

# Design and embodiment of stable system by change of action waveform by pulse module special quality of pulse style CO<sub>2</sub> laser for obstetrics and gynecology

(산부인과용 펄스형 CO<sub>2</sub> 레이저의 펄스모듈 특성과 동작파형 변화에 따른 안정된 시스템의 설계 및 구현)

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## 요약

CO<sub>2</sub> laser sees that is most suitable to get this effect through minimum formation damage and advantage that is root enemy of effect that happen in minimum cellular tissue depth of 0.1mm is stable living body organization or internal organs institution. Formation damage by ten can be related in formation's kind or energy density, length of evaporation time. If shorten evaporation time, surroundings cellular thermal damage 200 - because happen within 400um laser beam in rain focus sacred ground surroundings cellular tissue without vitiation me by evaporation Poe of very small floor as is clean steam can . Application is possible to vulva cuticle cousins by a paternal aunt quantity, uterine cancer, cuticle tumor by laser system that CO<sub>2</sub> laser gets into standard in obstetrics and gynecology application. Because effect that super pulse output is ten enemies of laser if uniformity one pulse durations are short almost is decreased, most of all pulse module special quality of pulse style CO<sub>2</sub> laser for obstetrics and gynecology mode stabilization by weight very, in this research to get into short pulse duration and higher frequency density, do switching by high frequency in DC-DC Converter output DC's ripple high frequency to be changed, high frequency done current ripple amount of condenser for output filter greatly reduce can . Ripple of output approximately to Zero realization applying possible inductor realization through a special quality experiment do .

## Abstract

CO<sub>2</sub> 레이저는 최소한 조직손상으로 이러한 효과를 얻는데 최적이라고 보며 0.1mm의 최소한의 세포조직 깊이에서 일어나는 효과의 근본적인 장점은 생체조직이나 내장기관에 안정적이다. 열에 의한 조직손상은 조직의 종류나 에너지밀도, 증발시간의 장단에 관계될 수가 있다. 증발시간을 짧게 하면 주위세포의 열적손상은 200~400um 이내에 일어나므로 레이저 빔은 비초점 영역에서 주위세포조직을 손상함이 없이 증발에 의한 제거나, 아주 얇은 층의 포를 깨끗하게 증발시킬 수가 있다. CO<sub>2</sub> 레이저는 산부인과 응용에 표준이 되는 레이저시스템으로 외음부 상피내종양, 자궁암, 상피 종양에도 적용이 가능하다. 슈퍼펄스 출력은 거의 동일하나 펄스지속시간이 짧으면 레이저의 열적인 효과가 감소가 되므로 무엇보다도 산부인과용 펄스형 CO<sub>2</sub> 레이저의 펄스모듈 특성은 모드안정화가 매우 중요함으로, 본 연구에서는 짧은 펄스지속시간과 고출력밀도 되도록, DC-DC Converter에서 고주파로 스위칭 할수록 출력 DC의 ripple은 고주파화 되는데, 고주파화된 전류 리플은 출력 필터용 콘덴서의 량을 크게 줄일 수 있다. 출력의 ripple을 근사적으로 Zero까지 실현이 가능한 인덕터를 적용하여 특성실험을 통하여 실현하였다.

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## I. Introduce

CO<sub>2</sub> laser had been used mainly much in laparoscope surgical operation mainly. Thermal effect of beam displays other result different constituent of cellular tissue and different conclusion of state examination of laser beam. Temperature increase priority solidification consists and next cutting or carbonization process happens and evaporation by breakdown of cellular tissue happens more than 300°C in cellular tissue. That CO<sub>2</sub> laser is most suitable to get this effect through minimum formation damage, fundamental advantage of effect that see and occurs in minimum cellular tissue depth of 0.1mm is stable living body organization or internal organs institution. Formation damage by ten can be related in formation's kind or energy density, length of evaporation time. Application is possible to vulva cuticle cousins by a paternal aunt quantity, uterine cancer, quality cuticle tumor by laser system that CO<sub>2</sub> laser gets into standard in obstetrics and gynecology application. Because most of existent medical treatment equipment select full-bridge DC-DC converter form, control 2 roads passed energy because switch pair that exist in diagonal line does on or off at the same time, important problem that happen in this action does so that energy that is stored in leakage inductance of transformer in case 4 switches are off all may be no exhausted passageway, Because ZVS-FB DC-DC converter makes gate signs of switch Q2 and Q4 have delay during time about gate signals of Q1 and Q3, though energy that energy that is stored in leakage inductance of the first transformer during this time

makes low-impedance passageway so that may circulate through body diode of switch, and moreover is stored in leakage inductance discharges energy that is stored in union capacitance of switch, is way that switching element do so that do ZVS (Zero Voltage Switching) action being used. That is, according as leakage inductance value increases, Deff decreases more. Do switching by high frequency in DC-DC Converter, output DC's ripple high frequency to be changed, current ripple that is done high frequency Tuesday can reduce greatly amount of condenser for output filter. But, to do device high frequency Tuesday, there is some measure limit, but ripple of output approximately to Zero realization applying possible inductor realization through a special quality experiment do. Specially, pulse module special quality of pulse style CO<sub>2</sub> laser for obstetrics and gynecology mode stabilization by weight very, in this research to get into short pulse duration and Go output wheat design and result that manufacture and experiment, brought result that improve of 13% about existing product, and if supplement as systematic late, it becomes thought to get into superior result.

## 2. Design

Because scattering of beam is much in establishment, century of beam by laying eggs increases. Specially, 600nm ~ if beam between 1500nm is entered a company beam century through laying eggs process increase, and tissue such as kidney increases until 4 ~ 7 times. Carbon dioxide laser beam that is wave

length 10.6um expresses transmission depth of about 0.01mm in water. Because carbon dioxide laser expresses transmission depth of 1/1000 mm in establishment, whole output can change to row in formation front. Absorption of oxidation globin 580nm ~ happening between 805nm than hemoglobin weaker absorption happen. Thermal effect of laser beam is evaporation effect for formation's integrity or solidification in medical treatment application. These phenomenon happens by beam investigations between tens second in Sums between laser output 10 w/cm<sup>2</sup>.

$$C = 4.17 \text{ kJ / Kg } * K \text{ -----(1)}$$

$$K = 0.54 \text{ W / mK } \text{ -----(2)}$$

$$W = Pt = L \rho V \text{ -----(3)}$$

$$D = P / (L \rho dX / t) \text{ -----(4)}$$

$$D = 4 Pt / (L \rho d^2) \text{ -----(5)}$$

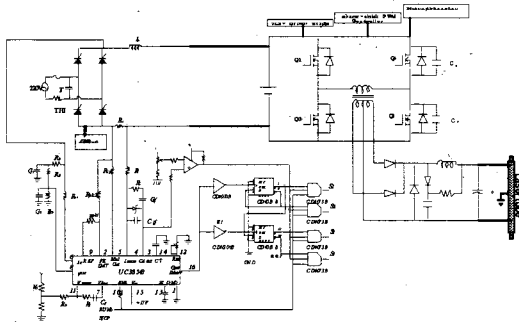
$$\tau = \delta^2 / 4 a \text{ -----(6)}$$

Zeal spread is decided by thermal conductivity and because organization is like with water, thermal conductivity K are appearing to way (6). Laser beam must have transmission depth that is less to operate tissue. As a result, high surface temperature is formed and tissue vaporizes. In case ignore heat conductivitys, beam energy W for evaporation of volume V are

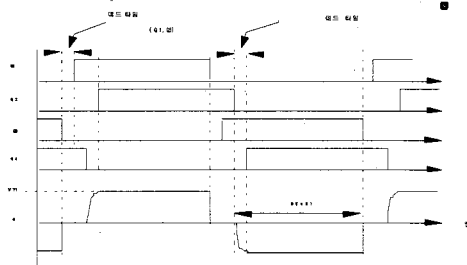
same with way (3). L expresses formation's density which increase being evaporation ten. In case required energy is 2.3J and uses carbon dioxide laser to issue additional paper money volume 1mm<sup>3</sup>'s formation, big error does not occur in this approximate. For formation exclusion necessary energy 4 ~ because 5J need incision depth for formation incision with way (4) save can. Store exclusion region is through minimum ten enemy damages formation which do and drop launches in gas state. Specially, leisure that try first time by medical is carbon dioxide leisure, and this laser emits wave length 10.6um of infrared rays area and average output is announced from 20 w to 100 w. Beam in formation's water transmission deeply in about 1/100 mm strong absorption have and organization by this strong absorption reaches in heating Go high temperature fast and formation's evaporation which gather to focus of beam happens. Solidification area is using much by integrity by thin relation. Laser output becomes output adjustment from 20 w to 100 w consecutively and time of exposure is available adjustment through water plant in 0.01 seconds. Pulse action can intercept laser beam periodically and supermarket pulse 0.1 ~ between 1ms discharge consist, and laser output that is the moment is increased to 5 ~ 10. There is average output becomes similar or low. If use supermarket pulse, can reduce formation's thermal conductivity. That output laser acts by basis mode and higher hrust mode can operate by multiplex mode action and beam diameter of multiplex mode becomes about double than basis mode beam.

### 3.Embodiment of system

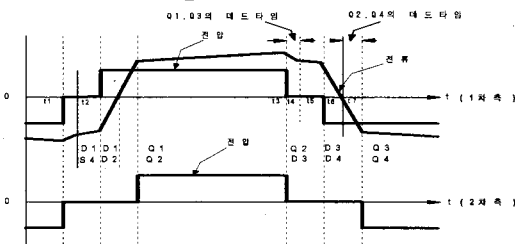
Achieving following process as that display basis circuit diagram and waveform of main circuit main circuit of 30 [V]/50 [A], DC-DC Converter of 20 [kHz] switchings of design wish to . Must do work of design and so on of choice,



[Fig .1] Block Diagram



[Fig .2] Time Pulse



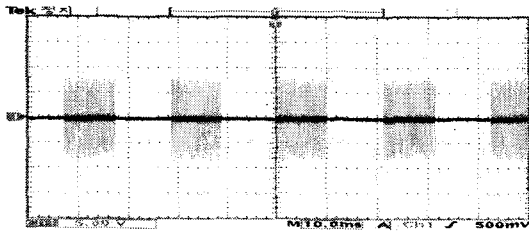
[Fig .3] Active Mode

#### 4. Experiment Result

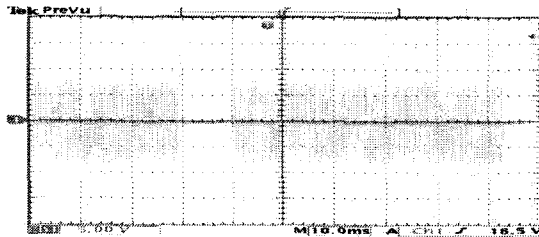
Switching element does suitable IGBT Ro in 20 [kHz] high frequency switchings, chose

to do device compact Tuesday me that have drive circuit on interior by IPM that is convenient. Pumping gas (pumping source) makes energy in ground state by here state (excited state) as device that laser for obstetrics and gynecology consists of vitality media that surround by optical activity (optical cavity). Used Pyrex (Pyrex) pipe that laser discharge tube is length 85cm, inside diameter 16mm, thickness 2mm and volume of discharge tube to generate discharge plasma is  $75\text{mm} \times \pi \times 64\text{mm}^2$ . Discharge department made attaching cathode of cylindrical and anode of saliva shape that make from aluminum to discharge tube, and distance between electrode did by about 75 cm. Manufacture Pyrex tube that is inside diameter 30mm, thickness 2mm doubly to prevent ailment of causable output by temperature rise by discharge Plasma at series action in discharge tube outer wall and composed water circulation chiller. Laser eruption efficiency drops because of this and state of eruption suspension and so on happens. Establish bypass (Bypass) pipe together to prevent this and reduced occurrence of impurities by CO2 molecular Harry when flowing of gas minishes temperature upswing and pressure difference of discharge within the jurisdiction by gas overheating round electrode as help and discharges because inserting small fan. After change by pulse of high tension using high voltage · high frequency pulse transformer, approved to discharge tube. Designed so that can be variable to repeat rate 100Hz ~ 1kHz and maximum pulse voltage that can get in rural districts were about 20kV. Is main part of pulse power supply to do to think laser whipping stoppage department, switching

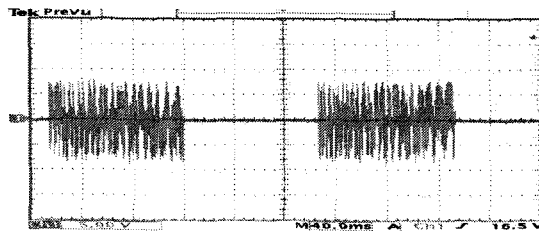
department, high tension? Is composed at control that use high frequency pulse transformer department, micorprocessor. When approved pulse of high tension to discharge tube in pressure 12 Torrs, is waveform that measure voltage waveform between quantity electrode using 1000:1 potentiometer (Tektronix:P6015A Opt.1R).



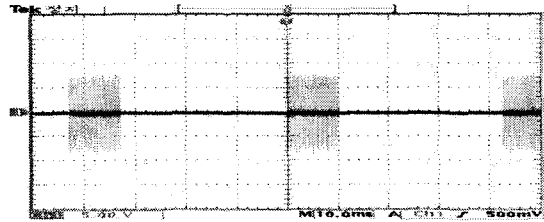
[Fig .4](pulse 2, gap 10ms, width: 10ms)



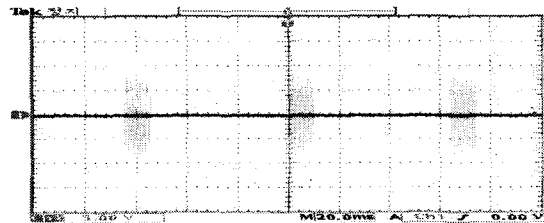
[Fig 5](pulse 2, gap 10ms, width: 50ms)



[Fig 6](pulse 2, gap 10ms, width: 100ms)



[Fig 7](pulse 2, gap 30ms, width: 10ms)



[Fig8](pulse 2, gap 50ms, width: 10ms)

## 5. Conclusion

Mixture ratio CO<sub>2</sub> of gas : N<sub>2</sub> : Measured output increasing working pressure by 3 Torrs from 6 Torrs to 15 Torrs in He = 1 : 9 : 15. According as working pressure rises, because CO<sub>2</sub> and N<sub>2</sub> molecular density increases, density of laser here sub-officer increases and because of spread cooling effect by increase of collision sectional area, laser output increases. Because spread cooling is dominate, maximum input that such domestic animals style CO<sub>2</sub> laser can input per unit volume is limited by 0.5 W/cm<sup>3</sup> degree. Therefore, must use high speed domestic animals style or sale through illegal channels style etc. that can augment energy that is engaged per unit volume to get higher output.

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