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Research on the Digital Machine for Killing the Larva of Longicorn Beetle with Microwave Based on the Arduino

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Abstract. Longicorn beetle is an important wood-boring insect. In order to probe into the effective eco-friendly method controlling longicorn beetle, this document recommends a new dual optical digital machine for killing the larva of longicorn beetle with microwave based on the arduino. This machine uses the arduino with temperature controller as the core, touch switch, and a temperature sensor as important parts. By using arduino and sensor measurement technology, a kind of economical close-loop grinding control system is formed to control the temperature with the control of duty cycle and frequency of pulses. The results of the operation showed that the temperature controlling, microwave power is adjustable, man - machine dialogue is woven and seized. It is reliable to be easy to operate and high in automation.

Keywords: pulse microwave; The microwave oven; The arduino; DS18B20 temperature sensor; Silicon controlled rectifier.

1 Introduction

Longicorn beetle is a kind of widespread occurrence of pests worldwide, is the floorboard of the superfamily coleoptera leaf beetle cerambycidae insects and their host variety, damage is extensive, such as forestry, garden trees and fruit trees were infect it, next, because it has a way of life of concealed, natural enemy species less, low interference by natural factors, etc, so control is very difficult, often cause harm in a cabin myself, even the deforestation. Longicorn larvae of vermicular, can crawl into life within two years, at the beginning of hatched larvae in the bark of feeding, with the increase of age, namely greater in phloem and xylem in feeding, trees conducting tissue damage, leading to death. Sawyer neutralising the commonly used method at present is mainly chemical method, namely: by dimethoate and dichlorvos highly toxic pesticides into wormholes, purpose of pesticides. The shortcomings of this approach is that as the longicorn larvae to become resistant to treatment, result in applying pesticide concentration increasing, the environmental pollution is more and more

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serious, at the same time, also cause serious damage to human and animal health. Therefore, attempts to make the field technicians physical methods neutralising the longicorn, but so far, there is still no good insecticidal equipment or physical insecticidal method can achieve the effect of neutralising the sawyer, high efficiency, high killing rate.

Microwave is a kind of can make the material in the inland waters molecules to vibrate and generate heat, therefore, in our already use microwave oven to heat food in the kitchen, and hotel, the hotel has to be used for drying, sterilization equipment, the effect is obvious.

Currently used in the microwave oven is infrared temperature detection device, the thermal stability of the sensor of the device, though, but as a result of microwave heating from the inside out, at this time of the infrared temperature sensor, temperature is only the surface temperature were collected and the internal temperature of the heated material difference is very big. At the same time, because now the microwave equipment for microwave magnetron is realized by using a timer to control, but this method reduces the life of a microwave magnetron, also have impact on control system.

Based on the above problems, in this paper, after studying, put forward a new kind of kill longicorn larvae of automatic control system. This design USES the arduino as the control core, DS18B20 temperature acquisition module for the temperature control unit for soil temperature and the temperature detection, closed-loop control to realize interpolation, interpolation signal transmission to the SCR to magnetron microwave output control.

2 Microwave Kill the Larva of Longicorn Beetle Composition Of the System

Microwave kill the larva of longicorn beetle system main structures is shown in Figure 1:

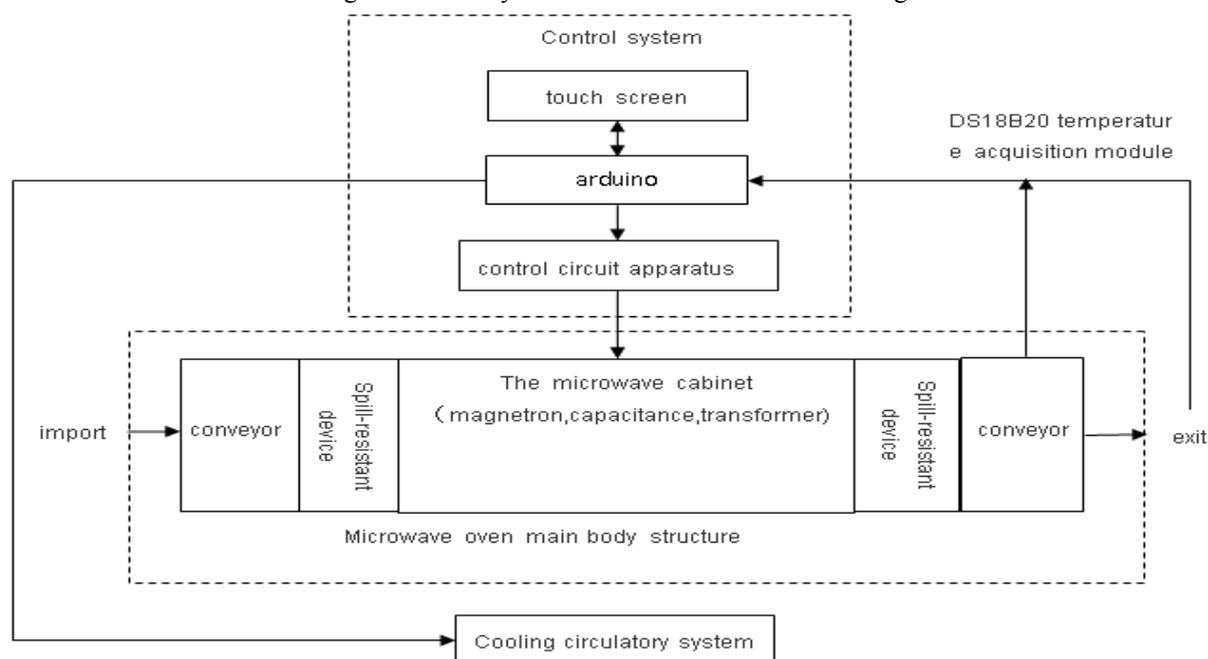


Fig. 1. the digital machine for killing the larva of longicorn beetle

- 1), Magnetron and cavity, adopts the structure combining a snap button.
- 2), Install the ring frame 12 groups of magnetron pulse current of capacitor and transformer and support. Type a panasonic m210-2 M1, maximum output power 900 w. Capacitor using the treasure chang 2100 v 1 u f microwave special capacitance, 12 groups of transformer the GAL - 700 - e - 1 s. 36 sets of SCR control on rectangular frame is divided into three groups of 12 groups of magnetron.

3), This system USES through the 12 v supply to the output transformer for power supply way of wind cold short of 12 groups of fans.

4), The control of this system adopts the arduino and touch key as the core controller to realize automatic control.

5), Temperature detection and feedback system USES DS18B20 temperature acquisition module, the detection of light soil and the internal temperature of the trunk, closed-loop control to realize interpolation.

6), Because the microwave will cause certain damage to human body, the closed loop type is adopted stainless steel sheet to prevent overflow, microwave scattering and in use process, made up of closed loop cavity surrounded the trunk or the roots of the soil.

3 Microwave Kill the larva of Longicorn Beetle of Electrical Control System

Microwave kill the larva of longicorn beetle control system is shown in Figure 2, through the picture you can see, the control unit is mainly the arduino and relevant input and output unit, temperature display, SCR, temperature sensor and controlled object.

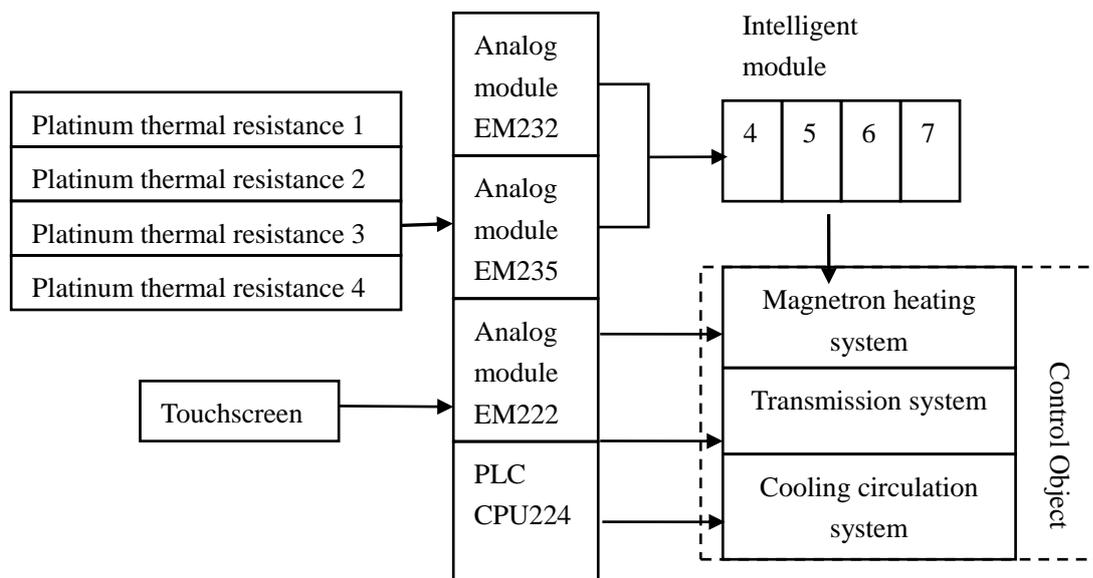


Figure 2 control system

3.1 Microwave kill longicorn larvae system hardware design

3.1.1 Arduino port circuit design

According to the control requirements of the system, need eight digital output port and four analog input ports and three analog output port. In order to meet this requirement, choose the Arduino UNO platform, this platform is the core of ATmega328 processing chip, a total of 14 digital input/output: 6 road PWM output port, no.6 analog input port, all the way ICSP header, a 16 MHZ crystal oscillator, a power switch,

A USB interface and a reset button. In the AREF new added two pin: SCL and SDA, support the I2C interface; Increase IOREF and reserve a pin, control panel can be compatible with 5 V and 3.3 V supply voltage.

Device name	The number	Rated power (KW)
Magnetron	90	0.9
Intelligent thyristor	48	0.05
cooling tower fan	1	1.1
water pump	2	2.2
elevator	1	0.75
oil pump	1	0.37
conveyor	1	2.2

3.1.2 Microwave kill longicorn larvae circuit design of the system

Choose intelligent thyristor control insecticidal machine heating unit, this system USES MJYS - JL - 450 type intelligent thyristor, thyristor module of the input signal of current 4 ma - 20 ma, or 0 to 5 v voltage, control principle are shown in Figure 3 below.

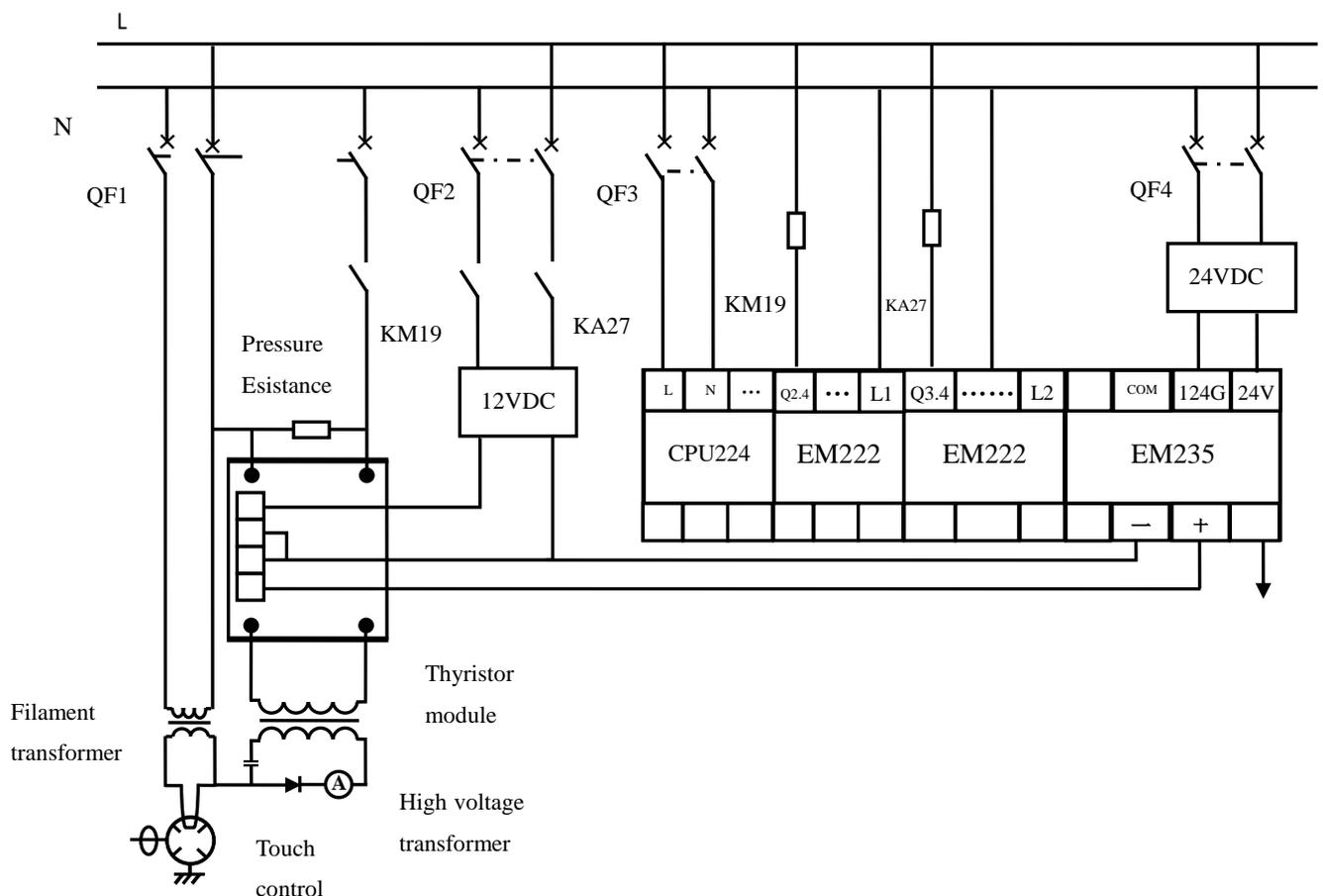


Figure 3 Microwave kill longicorn larvae circuit

The system control method is as follows:

- 1) use the arduino form PWM pulse signal timing control function, low level is the input signal is 4 ma thyristor, magnetron no microwave power is zero at this time; High electricity at ordinary times, silicon controlled rectifier input signal to 20 ma, microwave magnetron, at this time a single power 900 w.
- 2) power regulation. Through the change of the PWM duty cycle of the signal, when the duty ratio is less than 1, can activate the microwave magnetron output. So you can through the PWM pulse width modulation pulse rate and silicon controlled rectifier input signal to change the output power of microwave insecticidal machine.

3.1.3 Microwave kill longicorn larvae temperature control circuit design of the system

In the system of the temperature feedback collection unit adopts the digital temperature sensor DS18B20, the module will be collected the temperature of the analog signal into digital signal, the sensor includes a NTC thermometer element and a resistive touch wet element. DS18B20 temperature detection range in $-55 \sim +125$ °C, in $-10 \sim +85$ °C accuracy of ± 5 °C. In each bucket cover the bottom with a DS18B20, soil temperature signal collected and processed output PWM pulse signal, control thyristor module, change the power magnetron, achieve control of the temperature.

3.2 Microwave kill root nematode system software design

This system adopts the aiduino as processing core, the main program includes the main program, subprogram, temperature acquisition and practical program, microwave control instruction, fault alarm procedures, etc.

3.2.1 Microwave kill root nematode system temperature and pulse microwave control program

The core of this system is for the control of temperature and microwave power, the soil temperature DS18B20 temperature sensor acquisition and processing, the input signal to the arduino Atmel AVR ATmega328 processing, after processing by its send a pulse signal to the thyristor module change magnetron power to implement automatic regulation for temperature. This system has two kinds of manual and automatic operation mode. Automatic mode, the use of pid algorithm, and calculate the duty ratio, through the arduino central processing unit and output control signal, through intelligent thyristor adjust the duty ratio of pulse signal, change the power of microwave magnetron to for temperature control. When malfunction or insecticidal effect is not ideal the need for manual operation, the operator can be manually opened according to the actual temperature heating, namely in setting an interrupt program, through the manual button at the bottom of the screen to switch to the program change PMW duty ratio to change the role of the magnetron power. This system program design flow chart as shown in Figure 4:

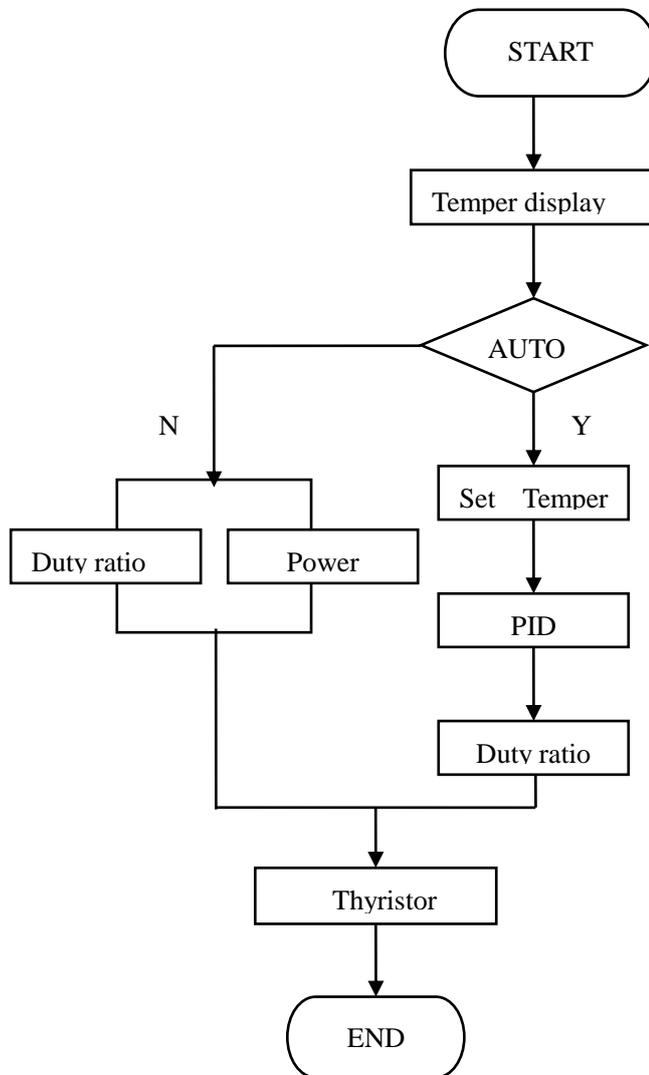


Figure 4 system program design flow chart

This system adopted by the arduino as the core control unit, by controlling the output power of microwave pulse duty ratio control, and adopted the DS18B20 temperature sensor to collect signal and output control signal so that a complete output, execution, feedback, to perform a closed-loop control.

4 Kill Longicorn Larvae of the Mechanical Mechanism of Microwave Insecticidal Machine Design

4.1 Neutralising the longicorn larvae of microwave insecticidal machine structure

The device including the telescopic rod, the top of the telescopic rod connected to the hull, microwave transmitter and controller installed in the shell, shell on the inside of the board to open hole, the inside of the shell plate respectively hinged on both ends the first arc baffle plate and a second reflex arc plate, the first arc baffle in the hinge parts setting first contact pressure, the second arc baffle in the hinge position setting the second contact pressure, the first arc the outer end of the baffle plate and a second reflex arc plate edge set opening snap button, the first baffle plate and a second reflex arc arc plate forming a circular cavity microwave irradiation after closure, hole and cavity microwave irradiation are interlinked, first arc baffle wall by first fittings installed first microwave leak proof brush, the second arc baffle wall brush through the second fittings installed the second microwave leak proof. The invention by microwave irradiation sawyer will kill, makes the killing rate of 100%, and characterized by the good insecticidal effect. The mechanical structure as follows in Figure 5:

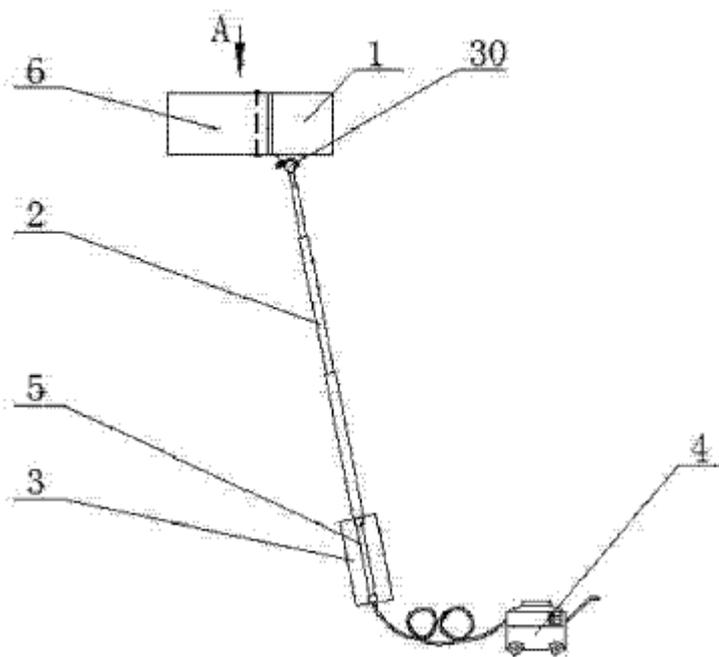


Figure 5 mechanical structure

1.the cavity 2.connecting rod 3. The control panel 4variable pressure control panel 5.wire6.microwave reflector 30. universal joint.

4.2 Structure of microwave irradiation

Mentioned in the present invention arc baffle the end of the opening and closing the structure of the snap button as shown in figure 7, the structure for optimizing structure, opening and closing of the snap button for concrete structure: the first reflex arc plate convex block set the end of July 23, 23 on both sides of the convex block with 29 arc grooves, the second arc baffle grooves set the end of June 22,

respectively on the 22 of the two grooves inside open half spherical tank 24, 24, respectively, on both sides of the opening half spherical tank is set to half spherical tank 24 raised near the center of the block is 26, each half spherical tank are installed within 24 28, spring spring 28 end connected to the spherical bead 25, 25 set on spherical beads baffle ring 27, baffle ring located in the half spherical tank within 24, 27 and 26 limit stop. When the contact pressure affected by external force, fit two curved reflector, two spherical bead 25 at arc grooves in the 29, implement two arc fit reflex plate.

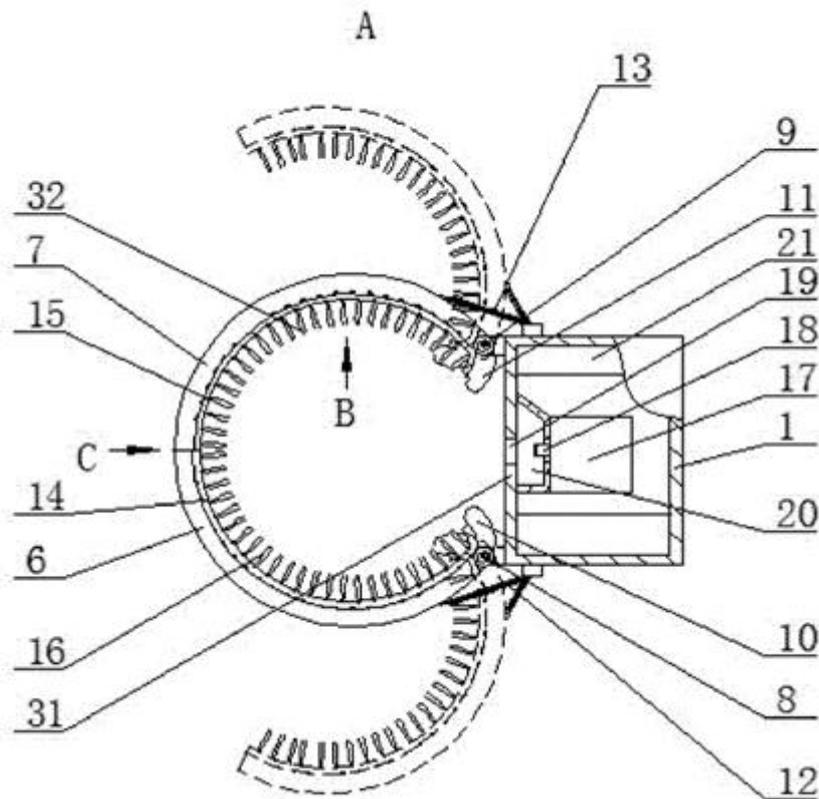


Figure 6 the structure of the snap button

Microwave insecticidal machine when using this design, the two pressure contact and collision tree trunk to make two reflex arc plate automatically closed, there will be a wormhole trunk as well in the closed two curved reflector formed the circular microwave irradiation cavity, at this point, the four microwave leak proof brush also closed with arc baffle ring shape formation, the two curved reflector closed after the formation of the circular cavity microwave irradiation to seal. Open microwave transmitter irradiation longicorn larvae, under the action of microwave irradiation, generate a lot of heat and moisture in the trunk at the same time, the longicorn larvae molecules under the action of microwave electromagnetic field produced deformation and vibration, make the function of the cell membrane produces change, until the cell membrane rupture, produce non-thermal effect, superposition of non-thermal effect and the heat generated by the trunk longicorn larvae were culling.

5 The Insecticidal Effect of Microwave Neutralising the Longicorn Larvae System

This design of neutralising the longicorn larvae microwave insecticidal machine, when use pull telescopic rod according to the height of trees to the length of the need, the microwave irradiation cavity into the trunk of a stem borer pest lateral, microwave irradiation cavity around the trunk and the cavity is closed, intermittent open microwave transmitter, the microwave irradiation cumulative time reaching 3 to 4 minutes, neutralising the longicorn larvae reached 100%, and trees 45 to 60 days, the continuous observation trees to normal growth, and before using microwave extermination are exactly the same, without any exception. The effect is according to the statistical data from experiment base. The applicant in the five years of poplar 1000 f to do the test, the poplar sawyer about 70% less trees are infection, the tree appear a large number of wormholes, peeling bark, longhorn beetle larvae into the depths of the trunk for 15 to 20 centimeters, the wormhole distribution within the limits of the upper 20 centimeters, was disseminated trees can be divided into two groups. Using the present invention insecticidal machine will fit with the trunk of the wormhole surrounded in microwave irradiation cavity, the first set of open microwave transmitter 60 seconds to stop and check the longicorn larvae death in about 31% and 60 seconds to stop and open the microwave transmitter, check the longicorn larvae death in about 70% and the third open microwave transmitter illuminate is 60 seconds, check the longicorn larvae insect body burst, all died. Continuous observation was light trees 45 to 60 days, tree growth all normal. By microwave irradiation at the same time, the second group of 80 seconds to stop and check the longicorn larvae death cases, 3 times, total radiation light 80 seconds after the stop check every time, when the third time after irradiation, check all longicorn larvae were killed, 45 to 60 days continuous observation by microwave irradiation trees, tree growth situation is the same as the first group, without any exception. The irradiation method, in the trunk of the wormhole within the scope of the upper 20 cm mobile microwave transmitter, repeat the above test method, inspection longhorn beetle larva mortality rates were 100%, and no impact for the growth of trees.

References

- [1] Sun Fengkun XingZeBing. Microwave technology principle and its development and application [J]. Science and technology innovation and application, 2014, 6:3-4.
- [2] Xue Dingping, cheung, Jiang Hui, etc. Food non-thermal effect of microwave processing research [J]. Journal of Chinese food, 2013, 2013 (13) : 143-147.
- [3] Jian-zhong li. Athermal biological effect of microwave on food microorganism and microwave sterilization technology [J]. Journal of southwest university for nationalities (natural science edition), 2006, 6 (32) : 1219-1222.
- [4] Cao Chongwen. Status of microwave vacuum drying technology [J]. Journal of drying technology and equipment, 2004, 3 (2) : 5-9.
- [5] Zhou Weigong loesch. Electromagnetic pulse sterilization study [J]. Journal of microwave, 2007, 3 (16) : 318 - 321-230.
- [6] NieShaoWu yue-lai hu, han-ying huang, etc. Grain insect-resistant mouldproof dedicated microwave oven design [J]. Journal of food and machinery, 2014, 1:114-117.
- [7] Wang dong. The power control circuit design of microwave heating system [J]. Journal of electronics, 2012, 11:57-58.
- [8]XiGuQin; Song Jizhen; Yin Qisheng; Li Kangsheng; Xu Jingmin . Tobacco Science & Technology. Zhengzhou Tobacco Research Institute of CNTC,Zhengzhou 450001,China2.Xuzhou Zhongkai Electromechanical Equipments Co.,Ltd.,Xuzhou 221005,Jiangsu,China
- [9] hong xin-sheng cheng, Wei Chongsheng. Insects juvenile hormone analogue "double oxygen wei" on the

biological effect of tobacco [J]. Journal of tobacco science and technology, 2006 (12)

[10]JingWeiDong; Ke li.Archives Science Study, Microwave insecticidal sterilization performance comparison study effect and side effects.

[11] Lin tao. Insects the heating plate temperature measurement and control system design based on MCU [D]. Northwest agriculture and forestry university of science and technology, 2009.