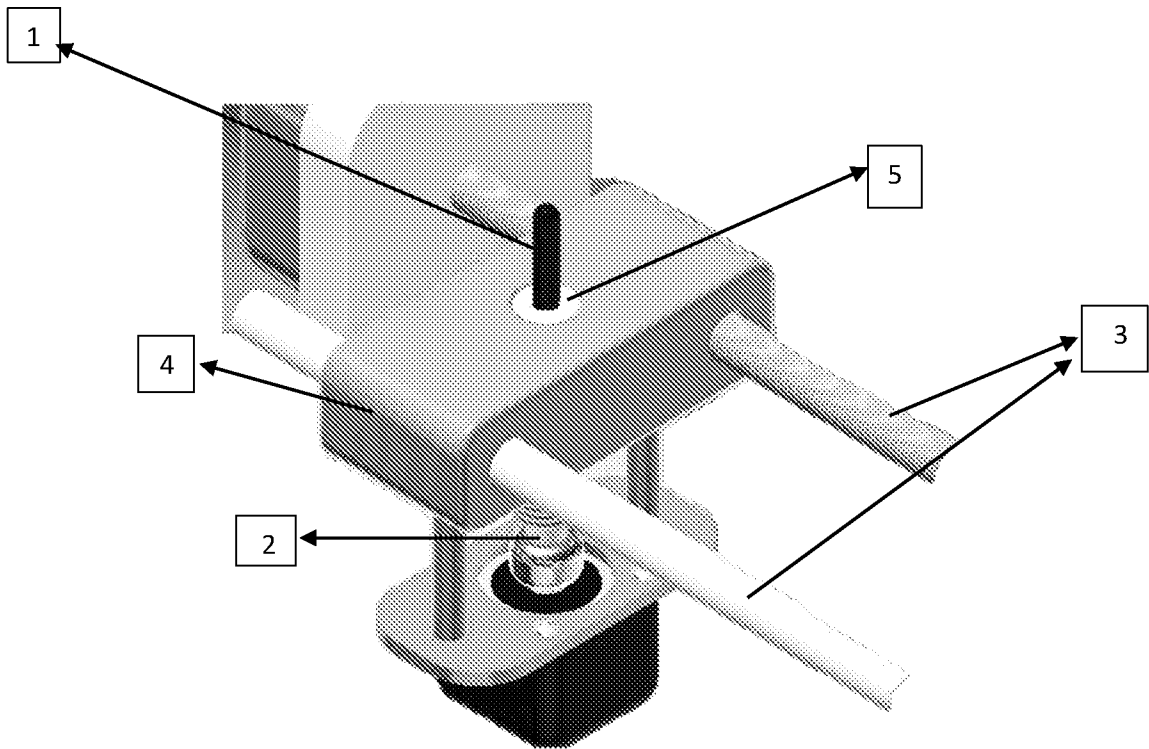


Figure 1-4

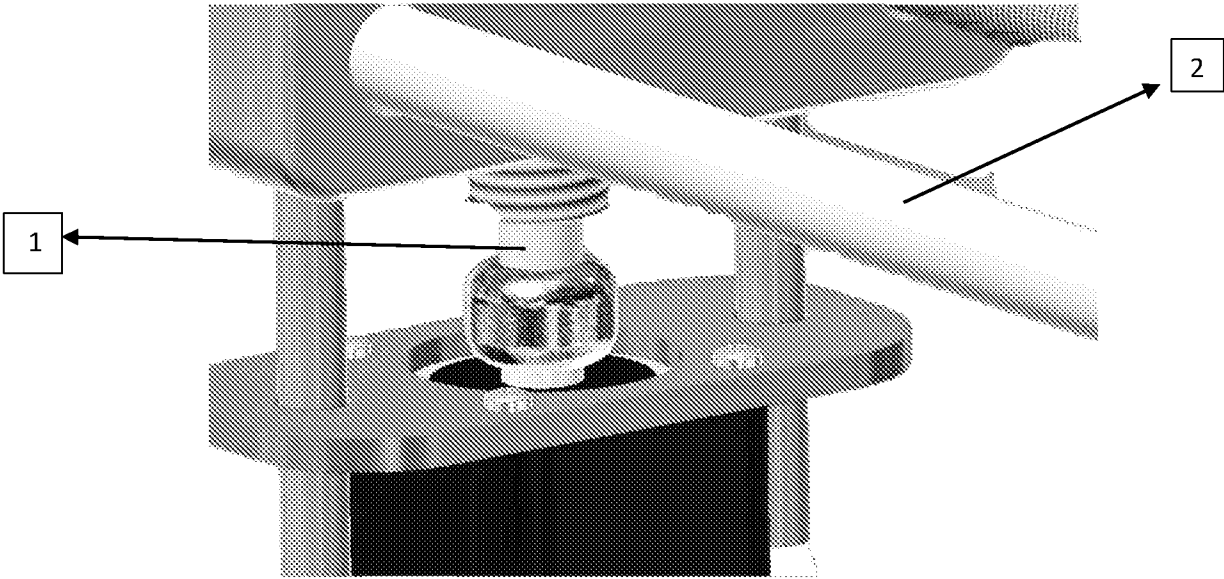


Figure 1-5

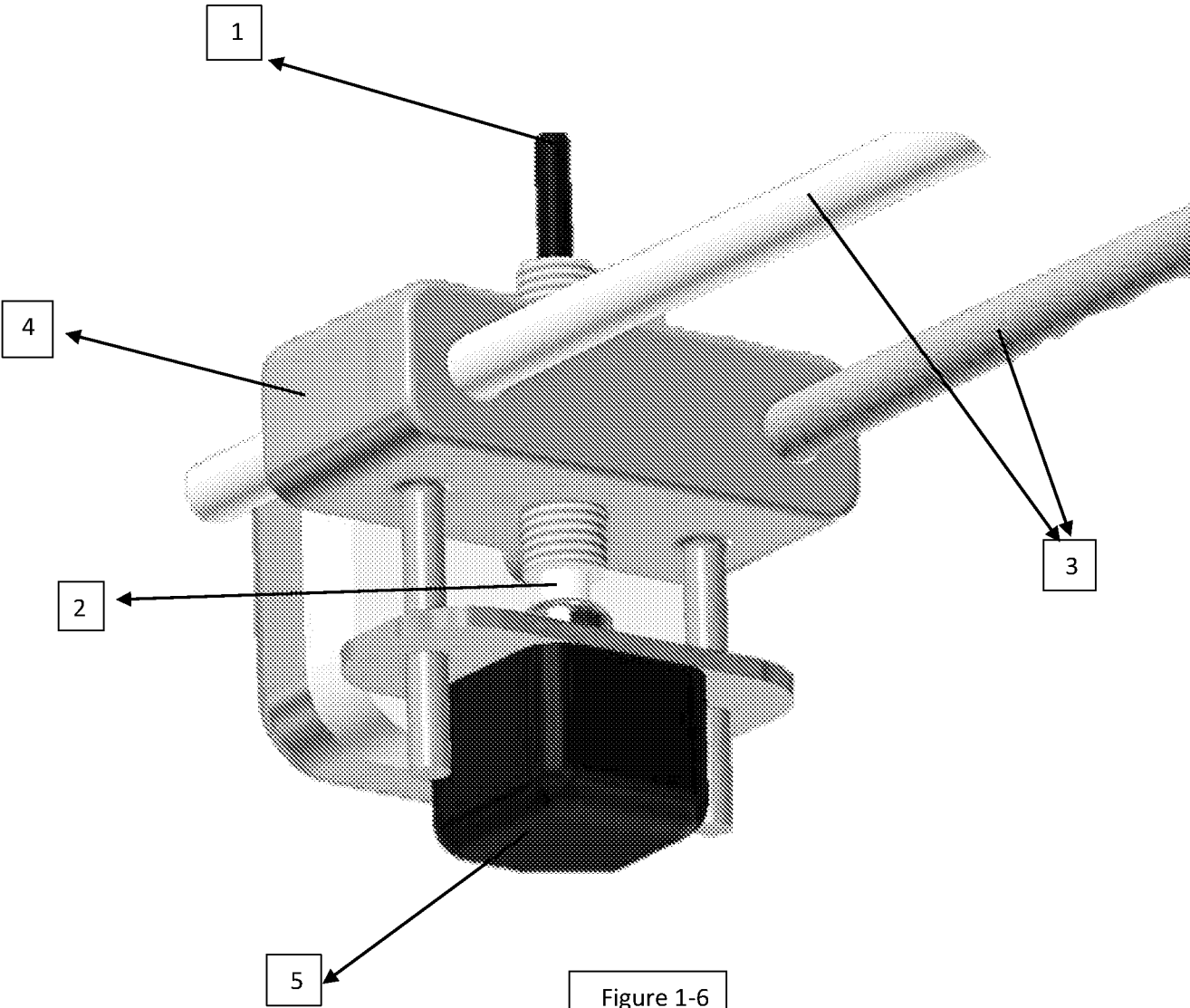


Figure 1-6

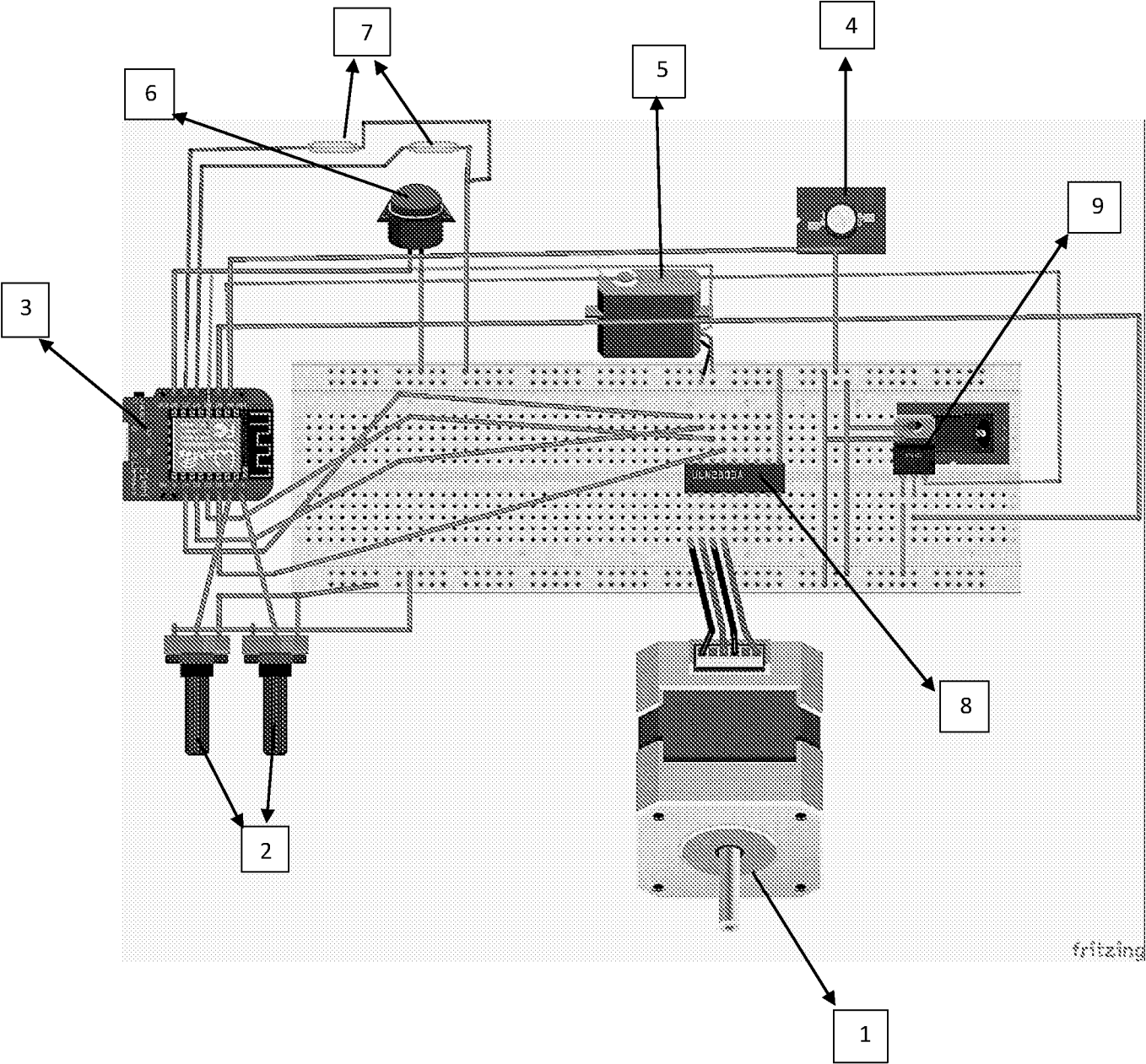


Figure 2-1



## INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER  
A61B3/00, A61F9/00 Version=2020.01

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61B, A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Databases: Total Patent One, IPO Internal Database

Keywords: vision correction, servo motors, vertical element, eye

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US20190094981A1 (MAGIC LEAP, INC.) 28 March 2019 (28-03-2019) Whole document	1-9
A	JP6549099B2 (Optimedica Corporation) 24 July (24-07-2019 ) 2019 Whole document	1-9
A	KR20170085557A (ZEISS CARL VISION INT GMBH ) 24 July 2017 (24-07-2017) Whole document	1-9

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

18-05-2020

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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

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Citation	Pub.Date	Family	Pub.Date
JP 6549099 B2	24-07-2019	AU 2014253904 A1	12-11-2015
		EP 2986258 A1	24-02-2016
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