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High pulse rate interferometry using a ruby laser and a cordin model 360 camera

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level is adjusted to yield optimum beam diffraction while the Q-switch is on. To remove the 20 W of power dumped into the Q-switch assembly during operation, the assembly is cooled by the same recirculating water stream used to cool the laser flash lamps and output etalon.

Additionally, the controller has inputs for various enable pulses that can be used to hold back a continuous synchronization pulse train until ready to gate out a portion of the train for Q-switching purposes. Thus, while the camera comes up to speed and the laser is pumped, the Q-switch is maintained in the non-pulse mode. The depth of Q-switching can be controlled by adjusting both the high and low RF power to the Q-switches, permitting one to optimize the lasing properties of the system. Laser flashlamp energy, ruby rod temperature, and delay between flashlamp firing and onset of lasing are also important variables for optimizing multipulse laser operation.

Timing

A typical experiment has the following subsystems that must be brought into synchronization with the experimental events: laser flashlamp power supply and firing circuits, camera speed control, and Q-switch pulsing circuits. Certain subsystems have other constraints; for example, the camera requires at least 10 s to come up to speed, can stay at speed for no more than 60 s, and must then remain off for at least 10 times the operating time (to allow lubricants to be redistributed and components to cool). The laser flashlamp power supply, once energized, will automatically dump its charge if the laser is not fired within 60 s. Once the laser flash lamps are fired, the ruby rods require several hundred microseconds to store sufficient energy to lase.

Thus, most dynamic experiments involving the multipulsed laser system will use the following sequence:

1. Start camera turbine.

2. When the camera is at speed, charge laser capacitor banks.

3. When the laser is ready to fire, begin dynamic event; for example, operate a piston driven impactor or activate a drop tower.

4. Use dynamic event to trigger the system. For example, prior to impacting the specimen, the impactor may break a laser beam, which in turn activates a delay circuit. Other timing events may be used, depending on the particular experimental arrangement.

8. The laser beam illuminates the experiment, generating interferograms or other data that are recorded by the camera, usually on Kodak High Speed Infrared film. Normally, timing is adjusted so that at least one data set is taken prior to impact or other loading event to record the condition of the specimen before dynamic loading occurs.

Delay Circuits

The delay unit was designed to satisfy the special requirements of multipulsed dynamic experiments. Firing the ruby laser generates considerable electromagnetic noise, and the pulse controlling the firing must be a fast 10-V signal with significant current. Other parts of the system require positive or negative slope TTL pulses of varying width, with some being terminated in 50 ohms.

The delay unit consists of two Stanford Research Model DG535 digital delay generators which provide the actual delays. A separate unit is capable of converting various input signals into an assortment of output signals. The latter unit also can convert either optical or electrical make-and-break signals into TTL pulses to accommodate

500 kHz.

SYNCHRONIZATION WITH THE EXPERIMENT

The series of pulses produced by the laser should be superimposed on some time interval of experimental interest. For most of the experiments to date, this time was determined by placing an acoustic detector adjacent to the region of interest. The specimen (or an identical copy) was impacted once prior to the test and the arrival of the stress wave detected acoustically. This information is used to identify the times at which dynamic deformation presumably occurs.

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