FIBER OPTICS SAGNAC INTERFEROMETER FOR DISTRIBUTED SENSOR

DRDO has developed a fiber optics Sagnac interferometer for distributed sensing applications using a low duty cycle (one per cent) pulsed laser source. The dynamic range can be enhanced in this system compared to others with CW laser because of the high power laser source employed with this system. In terms of rotation sensing it can detect 0.27°/hr rotation rate. System is flexible as for higher sensitivity, the fiber length in the sensing coil can be increased.


Fiber Optics Interferometer

A Pigtailed Perkin Elmer laser diode operating at λ =1300 nm and a duty cycle of one per cent gives 535 mW of peak power at 4 A forward current. The sensing coil of the interferometer is 600 m of SM silica fiber wound on an aluminium former. An appropriate laser driver circuit has been developed for optimised operation. The detector used is a Pigtailed Perking Elmer pin photo detector with responsivity of 0.75 at 1300 nm. Along with these, two directional couplers are used.

The interferometer is very sensitive and can find applications in ultra sound detection and current sensor.

Technology Focus highlights the technological developments in DRDO, and also covers the products, processes and technologies.

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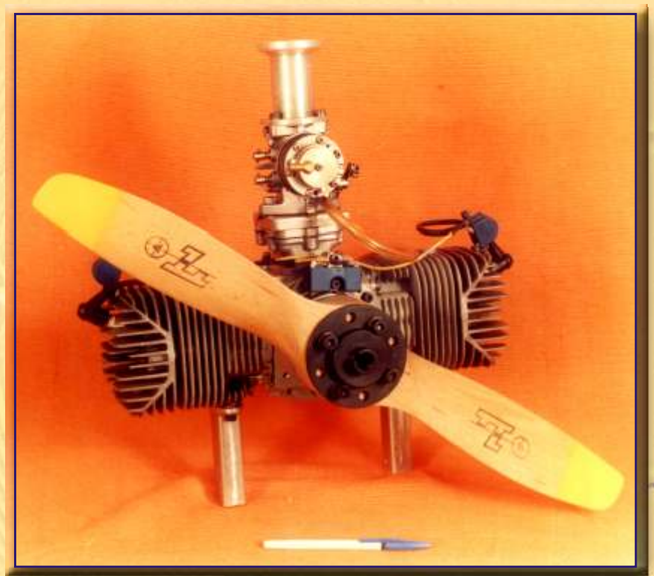
Technology Focus

BULLETIN OF DEFENCE RESEARCH & DEVELOPMENT ORGANISATION

TWO STROKE ENGINES FOR UAV

In This Issue


Two cylinder engine for UAV

Lightweight, high power and compactness with reliability are unique requirements of an engine of an unmaned air vehicle (UAV). DRDO has designed and developed lightweight, high specific power, two-stroke two cylinder, and four cylinder gasoline naturally aspirating reciprocating air breathing engines for indigenous UAV. The two cylinder engine, weighs only 10 kg and develops 21-22 hp at 7000 rpm. Whereas, the four cylinder engine weighs 22 kg and develops 37-38 hp at 7000 rpm. The crankshaft of the engines is of multi-piece design and its components have been assembled together with interference fit with the help of liquid nitrogen. The engine cylinders are made up of cast aluminium with vertically arranged cooling fins to provide effective cooling.

The diaphragm type carburetors, which allow all position operation, are mounted on a reed valve housing. The ignition has been provided by an engine-mounted capacitor discharge system comprising of magneto flywheel, electronic modules, ignition coils and spark plugs.

Both the engines have been tested under simulated high altitude condition with 30" x 22" propeller up to 14000 feet from sea level in climatic test facility.

Four cylinder engine

Technical Specifications

	Two cylinder engine	Four cylinder engine
Displacement	684 cc	342 cc
Composite ratio	7	7
Maximum power	21-22 bhp @ 5500-7000 rpm	37-38 bhp @ 5500-7000 rpm
Maximum torque	5.5 kg-m @3500 rpm	2.8 kg-m @ 3500 rpm
Idle speed	2000-3000 rpm	2000-3000 rpm
Induction	Reed value	Reed value
Ignition	Electronic capacitor discharge	Electronic capacitor discharge
Carburetor	Diaphragm type	Diaphragm type
Weight	10.5 kg	22 kg

LOW VULNERABILITY AMMUNITION

Existing ammunition containing conventional gun propellant is extremely vulnerable to external stimuli due to the use of nitric esters in the gun propellant formulation. Besides, the accidental initiation of onboard ammunition can be cause of major catastrophe, resulting in casualty of tank crew and loss of costly equipment. The avoidable loss of man and machine necessitated the development of low vulnerability ammunition (LOVA) gun propellant.

The concept of LOVA gun propellant evolved by formulating a propellant which is less sensitive to impact, friction and heat stimuli, while achieving force constant, at par with the conventional propellants.

DRDO has successfully developed the technology for the processing of nitramine-based low vulnerability ammunition propellant by achieving the desired low vulnerability characteristics, while realising the force constant to the level of l056 J/g. The propellant is processed by a safe, cost effective, reliable, and patented two stage wet process.

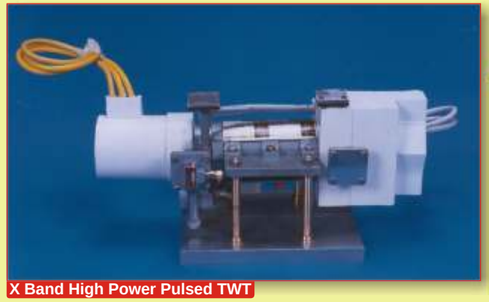
Low Vulnerability Ammunition

Salient Features

	LOVA Propellant	Conventional Propellant
Force constant (J/g)	1050	1040
Flame temperature (K)	2850	2800
Impact sensitivity (height for 50 per cent explosion) (cm)	50	29
Friction insensitive up to (kg)	36	19
Ignition temperature (^{o}C)	220	180

X Band High Power Pulsed TWT

Microwave tubes are the prime source and amplifiers for high power microwaves in radar, communication, electronic warfare, and industrial systems. Traveling wave tube (TWT) is one of the microwave tubes used as an amplifier in radar, onboard a ship, and for an airborne application. DRDO has developed a x band high power pulsed TWT for airborne radars. This tube uses an inter-digital slow-wave structure, a



X Band High Power Pulsed TWT

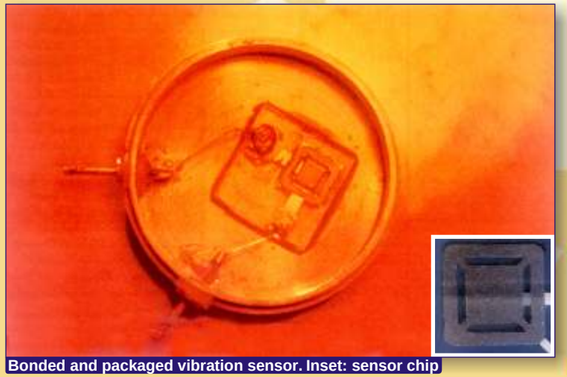
non-intercepting gridded electron gun, and a single-stage depressed collector. It is capable of delivering a minimum of 6.5 kW of pulsed power at 10 per cent duty. A compact size, lightweight, and low thermal dissipation as compared to imported equivalent TWT's are some of the main features of the tube which makes it suitable for airborne radar applications. This tube has passed all electrical tests for radar performance and stringent environmental tests for safety of flight.

Salient Features

Peak power output	:	6.5 kW
Duty	:	10 per cent
Frequency	:	x band
Bandwidth	:	200 MHz
Gain	:	38 dB (min)
Size	:	450 mm x 130 mm x 110 mm
Weight	:	6.5 kg
Cooling	:	Coolant at 60 ^{o}C

SILICON-BASED VIBRATION SENSORS

DRDO has developed vibration sensors using silicon micromachining to sense vibrations in a machine in the 30-200 Hz frequency band. The sensing element in the silicon vibration sensor is a seismic mass suspended by thin silicon hinges mounted on a metallised glass plate forming a parallel plate capacitor. The movement of the seismic mass along the vertical axis is monitored to sense vibrations. This is obtained by measuring the change in capacitance.



Bonded and packaged vibration sensor. Inset: sensor chip

The movable plate of the parallel plate capacitor is formed by a block connected to a

surrounding frame by four cantilever beams located on sides or corners of the seismic mass. Several sensors in the chip sizes of 1.6 cm x 1.6 cm, 1 cm x 1 cm and 0.7 cm x 0.7 cm have been fabricated and packaged in an aluminium package and tested on a vibration calibration system. The sensor has potential applications in aerospace and automobile industry.

Salient Features

Chip size	:	1.6 cm x 1.6 cm
Frequency bandwidth	:	30-200 Hz
Sensitivity	:	10 mV/g

MBT RATION

Operational ration packs are an essential requirement for all the troops who have to subsist on these ration packs during patrols, exercises and combat operations. Ration packs are designed in such a way that the troops are able to prepare nutritious meals from ready-to-eat or ready-to-cook products in the shortest possible time. Besides, the ration should be self contained, packed to suit the armoured vehicle designs, easily utilisable even while in operation, have a long shelf-life to meet logistic needs of the troops and provide adequate energy and other nutrients. In order to meet these requirements, DRDO has developed ration packs for the crew of main battle tank (MBT).

MBT Ration

The MBT ration of one tank includes four packs each of first day, second day and third day rations and eight accessory packs considered adequate for four persons for three days. The first day ration pack (instant *halwa* mix, veg *pulav, chapaties, dhal curry* and chicken curry) weighs 2 kg and provides 4000 kcal. The second day ration pack (instant *upma*, *chapaties*, *cholay* curry, veg and chicken *pulav*, potato peas curry), weighs 2 kg and provides 4000 kcal, while the third day ration pack (biscuits, softbar, nutribar, *chikki* and tea) weighs 1.5 kg, provides 3000 kcal, and is for use in emergency situations. The ration has been recommended for the operational use after the successful trials.

HIGH PRODUCTION TECHNOLOGY FOR PROTECTED CULTIVATION OF TOMATO


Tomato cultivation under protected conditions

Tomato (*Lycopersicon esculentum (L.) Milll*) is the most widely grown solanaceous vegetable. The acid sweet taste and unique flavour account for its popularity and diverse usage. It is a rich source of ascorbic acid (vitamin C), which varies from 10-65 mg/100g fresh fruit weight and vitamin A, and ranks number one in nutrient contribution to the diet. It also lowers the cholesterol level and bolster resistance to cancer in numerous ways. Commercially, it has got importance throughout the world both for fresh fruit market and the processed food industries. In hills, its demand is increasing day-by-day. However, there is a big gap in its demand and supply due to very low production. Prevailing low temperature, snow and frost injury during winter and heavy rains, hail storms during summer and spring seasons, traditional cultivation methods and non availability of quality seeds are main limiting factors of its cultivation. Keeping in view the importance of the crop, constraints of agro-climatic conditions and benefits of protected cultivation, DRDO has developed an efficient cultivation technique for mid and high altitude areas under protected conditions to get maximum production and higher benefits per unit area.

Salient Features

- Four to five times more production per square meter than the conventional method
- Enhanced life span of single crop by 3-4 months instead of 20-25 days in conventional method
- Maximum 15 harvesting fruits suitable for long distance transportation
- Crop harvesting according to market demand
- Minimum use of fungicides and insecticides due to better management of crop
- Round the year production and maximum vertical space utilisation under protected structures
- Self-employment on farm can be increased

The technique developed by DRDO has many advantages over the traditional field tomato production methods. It is highly productive, amenable to automation, and conserves water and land resources. It is eco-friendly and does not require any sophistication. The technology would be a boon for the mid and high altitude regions for commercial cultivation of tomato crop during hostile winters and rainy seasons hitherto considered impossible. Even farmers having very small holding can also plan commercial tomato cultivation. Increased productivity with high returns without any sophistication favours its early adoption in the hills of the central Himalayas.

OPTICAL FIBER TACHOMETER


Optical Fiber Tachometer

DRDO has developed a state-of-the-art optical fiber for sensing the rotation rate (RPM) of shafts and pulleys.

The optic fiber sensor is a non-contact device and works on extrinsic fiber optic sensing method that uses on-off modulation technique. The digital output of the detector is read directly on a handy and compact 12 cm x 8 cm x 8 cm RPM counter designed for the purpose. The output can also be integrated to a micro-controller storage device or a PC for further usage or storage of data.

A single unit, hand held, stand alone interferometer can be operated on a single 9 V battery. It can count up to 9999 rotations per minute with an accuracy of $\pm$ 1 per cent and the data refreshed once in every second. The range of operation can be further enhanced with changes in the electronic counter circuit and display system.

The sensor is immune to EMI and RFI and suitable for both military as well as industrial applications. In comparison to a conventional IR tachometer, this device is better suited for applications where the direct visual contact with rotating shaft or pulley or flywheel is not possible. The applications of the sensor can also be integrated with drive feedback control system.