

not running or battery voltage is low, to prevent battery depletion

### C. Control of Spring Rate and Damping Force

Spring rate and damping force characteristics are changed at the same time. This change occurs for the four wheels at the same time also. This control of characteristics is applied in two ways before vehicle behavior and following such behavior

1) For the control of the spring rate and damping force, change of the characteristics should be completed before the beginning of suspension stroke. This is especially necessary for one-shot behavior. The predictive control adopted to the system is shown in Table III

2) If the vehicle travelling conditions are detected from the vehicle behavior, the problem that the change of characteristics called for cannot be completed until after actual occurrence of such conditions is inevitable. In such cases, continuity of the conditions to be controlled is required to make the control effective. The tracking control implemented by this system is summarized in Table IV

## V. RELATIONSHIP BETWEEN DRIVERS AND SYSTEMS

The system provides interfaces between the vehicle and the driver in two aspects apart from driving of it. One is the selection of the control mode as discussed in Section IV-A, which is conducted using the pushbutton switches at the console box. The other is the recognition of suspension status. Information on the vehicle status will give the driver a feeling of fun and freedom from care as well as ensure safety. The system, which can provide a variety of information concerning vehicle status, is connected with the MultiDisplay System and displays its information on the CRT of that system. Use of the CRT allows information to be displayed as graphics and characters, multiple pattern display on the same area of the CRT or animated display, all of these features helping drivers recognize information easily. An example of a suspension status display is provided in Fig. 13.

## VI. DIAGNOSIS

Diagnosis is a critical factor for system reliability and maintainability. Its major functions are to output warning information by detecting system problems at an early stage, to implement failsafe control, and to store information on troubles that have no recurrent characteristics.

The diagnosis detects occurrence of problems by two different methods. One of these two methods is to detect a problem directly from electric signals. This diagnosis method covers the following parts:

- 1) Spring rate and damping force control actuator
- 2) Height control valve
- 3) Relay of compressor drive motor
- 4) Compressor drive motor
- 5) Height sensor

The other method, which detects a problem logically through assumption, is applied to air systems and the following two cases are judged abnormal.

TABLE III  
SPRING RATE AND DAMPING FORCE CONTROL (PREDICTIVE CONTROL)

Item	Sensor	Purpose
Anti-dive	Speed sensor	Before the vehicle attitude change begins.
Anti-roll	Stop amp switch	suspension is changed
	Speed sensor	harder to restrict
Anti-squat	Steering sensor	
	Throttle position sensor	attitude change
Anti-bounce	Speed sensor	Irregularity of roads is detected by the vertical movement of the front wheel's and suspension is changed softer before the rear wheels pass through the detected irregularity to reduce shock
	Height sensor	

TABLE IV  
SPRING RATE AND DAMPING FORCE CONTROL (TRACKING CONTROL)

Item	Sensor	Purpose
Response to speed	Steer sensor	Suspension is set harder to improve traveling stability at high speed cruising
		Since vehicle speed change is gradual tracking control has satisfactory effect
Response to rough road	Speed sensor	Suspension is set harder to restrict pitching and bouncing on rough road
	Height sensor	

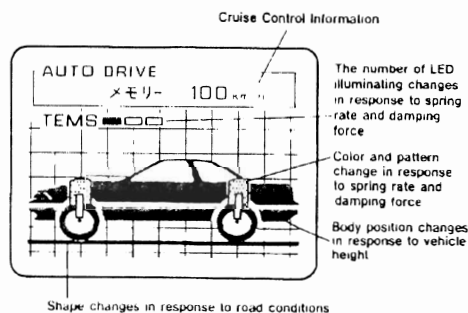


Fig. 13. CRT display.

- 1) Height adjustments are not completed within the specified duration.
- 2) Upward control is repeated for the same target height.

This logical detection method uses judgment criteria that have been set based on the results of on-vehicle tests conducted assuming virtually all possible vehicle operation conditions.

Some troubles, such as plugging of air tubes, occur only temporarily and do not reoccur. Information of such temporary troubles must be retained in memory until proper repair is completed. It is very important to take proper measures for temporary problems and prevent reoccurrence of them to improve the system's reliability. It also has the merit of improving the driver's feeling of safety. Therefore, the ECU has the function of storing all diagnosis information. The stored information can be cleared by grounding the check