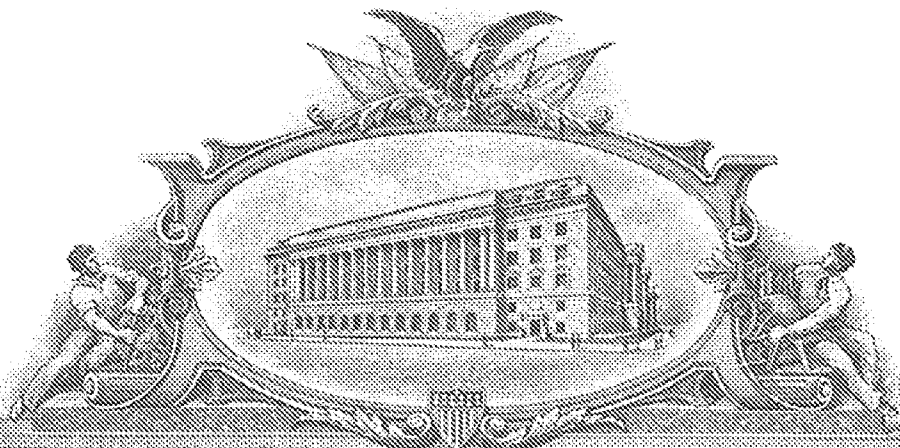


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Electronic Acknowledgement Receipt	
EFS ID:	32657615
Application Number:	62673040
International Application Number:	
Confirmation Number:	7123
Title of Invention:	System and method for reducing illicit crop yield from distance using airborne energy beam
First Named Inventor/Applicant Name:	Morgan Perry
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Filer:	Morgan Perry
Filer Authorized By:	
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File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Provisional Cover Sheet (SB16)	FlightSABER_ProvisionalSB_20180517.pdf	2032350	no	3
			ad889fbc6574a9b69a7babe612a41c4a944007e1		
Warnings:					
Information:					
2	Specification	FlightSABER_PPA_20180517c.pdf	401349	no	10
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Warnings:					
Information:					
3	Drawings-other than black and white line drawings	FlightSABER_PPA_Drawings_20180517c.pdf	678431	no	3
			8d14afe2c1b0c5fd130324b533ed1671c9bc5bf7		
Warnings:					
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4	Certification of Micro Entity (Gross Income Basis)	FlightSABER_SB15a_20180517.pdf	575261	no	2
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5	Fee Worksheet (SB06)	fee-info.pdf	29283	no	2
			b6602c37fd392591b45c8fa52844a0b0ddf660d5		
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If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

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Provisional Application for Patent Cover Sheet This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)					
Inventor(s)					
Inventor 1					Remove
Given Name	Middle Name	Family Name	City	State	Country i
Morgan		Perry	Arlington	WA	US
All Inventors Must Be Listed – Additional Inventor Information blocks may be generated within this form by selecting the Add button.					Add
Title of Invention		System and method for reducing illicit crop yield from distance using airborne energy beam			
Attorney Docket Number (if applicable)					
Correspondence Address					
Direct all correspondence to (select one):					
☐ The address corresponding to Customer Number			☒ Firm or Individual Name		
Firm or Individual Name 1			Morgan Perry		
Firm or Individual Name 2					
Mailing Address of Applicant:					
Address 1		17708 49th Dr. NE Ste. C			
Address 2					
City		Arlington	State/Province		WA
Postal Code		98223	Country i		US
Phone		206-335-7710			

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.	
☒ No.	
Yes, the invention was made by an agency of the United States Government. The U.S. Government agency name is:	
Yes, the invention was under a contract with an agency of the United States Government. The name of the U.S. Government agency and Government contract number are:	

Entity Status**Applicant asserts small entity status under 37 CFR 1.27 or applicant certifies micro entity status under 37 CFR 1.29**

- ☐ Applicant asserts small entity status under 37 CFR 1.27
- ☒ Applicant certifies micro entity status under 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
- ☐ No

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Signature

Please see 37 CFR 1.4(d) for the form of the signature.

Signature	Morgan Perry/		Date (YYYY-MM-DD)	2018-05-17
First Name	Morgan	Last Name	Perry	Registration Number (If appropriate)

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **This form can only be used when in conjunction with EFS-Web. If this form is mailed to the USPTO, it may cause delays in handling the provisional application.**

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE (USPTO)

Utility Patent Application (Provisional)

TITLE: System and method for reducing illicit crop yield from distance using airborne energy beam

INVENTOR: Morgan Perry

FIELD OF INVENTION

The apparatus relates to reducing unwanted plant growth and/or crop yield. It may fit the cooperative patent classification (CPC) A01M21/04. More specifically, the apparatus relates to using one or more lasers from an airborne platform (manned or unmanned) to reduce illicit drug or drug precursor production at the agricultural source while providing improved levels of safety to personnel and/or equipment engaged in that interdiction through keeping them at distance from the source and possible hostile actors.

BACKGROUND

Illicit drug interdiction efforts around the world to curtail crop production at the source have ranged from physical destruction of crops by troops to controlled burns to chemical herbicide applications by aircraft. Each of these have proven only effective in the minority or impractical. Aerial herbicide spraying has been somewhat effective in reducing illicit crops but has been curtailed and likely has little future because of significant adverse effects on the environment and people in addition to the high risk the aircraft and pilots run of being shot down in their required low passes over the fields, just a few meters above ground.

In the agricultural industry, researchers have been successfully using energy beams in a wide range of the electromagnetic (EM) spectrum – including the microwave, infrared (IR), visible, and ultraviolet (UV) ranges – to inhibit weed growth in experimental settings at close range. However, industrial implementation of these techniques have largely been stymied because of the yet-to-be sufficiently solved problem of distinguishing between crop and weed in real-time.

In another industry, military energy beam weapons such as the US Navy's LaWS and the US Army's ATHENA have been successfully tested and developed for use against hard targets such as aircraft and ground vehicles proving effective over distance. Principal challenges for these lasers have been to maintain the laser on target, or a specific small area of the target, for an extended period to transfer sufficient energy to disable the target.

This apparatus differs from prior art in that it is specifically designed to be operated and effective from distance and by that distance not be readily subject to being disabled or otherwise damaged or destroyed (e.g., through small arms fire) by those who have interest in the illicit crop. Prior art does not reflect anticipation of or design for operator lack of control of or safe access to the target vegetative

area. US patent and/or publication numbers 3652844, 7875861, 2016/0205917, 2016/0205918, 9565848, and 2017/0188564, and international/Chinese priority number CN20152607118U 20150813 address use of lasers for weed control, but each differs in critical ways from this apparatus:

US Patent 3652844 makes a solitary mention of an aerial platform for a laser but the laser, laser wavelength, duration on target, and explicit dismissal of distance concerns within the patent indicate the current apparatus was not contemplated or anticipated in the previous patent. Further, the USPTO has issued the other patents cited here which demonstrates the USPTO has interpreted this patent narrowly.

US Patent 7875862 makes passing reference to an airborne platform for its laser, but explicitly calls it out as “low flying aircraft” and diagrams it as such addressing no necessary issues related to lasing from distance; further, this prior patent is limited to the UV range of the EM spectrum.

US Patent Publication US 2016/0205917 A1 refers to elevated laser platforms but specifically states such are stationary while in use.

US Patent Publication US 2016/0205918 A1 refers to elevated laser platforms but specifically and centrally describes a physically separate light redirector not consistent with the current apparatus. This prior art specifically contemplates “close-to-the-ground” mechanisms and when it does contemplate a laser source at greater distance to the target, it cites it as being “stationed (e.g., temporarily, semi-permanently, or permanently) along the border of a field” making clear a distant aerial platform is not envisioned or anticipated.

US Patent 9565848 makes a single reference to a laser mounted on an aircraft, but the laser power levels (1 Watt and below) cited as “suitable” and the precision targeting of only weed (not crop) meristems make it clear distant aerial lasing is not contemplated or anticipated.

US Patent Publication US 2017/0188564 A1, filed by the same applicant and inventors as US Patent 9565848 above, makes the same single reference to an aircraft but contemplates nothing more than in the previous patent. This is particularly notable because this was filed over three and a half years later, demonstrating ample time for the applicant to correct or expand on its airborne ideas, should it have had anticipated the current apparatus.

International/Chinese Application/Priority Number CN20152607118U 20150813 is focused on an aerial laser platform, but principally on the mechanisms related to its flight mechanisms and rotors, as for a light, multi-rotor drone. Nothing in the application suggests or contemplates or anticipates use of powerful kilowatt or greater level lasers on large aircraft at significant distance from a hostile target. This application is also expired.

Beyond patents, one document – Rubenchik et al., July 20, 2009; Environmentally Clean Mitigation of Undesirable Plant Life Using Lasers – contemplates use of powerful airborne lasers against weeds, specifically poppy crops. However, it specifically describes and depicts lasing from a distance of “a few meters to tens of meters” from the field and a flight and treatment rate of one meter per second, both of which make the idea impractical because the drone aircraft would be readily shot down by crop growers, something the authors did not contemplate or design for. Further, the authors make no provision for supplying the significant energy requirements their conception calls for, nor how their cited treatment rate (0.1 J/mm²) would be effective when the lowest effective treatment rate in the one

research article they cite (Mathiassen et al., 2006, The Effect of Laser Treatment as a Weed Control Method, *Biosyst. Eng.* 95 (4) 497-505) is more than 150 times higher. Their projected effect from broadcast treatment is also more than an order of magnitude below temperatures required for lethal levels according to the empirically demonstrated relationship between plant cell lethal temperature and temperature holding time developed by Lepeschkin (Lepeschkin, W.W., 1912, Zur Kenntnis der Einwirkung supamaximaler Temperaturen auf die Pflanze. *Ber. Deut. Bot. Ges.* 30, 713-714). Therefore, the authors' concept is distinctly different from both the concept and design for the current apparatus.

The current apparatus further differs from prior art in that it requires no distinguishing between crop and weed; rather, the illicit crop as a whole is targeted. It further differs in that other laser weed control efforts are aimed primarily at eradication, destruction or otherwise killing unwanted plants, usually with the purpose and design of promoting crop yield. The current apparatus is designed to reduce illicit crop yield associated with plants; further damage, destruction, or killing of such plants would be an incidental result and even possibly wasted effort and energy and undesired environmental impact; this is especially true for illicit crops, such as opium poppies, that require aggressive crop rotation and therefore effort expended on plant destruction beyond that required for reducing the crop yield is likely wasted and possibly counterproductive. The apparatus differs from energy beam weapons in that those weapons are designed to track and maintain sustained targeting of the laser on a discrete spot on a hard target such as a moving military vehicle; this apparatus is designed to target a stationary, dispersed soft target (e.g., poppy seed pod stems or coca plants/leaves) that may be spread over a large area and includes safety systems to avoid impacts to structures and/or people or animals, a distinctly different objective that requires distinctly different design and capabilities.

BRIEF SUMMARY OF THE INVENTION

The apparatus integrates several existing or emerging technologies into an illicit crop yield reduction system that keeps the apparatus and/or operators at increased distance for safety from those who would seek to protect the illicit crop yield. The apparatus incorporates an aircraft – hereinafter of any of a variety of kinds including lighter-than-air (powered or not powered), fixed-wing, rotor-wing, tilt-wing, tilt-rotor, or autogyro, being either manned or unmanned [e.g., an unmanned aerial vehicle (UAV)], being either tethered to a fixed or mobile land base or free flying – and one or more energy beam sources such as a laser source, one or more power sources such as an aircraft engine and/or auxiliary power unit (APU), one or more electrical generators and/or alternators, one or more optical focusing and targeting devices, an energy beam control unit and control station, one or more heat dissipation/chilling units, a geographical positioning system such as Global Positioning System (GPS) or Global Navigation Satellite System (GLONASS), positioning data for aircraft and target, real-time or near real-time optical sensor systems such as light detection and ranging (LiDAR) and/or forward-looking infrared (FLIR), laser and optical sensor system stabilization platforms, target area energy beam scanning algorithms, ground-based threat countermeasures such as armoring/plating and/or flares, and energy beam safety shutoffs to prevent collateral effects to humans, animals or structures in target areas and to prevent operation of beam off target.

BRIEF DESCRIPTION OF THE DRAWINGS

Some embodiments of the apparatus are illustrated as an example and are not limited by the figures of the accompanying drawings, which are not necessarily drawn to scale, in which like references may indicate similar elements and in which:

Figure 1 depicts an oblique elevation view of an embodiment the system airborne in relation to a target illicit crop field, including non-target fields and people and structures in the target field to avoid.

Figure 2 depicts a plan view embodiment of the system equipment within a system aircraft.

Figure 3 depicts a flow chart of system logic executing procedures and sequences for safety and lasing of target areas.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 provides an oblique elevation view of an embodiment of the apparatus in an aircraft (either manned or unmanned) (106) in operation in relation to a target land area (101) and an adjacent non-target area (102). Depicted are two non-target items – a person (104) and a structure (105) – within the target area that the apparatus is designed to keep safe by skipping over them (e.g., temporarily shutting off) in its execution of its preprogrammed target scanning pattern. The person – or an animal – in or around the target area is identified before and during lasing by real-time or near real-time heat signature sensing from a sensor system (107) such as FLIR that senses heat energy (110) from the target area identifying likely and possible human and animal radiation sources. The structure is identified before and during lasing by real-time or near real-time shape sensing using a sensor system (108) such as LiDAR that emits a beam (111) of energy and reads return signal and return signal strengths identifying shapes and sizes of structures. Signals collected by the sensor systems are fed in to the laser control system in advance of and continuously during engagement of the laser system providing continually updated location information on people and structures on or near the target area for the laser system to avoid. Sensor and laser systems included in the apparatus operate in rapid cycle times such that no human or animal movement within or into the target area would be nearly fast enough to defeat the safety systems of the apparatus designed to avoid them. An appropriate safety margin around such objects and beings to avoid is also employed. When the safety sensor systems have been activated and have communicated their initial complete and ongoing updated target area data to the lasing system, the laser beam (109) can be activated and a predetermined lasing scan pattern of the target area can be conducted incorporating modifications according to the collected safety system data. All laser beams spread and scatter to some degree according to distance, atmospheric conditions, wavelength and other factors; because of this, the apparatus laser beam will start out many decimeters or meters tall upon exit from the apparatus and be aimed in at the target according to distance to target area and predetermined rates and calculations in order to reach a desired small height at the target in order to transfer a high irradiance, or energy per area, to a small area and cross section of the target plants (103), predetermined to reduce crop yield. In the case of opium poppies, *Papaver somniferum*, this could be targeted to the seed pod stem prior to the maturation of the seed pod. Given that the stems are generally vertical, the beam pattern is most efficient when being predominantly perpendicular to the target stems, therefore predominantly horizontal (hereinafter horizontal). The

target area would be treated using numerous continuous, quasi-continuous, and or broken horizontal beam paths across the target area until plants in the target area were treated adequately. A beam that is moving horizontally at several meters per second or more through the target area need not be tightly focused in the horizontal dimension as several centimeters of the width of the beam will cross the same area on the crop within a very short (e.g., several millisecond) timeframe; so the apparatus can produce a rectangular or line beam of several centimeters at target in the horizontal dimension with similar effectiveness but less cost, complexity, and weight on the apparatus aircraft compared to achieving a circular beam at target tightly focused in both horizontal and vertical directions. Such an approach (e.g., allowing for a less focused beam in the horizontal direction) may also allow for use of laser sources that spread more (e.g., are lower quality) in one axis than in another, such as a diode bar. Such an approach also allows for a laser exit lens and/or aperture to be relatively narrow, such as only a few centimeters wide, while being relatively tall, such as as much as several hundred centimeters and focusing the beam waist at target down to as little as a few millimeters to a few tenths of millimeter in height, again depending on wavelength and beam quality. In the case of large aircraft and/or in the case of affixing or suspending or extending the focusing system of the apparatus outside the aircraft, especially an aircraft that can remain airborne with low or negligible forward speed through the air, the laser exit lens could be extended vertically to many times the above-cited length, allowing for increased effectiveness through tighter focusing of the laser beam at target and/or greater distances between apparatus and target without sacrificing effectiveness, or a combination of the two. In general, the larger the exit lens of the apparatus, the longer the apparatus' range and/or the greater ability to focus the energy beam to increase treatment rate; working against this principle are greater costs, weight, and other practical considerations, such as manipulating/controlling the lens, and safe operation of the aircraft, all of which need to be balanced for specific embodiment and situational needs.

The apparatus transfers enough radiated energy (e.g., 1-3 J/mm²) to the target plant to lethally overheat or otherwise critically metabolically disrupt a narrow cross section of an important part of the plant, such as a seed pod stem of an opium poppy plant. In the case of an opium poppy stem cross section of 0.4 cm diameter, the beam may transfer about 2-15 J/cross section, depending in part on the vertical beam height at target. These amounts are likely to cause immediate or rapid cell death and plant stem failure; lesser amounts may prove sufficient in practice for inhibiting maturation of the opium poppy seed pods, in which case lower irradiation rates can be accepted and acre per hour treatment rates can be increased.

The apparatus as noted has numerous safety features because such are needed for a high-powered "open" laser (e.g., one not enclosed in industrial or laboratory equipment). With the combination of precise positioning data and systems, LiDAR, and FLIR, the apparatus can operate in the open with an expected 100% on-target-area rate with an expected 0% rate on human or animal heat signatures or structures within the target area. Safety margins around the perimeter of the target area and around human and animal heat signatures and structures will be sufficient to force laser shut off prior to the beam straying into these non-target areas, even if the aircraft hits turbulence, the targeting system is otherwise bumped, or safety scanning or positioning data is lost. Because of the inherent safety issues related to using a powerful open laser, and because of the likely use of this apparatus without the target land owner's consent, this apparatus will likely be used by law enforcement, government entities, and/or government contractors or those otherwise with governmental authority to use the apparatus.

As in FIG. 1, the apparatus will be flown in a pattern, typically circular or nearly so, around the target area with the vertical distance (A) and the horizontal distance (B) set by the needs of the specific implementation. Particularly when the flight radius around the target area is small, an aircraft suited to safe slow flight is preferable due to the relatively small radius flight pattern; a fixed-wing aircraft with slow-flight capabilities (e.g., 45 knots or less) or a lighter-than-air aircraft is preferable in this case for efficiency, but a rotor-wing or other aircraft could also be effective. The apparatus could be affixed to the aircraft and/or affixed outside of the aircraft and/or suspended from the aircraft. Ignoring hostile action from those interested in the value of the crop yield, a specific ratio of horizontal distance to vertical distance – perhaps in the vicinity of 2:1 to 4:1, or larger especially for a tethered (either to a fixed or moving ground base) airborne platform embodiment of the apparatus – will prove ideal for allowing each pass of the laser beam to cross many stems without it also being impeded by other vegetation such as leaves and neighboring crops or trees and yet still terminating in the ground of the target area rather than continuing off target horizontally. Similarly ignoring hostile actions, being closer to the target site is generally preferred as it allows for less scattering of the beam, less divergence of the beam and therefore more opportunity to transfer efficient and concentrated energy/radiation to a small area of the target plants. However, hostile action is anticipated and safety is increased for the apparatus and any airborne operators of the apparatus by increasing distances of the apparatus to the target and vertically between the apparatus and the ground, and therefore distances to hostile entities on land. These two objectives – increased effectiveness and increased operator/apparatus safety from land-based threats – generally run counter to each other and preferred horizontal and vertical distances have to be determined on a case-by-case basis. Small arms fire is the most prevalent and likely means of hostile action against the apparatus and the AK-47 is (one of if not) the most produced and popular small arms in the world with an effective firing range of approximately 350 meters (on level ground), less upward. This establishes an approximate lower-end distance to target from which the apparatus will likely operate in hostile areas, with the ratio between horizontal distance and vertical distance being selected based on the specific implementation as described above. The upper distance limit is based largely on laser wavelength, laser quality, and size and cost of the specific implementation of the apparatus, as greater distance is generally associated with greater safety from hostile action. An embodiment of the apparatus using a larger aircraft and a short-wavelength, high-quality laser with lesser concern for operating costs could be as far away from the target area as 5,000 meters or more and as high above ground as 3,500 meters or more. Greater distances require greater air traffic control authorizations and restrictions and considerations as the energy beam is passing through greater distances and more airspace.

FIG. 2 shows components and optional components of the apparatus as may be arranged in an aircraft. Safety sensors such as FLIR (206) and LiDAR (207) were shown on the outside of the aircraft, under the wing and under the fuselage respectively, in FIG. 1 and are shown again here in the apparatus aircraft (201). An airborne pilot station (202) and a technician station (203) for manned aircraft embodiments with technical control system and interface and data recorder (204) are shown in the flight deck of the aircraft. A high-capacity generator (210) is shown forward of the firewall and a chiller/cooling/heat dissipation unit or refrigerant (205), laser source (208), a programmable and variable-focal-length targeting lens system with stabilization and rotatable/gimbaled mounting (209), an APU (211), and ballistic armoring (212) in and around the cabin area. Various embodiments of the apparatus could have system locations different from what is depicted in FIG. 2. For example, the APU could be located in another compartment, such as a compartment beneath the cabin; or the FLIR sensor could be located

under the fuselage instead of under a wing; or the targeting system could be aiming out the other side or front of the aircraft; or the ballistic armoring could cover more or less of the aircraft or different areas, etc. Similarly, various embodiments of the apparatus may have fewer or more of some of these components. For example, the technician station and control interface and/or the pilot station could be remote from the aircraft and those functions could be handled remotely and instructions transmitted to the aircraft apparatus, such as an embodiment of the apparatus on a UAV; or the technical and pilot stations could be merged into a single station and operated by a single person; or an APU may not be needed or more than one may be employed; or multiple generators may be employed such as a second generator connected to the APU; or the LiDAR system may be considered unnecessary for a given implementation; or multiple lasers and/or targeting systems may be used. The apparatus may be deeply integrated with the aircraft – for example with GPS, autopilot, power systems, laser beam aircraft exit opening, cooling system, etc. – such that the aircraft would not qualify for standard or normal category airworthiness but would have to be operated in a special, experimental, restricted, public-use or other non-standard category. Or it may be self-contained to the point that normal airworthiness is not affected and the apparatus includes a power source and/or fuel supply separate from that of the aircraft.

FIG. 3 provides a flow chart process for activating and operating the apparatus. Before use, the apparatus is started and run through a system diagnostic (301). Then a target area is selected based on an efficient or appropriate target sequence (302). Once the next target area is selected, the apparatus aircraft is flown to a designated flight pattern around the target area (303), the scanning systems and laser targeting systems and cooling systems can be brought on line (304). The apparatus then confirms active and acceptable readings or not from the safety scanning systems (305) and confirm that the scanned target data and actual position data are consistent or not with the target data from the target database (306) to ensure only the appropriate land area is lased. Only after these several safety measures are taken is power supplied to the laser and is the laser activated on its pattern on the target area for a prescribed duration (307) according to the target area size, the laser scanning speed, distance and elevation, and other system factors. Upon passage of an allocated time for a given contiguous target area, the laser power is shut off and the control system determines if the lasing was completed as expected for the target area (308) and records data from the lasing of the target area and moves on to the next target area (302 and 303).

The speed of operation of the apparatus (e.g., acres treated per hour) depends on numerous factors, including the wavelength, type, power and quality of the laser (e.g., a 308-nm UV pulsed 450W pulsed laser with low M-squared value is very different for the apparatus from a 1070-nm near IR 10 kW continuous wave laser with lower beam quality), the nature of the target plants, and the selected distance and elevation of the aircraft to the target area. That said, an embodiment of the apparatus using a 1470 nm wavelength, low M-squared value fiber laser or higher M-squared value direct diode laser stacked to several kW or possibly tens of kW operating from 800 meters from target and 300 meters above ground can lase several acres to several tens of acres per hour of opium poppy fields to prevent maturation of seed pods. For greater stealth and potentially greater safety from ground threats, the apparatus can be used at night and can selectively embody only non-visible wavelengths of laser. For less stealth and/or for more operating time per day the apparatus can also be used during the day and also be used with lasers in the visible range of the EM spectrum. Wavelength is selected on numerous criteria based on the specific application of the apparatus, importantly on distance requirements,

atmospheric conditions and the target crop absorption spectra. Opium poppy plants, for example, have absorption peaks at wavelengths of 350-475 nm, around 670 nm, around 1470 nm, and around 1950 nm, which would be leading choices for apparatus laser wavelength for that plant. Within these leading choices, 670 nm may be selected against – or for – specifically because it is visible and if the objective for the apparatus is to be stealthy or alternatively to be blatant or because this is a wavelength that is also used for plant growth and therefore harder for those wishing to establish countermeasures to prevent while simultaneously allowing sunlight to reach the crop to grow it. Wavelengths of 1470 and 1950 nm may be selected because they penetrate deeper into the vegetation (as may be more appropriate for dense coca plants) and because they are in the “eye safe” region of IR. Or a wavelength in the range of 380-400 nm may be preferred because it diverges less in the atmosphere allowing for a more focused beam on target from farther away and scattering is not significant for the high and hot environment that the apparatus is intended to be used in a given situation. The specific atmospheric environment and vegetative target for a given need will influence the preferred wavelength and that will in turn have implications for the selected laser technology, cooling requirements, and other components and aspects of the apparatus.

Earlier discussion of the apparatus indicated it is intended to be used outside of small arms fire range, yet FIG. 2 presents the aircraft with ballistic armoring. This is because being outside of every possible ground-based threat – such as larger caliber vehicle-mounted weapons – is likely not feasible; therefore, ballistic armoring is sensible to further reduce threat to apparatus, aircraft and/or crew. An embodiment of the apparatus aircraft in an extremely hostile environment may include land-to-air guided missile countermeasures and systems such as chaff and flares.

In an embodiment with the appropriate authorization, the apparatus aircraft could be modified not only to lase target land areas of illicit crops, but also to include additional, distinct programming to respond to threats, using the apparatus as a weapon against those threats; as the apparatus aircraft may be operating with others in the vicinity, these apparatus aircraft could be programmed to share threat data and combine and coordinate in response raising the overall level of safety for crew, aircraft and/or apparatus. In such a situation, the aircraft could retreat to greater distances and/or circle the threat alone or with other apparatus aircraft to ensure multiple attack angles on the ground threat; the LiDAR and FLIR systems would provide key targeting information to, for example, concentrate lasing on disabling weapons and vehicles while avoiding potential maiming of people.

Various countermeasures to the apparatus are considered beyond firearms, among these being solid physical barriers, inflatable reflective barriers such as using Mylar sheeting, “human shields,” mirrors and other reflective materials, and water spray or vapor or dust or other potentially absorptive or scattering barriers. The apparatus overcomes each of these countermeasures either through routine operation or adjustments to its operation. For example, human shields are avoided through use of the apparatus program to avoid lasing of sensed heat signature(s); light-weight/thin barriers such as balloons, films or thin sheeting can simply be lased through; structural barriers and large reflective objects can be avoided through changes in flight altitude and corresponding changes to the downward angle of lasing along with avoiding LiDAR-sensed structure locations. Barriers that would be effective at preventing the apparatus from working would also be effective at preventing sunlight from reaching the target crop, thereby inhibiting crop growth; given that the apparatus can be used day and/or night and can be brought to bear on any target in a large geographical area very quickly, such barriers could not effectively be used against the apparatus while still promoting target crop growth; other more

permanent and sophisticated selectively permeable barriers would likely prove impractical for widespread implementation, and even then the apparatus could be modified (e.g., to another wavelength selection) to defeat such. A typical opium poppy field in Afghanistan is approximately one acre, in part because of intensive labor requirements at harvest and limited available labor during the few weeks of harvest season; the apparatus can arrive at such a target area quickly and lase the area within a few minutes, not allowing those wishing to erect a reflective solid barrier to do so quickly enough to respond; leaving such a solid barrier in place continually itself inhibits the crop growth. Programmatic or political countermeasures – for instance ones which effectively apparatus flight of the apparatus within country – may be effective but are outside the scope of development of the apparatus.

An embodiment of the apparatus involves a system and sensor for targeting the laser beam from plant stem to plant stem, or meristem to meristem, or other selected part of a plant to a selected part of the next, rather than in a multi-line lasing pattern for a target area embodied and described above. This would allow for the same effect of preventing crop maturation, but would be much more efficient in the use of the laser resulting in greater areas treated per time.

An embodiment of the apparatus described herein involves the same using continuous, quasi-continuous, and/or pulsed lasing and/or linear, dashed, curved, dotted, broadcast, random, and/or other geometric or free-form lasing patterns and/or laser beam shape for the target area.

CLAIMS

I claim:

An apparatus and/or method comprising any component and/or feature herein described, either individually or in combination with any component and/or component and/or feature or features, in any configuration.

An apparatus and/or method for reducing plant yield that functions without the need for safe physical access to or near to and/or control of the target plant area, comprising many or all of the following:

an aircraft (manned or unmanned, tethered or free flying);

one or more power sources such as an engine;

one or more generators and/or alternators;

one or more lasers and/or energy beams;

one or more cooling and/or heat dissipation, chiller, and/or refrigerant systems;

one or more geographical data sets for the target area and surroundings;

one or more geographical positioning and/or locating systems;

one or more laser focusing and targeting systems;

one or more technical control systems and interfaces;

ballistic armoring;

one or more data recording devices; and

one or more optical sensor systems providing real-time and/or near real-time data from the target area.

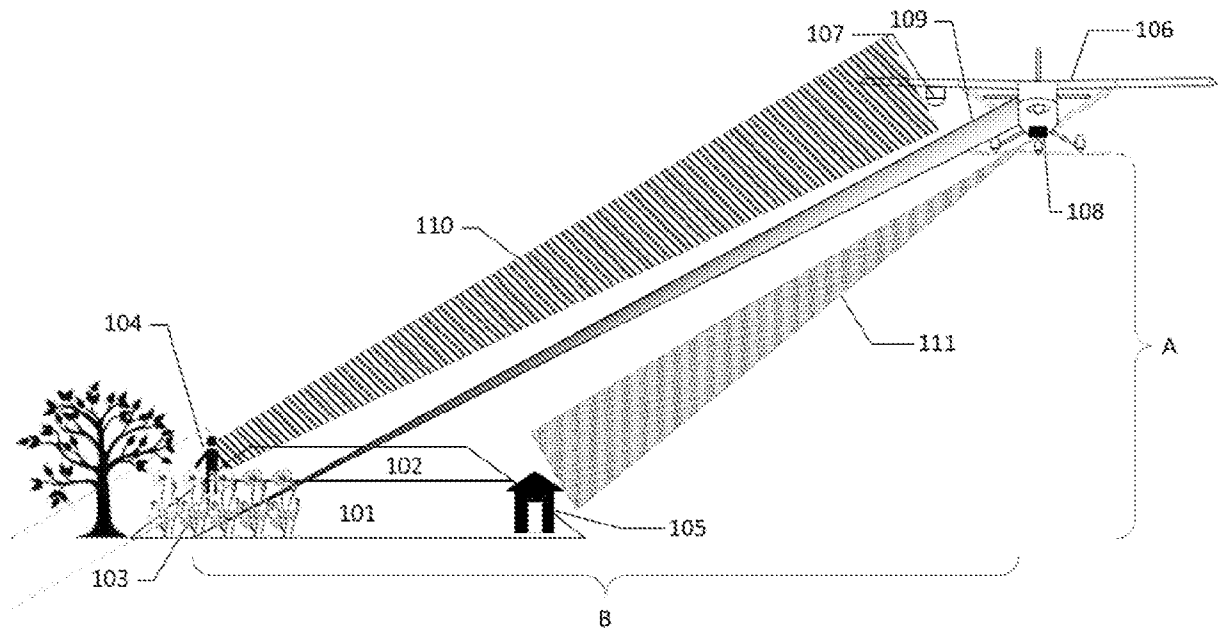


FIG. 1

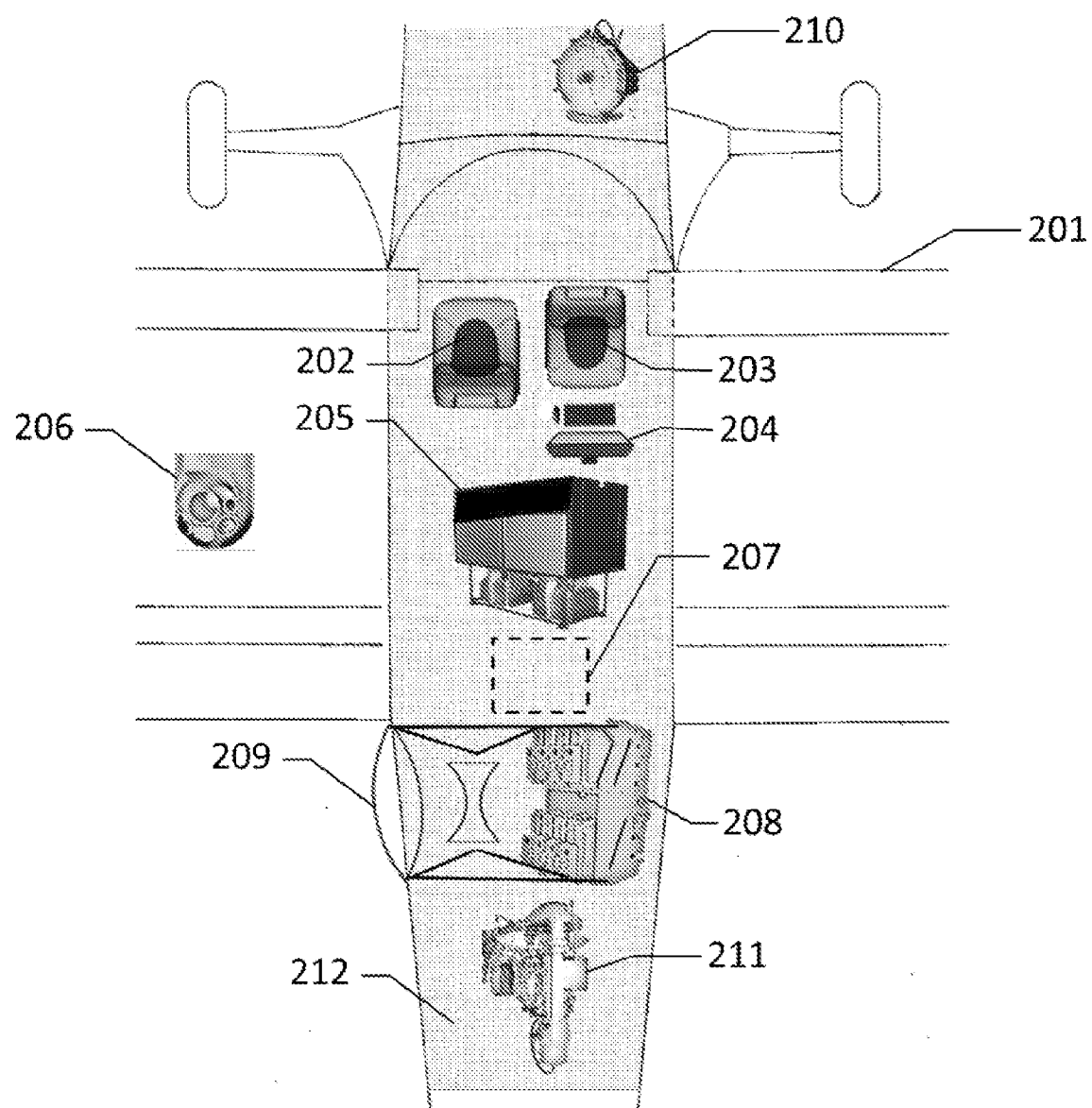


FIG. 2

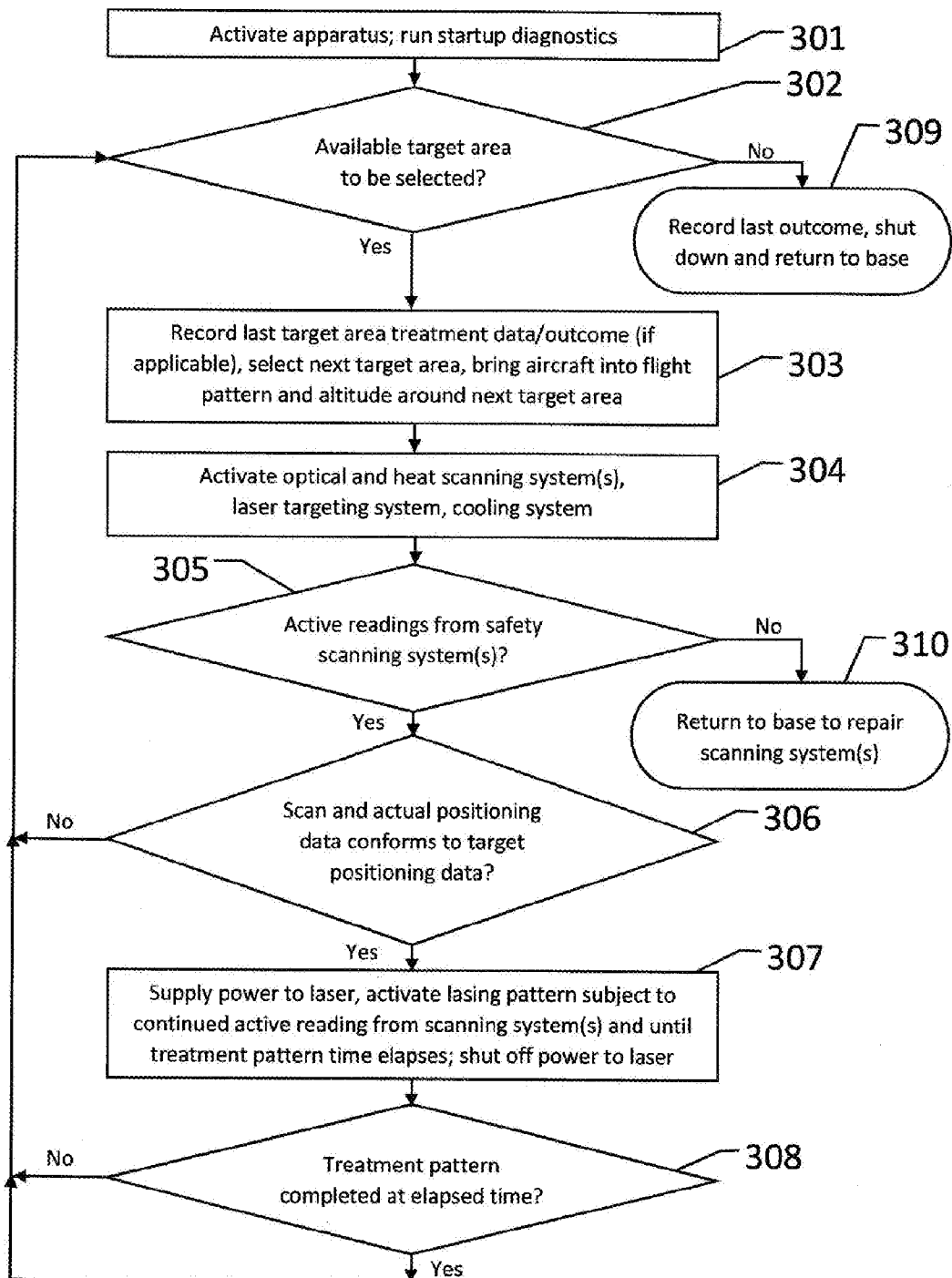


FIG. 3

SCORE Placeholder Sheet for IFW Content

Application Number: 62673040

Document Date: 05/17/2018

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