(fig. 10). This is a cutaway of the second stage with its single J–2 engine and "payload" which was a nose cone shroud provided by the Marshall Space Flight Center.

To accomplish the lunar mission, the engine will be required to burn for about 100 seconds to place the tremendous lunar payload into earth orbit at a speed of about 17,000 miles per hour. After attaining earth orbit and within a time period of 1½ to 4½ hours; thereafter, the engine will be required to restart to take us out of the parking orbit, into the lunar corridor, and onto the lunar trajectory at a velocity of approximately 25,000 miles per hour. That is quite a trick. However, we have worked out much of the technology associated with restarting this engine. Part of the problem, or one of the unknowns, was the behavior of liquid hydrogen which only weighs six-tenths of a pound per gallon. We had to be sure that the hydrogen would settle into the bottom of the tank and remain settled in earth orbit so that the engine could be properly restarted.

I have a film clip (fig. 11) which shows stage separation and onboard camera coverage of the experiment. The second stage separates from the first stage. The flames you see are from the ullage motors which are fired to settle the hydrogen into the bottom of the tank. Here you see the hydrogen settled. To observe LH_2 behavior, markings were placed on the tank wall as points of reference for viewing from two onboard television cameras. One of the cameras was inoperative; however, we decided to go ahead with the launch anyway. The second stage fires for the first time. The hydrogen bubbles up into the top of the tank and, subsequently, resettles into the bottom of the tank.

ACCOMPLISHMENTS - 1966 UPRATED SATURN I

THREE SUCCESSFUL APOLLO MISSIONS

- PROVED DESIGN
- PROVED FLIGHT WORTHINESS OF J-2 ENGINE AND LIQUID HYDROGEN SECOND STAGE
- DEMONSTRATED MATURITY OF PROPULSION, GUIDANCE AND CONTROL, AND ELECTRICAL SYSTEMS
- MSFC-CONTRACTOR-KSC-MSC INTERFACE EXPERIENCE
- APOLLO MISSION SUPPORT CAPABILITY
- EXPERIMENT TO VERIFY ABILITY TO CONTROL LIQUID HYDROGEN DURING FLIGHT AND LOW-GRAVITY CONDITION

FIGURE 9