CORNELL AERONAUTICAL LABORATORY, INC.
BUFFALO, NEW YORK 14221

SPIRAL JUMP STUNT
OPERATIONAL MANUAL

Prepared by the
TRANSPORTATION RESEARCH DEPARTMENT
for
J. M. PRODUCTIONS, INC.
ORCHARD PARK, NEW YORK

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SAFETY NOTICE

The Astro Spiral Jump is a spectacular stunt for automobile thrill shows. The potentially hazardous nature of the involved vehicle maneuver requires careful attention to setup and maintenance details for both the vehicle and the ramps. Operation outside the specified conditions of speed and lateral placement of the vehicle or with improper setup or maintenance of the ramps and/or vehicle can produce landing conditions that may be hazardous for both the driver and spectators. Therefore, extreme caution must be exercised in the performance of this stunt.

1.0 COMPONENT DESCRIPTION AND MAINTENANCE REQUIREMENTS

1.1 TAKE-OFF RAMP

The take-off ramp is a complex wooden structure with one pivoted section to provide a local slope change. It includes a narrow metal track, for contact by the small wheel mounted under the rear axle of the vehicle, and metal guide rails to aid in the achievement of the proper lateral position of the vehicle. In the following, the function of each ramp feature is briefly described and the associated maintenance requirements are defined.

1.1.1 Drop Section

On the left side of the ramp, with respect to the direction of vehicle approach, a short section of the deck is pivoted to permit a change in its vertical slope subsequent to traversal by the left front wheel. The function of this section of the ramp is to impart a small positive roll velocity to the vehicle (clockwise when viewed along the longitudinal axis of the vehicle in the forward direction) via the left front wheel. The positive roll velocity, combined with a drop action of the ramp section, provides clearance for the left rear wheel during the transition of axle support loading from the left rear wheel to the small wheel mounted under the left side of the rear axle.

The drop action of the pivoted ramp section is triggered by contact of the left front wheel, subsequent to unloading of the pivoted section, with a lever attached to a supporting block under the pivoted section. To prevent inadvertent triggering of the lever by ramp vibrations, a breakaway-type restraint in the form of a nylon cord is used. The nylon cord is tied to the fixed base of the drop section, looped once around the lever assembly and held taut with adhesive tape (i.e., no knot is used on the lever attachment). The objective of this form of restraint is to minimize the resistance during actual triggering. In the development tests that have been performed, the described form of restraint of the trigger lever has been demonstrated to serve the purpose.

1.1.2 Metal Track for Small Wheel Under Axle

The metal surface portion of the take-off ramp is designed for contact by the small wheel mounted under the left side of the rear axle of the vehicle. Its vertical profile produces a critical impulse to the rear axle. The stainless steel cover plate is aimed at achieving a smooth, low-friction surface.

A heavy coating of "Lubriplate" must be applied to the metal surface prior to each performance to retain a low friction coefficient. It should be inspected after each jump for scratches and/or dents. Scratches must be removed by buffing or grinding. Any indentations greater than 1/8" deep must be removed. Note that a recurrance of denting should be corrected by the addition of supplementary local support under the metal plate.

1.1.3 Guide Rails

The guide rails attached to the surface of the take-off ramp serve (1) to aid in achieving proper lateral placement of the vehicle during ramp entry, (2) to limit effects of inadvertent steer inputs, and (3) to supplement the lateral force generated by the RF tire near the end of the RF contact with the ramp.

The paint coating of the contact surfaces of the guide rails must be maintained to prevent corrosion and, thereby, to retain smoothness. A heavy coating of "Lubriplate" must be applied prior to each performance so that the surfaces will be slippery and climbing tendencies of the tires will be minimized.

Attachment points and welds of the guide rails must be inspected after each jump and indicated repairs must be made to insure structural integrity. Deformations must be removed, and points of recurring deformations should be corrected by local reinforcements.

1.2 RECEIVING RAMP

The receiving ramp is a wooden structure with a contoured plywood surface that is aimed at providing the maximum practicable tolerance on the entry speed of the vehicle at the take-off ramp. It has been designed to support the analytically predicted loading of "design condition" landings (i.e., 0° to 7° of yaw toward the receiving ramp, 10° to 25° of nose down pitch, initial contact by the LF wheel). Subsequent to each landing, the receiving ramp must be inspected for structural integrity and surface defects and repairs must be made as required.

It should be noted that the development program has included only six experimental landings and, therefore, "design condition" landings cannot be assured. Following "abnormal" landings, inspection and repairs of the receiving ramp are of critical importance to the safety of further performances of the stunt.

1.3 VEHICLE

The vehicle is an extensively modified 1972 American Motors Javelin SST with a 6 cylinder engine and an automatic transmission. The specific modifications are described in the following paragraphs:

1.3.1 Functional Modifications

1.3.1.1 Small Wheel Mounted Under Reinforced Axle

A forged steel wheel with a polyurethane tread (Rapistan 8X3 ADIRZ) is mounted under the left side of the rear axle. The axle housing is reinforced to support large bending loads.

1.3.1.2 Modified Jounce (Compression) Bumpers

The standard jounce bumpers have been replaced with larger, longer-stroke bumpers. The specific replacement parts have been taken from the following vehicles:

FRONT - 1968 Buick rear suspension bumpers.

REAR - 1970 Ford pickup truck front suspension bumpers.

The clearances to the revised jounce bumpers have been adjusted as follows:

FRONT - 1.00" clearance to lower control arm contact point

REAR - 1.50" clearance to frame contact point

The specified clearances should be checked periodically and adjustments made in bumper shimming, as required.

1.3.1.3 Raised Front End

Heavy-duty front coil springs have been installed in the front suspension to increase ground clearance under the relatively large front overhang. The jounce bumper brackets have been moved down and spacers have been welded to the lower control arms to retain the original amount of maximum suspension travel at the "metal-to-metal" condition of strike through.

1.3.1.4 Special Shock Absorbers

The original equipment shock absorbers have been replaced with special units provided by the Monroe Auto Equipment Company, in which custom valving codes have been applied.

The condition of the shock absorbers and their mounting parts must be checked after each performance of the jump. A visual check should be supplemented by manually oscillating the vehicle and checking the general damping level and, also, the relative movement that occurs between the shock absorber ends and the chassis mounting points. Defective shock absorbers and/or mounting hardware must be replaced.

1.3.1.5 Centered Driver Seat and Controls

To achieve symmetry in the lateral distribution of vehicle mass, the driver seat and controls have been moved to a laterally centered position.

1.3.1.6 Panhard Rod on Rear Axle

A Panhard rod has been fabricated and installed on the rear axle to prevent lateral motions of the axle under conditions of side loading through the small wheel mounted under the left side of the axle.

1.3.1.7 Expanded Scale Speedometer

A P.M., DC Tachometer driven by the speedometer cable is used to operate a zero center meter. The voltage developed by the DC tachometer is biased out of the meter circuit by a battery so that when the vehicle is at a set speed the meter reads zero, which is located at the center of the meter. The gain adjustment is used to adjust the scale factor for the meter and the bias adjustment to adjust the set speed. The bias adjustment is made by observing the speed of a calibrated 5th wheel at the set point and adjusting until the meter reads center scale.

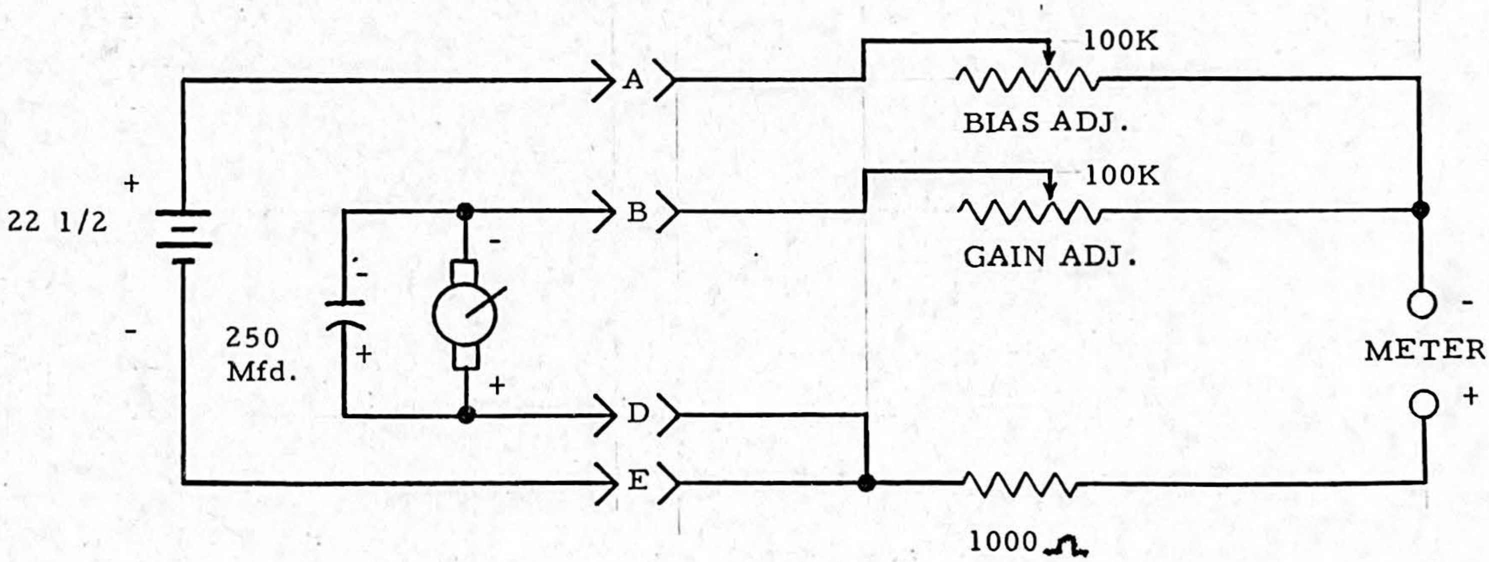


FIGURE 1: ZERO CENTER METER

1.3.1.8 Automatic Speed Control

A modified Ford Motor Company speed control has been installed to aid in the rapid achievement and in the maintenance of selected vehicle speeds. The standard control system, as provided by the Ford Motor Company, is described in the Appendix of this manual. The modifications that have been made in the system are briefly described in the following paragraph.

The modifications to the basic speed control system include the addition of two vacuum tanks in parallel connected to the engine manifold vacuum through a check valve so that approximately 15 inches of constant vacuum is available for the speed control. The vacuum valve which is part of the basic system has been removed and the switch wires are shorted together. These changes permit engagement of the speed control at any vehicle speed, including a standing start.

1.3.2 <u>Modifications for Driver Protection</u>

1.3.2.1 Roll Cage

A complete roll cage, in compliance with NASCAR recommended practice has been installed.

1.3.2.2 Restraint System

A full restraint belt system (i.e., double shoulder straps and lap belt) has been installed.

1.3.2.3 Heavy-duty Tires and Wheels

The standard equipment tires have been replaced with Dunlop 4-Ply Nylon E78 x 14 tires with tubes mounted on heavy-duty wheels. An inflation pressure of 60 psig is used only during speed calibration and actual performance of the stunt.

The tires and wheels must be thoroughly inspected for damage after each jump. Damaged parts must be replaced.

1.3.2.4 Special Fuel Tank

The standard equipment fuel tank has been replaced with a 1/2 gallon capacity tank to reduce the potential hazards of a fire.

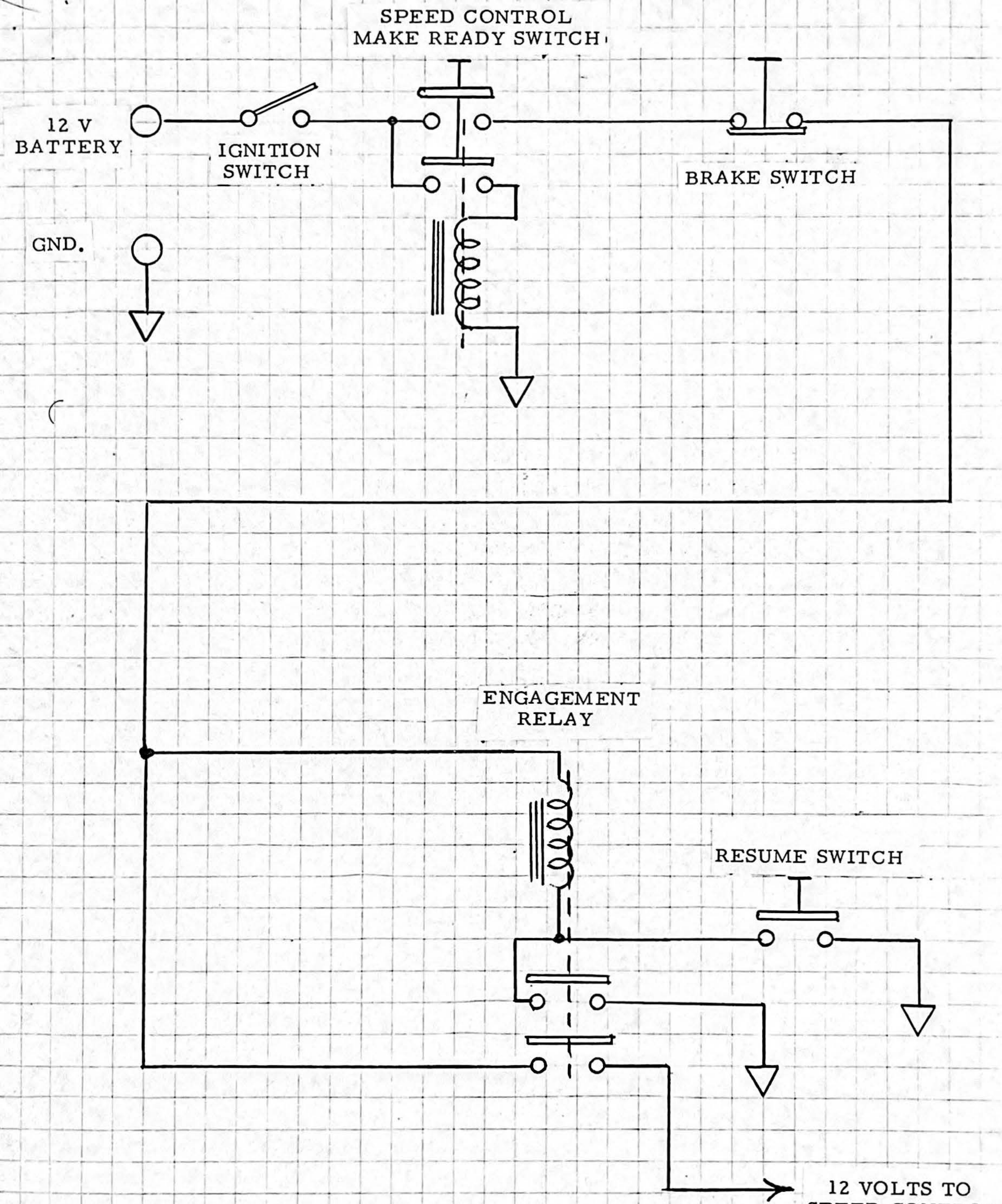


FIGURE 2 SPEED CONTROL ELECTRICAL DIAGRAM

2.0 SETUP PROCEDURE FOR RAMPS

The space requirements for performance of the Astro Spiral Jump are approximately as follows:

2.1 RAMP INSTALLATION SPACE

A level (± 2°) and flat surface approximately 100' x 25' is required for installation of the take-off and receiving ramps.

2.2 RUNOUT DISTANCE

A minimum of 100 feet of runout distance must be provided beyond the end and off the right hand side of the receiving ramp. When the available runout distances are less than 200 feet, safety barriers must be erected that are capable of stopping the vehicle from a speed of approximately 35 MPH.

2.3 APPROACH PATH

The approach path must be at least 200 feet long. Trial runs must demonstrate that a stable speed of 40 ± 1 MPH and a lateral position that is within ± 5 inches of the centerline of the guiderails can be achieved prior to contact with the take-off ramp on the actual terrain surface.

After it has been established that the above requirements can be met, the following measurements and markings are required for ramp installation.

2.4 LAYOUT OF RAMP INSTALLATION (See Figure 3)

A 100 foot long centerline should first be marked along the longitudinal axis of the ramp installation space.

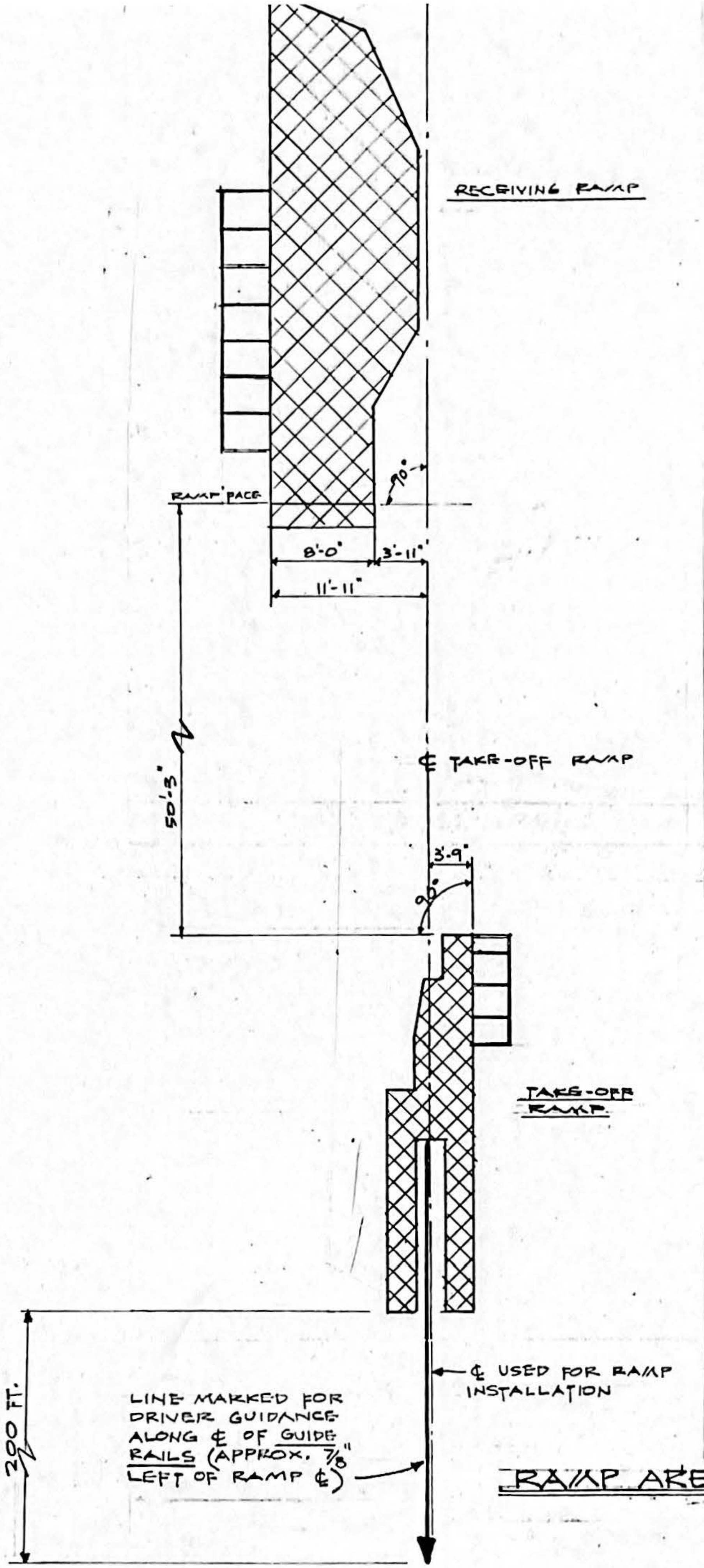
The start of the take-off ramp must be located at the approach point where trial runs have achieved a stable speed of 40 $\pm$ 1 MPH. The right hand side of the take-off ramp (i.e., side of deck rather than lateral braces) must be aligned with and located 3 feet, 9 inches to the right of the longitudinal center line.

The longitudinal centerline that is used for ramp installation is the actual centerline of the take-off ramp. Both ends of that ramp should be measured with respect to the longitudinal centerline to insure proper alignment. However, the guiderails are not centered on the take-off ramp. Therefore, the line marked for driver guidance should be centered between the guiderails and should run parallel to the centerline of the take-off ramp. The initial portions of the guide rails, that are staked to the ground, should be twelve inches further apart at the approach end than they are at the point where they match the spacing of the adjoining ramp-installed sections.

At the point on the longitudinal centerline that is 50 feet, 3 inches forward of the end of the take-off ramp, a perpendicular to the longitudinal centerline must be marked.

The left hand side (i.e., the higher side) of the receiving ramp must be aligned with and located 11 feet, 11 inches left of the longitudinal centerline (relative to the direction of vehicle travel). The leading edge of the receiving ramp (i.e., the actual deck rather than the 45° extension) must lie along the previously marked line that is perpendicular to the longitudinal centerline.

As an additional check, the initial 8 feet of the right hand side of the receiving ramp should lie 3 feet, 11 inches to the left of the longitudinal centerline.



RAMP AREA LAYOUT

3.0 CHECK LIST PRIOR TO PERFORMANCE

(1) Calibration of expanded-scale speedometer. (Remove calibration 5th wheel before take-off.)

(2) Trial runs with speed control to check functioning and accuracy.

(3) Retractable wheel lowered and locked under rear axle.

(4) Drop section of take-off ramp set up and restraining string attached to trigger mechanism.

(5) One-half gallon fuel tank full.

(6) Hood tied down.

(7) Doors bolted shut.

(8) Complete driver restraint system on.

(9) Guidance aiming device attached to hood.

(10) Check tire pressures at 60 psi.

(11) Emergency equipment standing by.

(12) Windows down.

(13) Transmission in D2 range.

(14) It should be noted that wind conditions can significantly affect approach speed with ramp in place.

4.0 CHECK LIST SUBSEQUENT TO LANDING

(1) Check for bent wheels and/or damaged tires.

(2) Inspect suspension components for damage.

(3) Test steering system compliance, or lost motion.

(4) Inspect guide rails on take-off ramp for loose attachment points and/or welds.

(5) Remove bias battery from zero center meter (i.e., expanded-scale speedometer).

(6) Remove pressure from tires to 40 psi or less.

APPENDIX

Speed Control System (Ford Motor Company)

The following pages have been reproduced from applicable sections of the

1964 Ford Thunderbird Shop Manual
Service Department, Ford Division
Ford Motor Company

and from installation instructions for the 1965 Ford Speed Control Kit.

PART 16-5 SPEED CONTROL

1 DESCRIPTION AND OPERATION

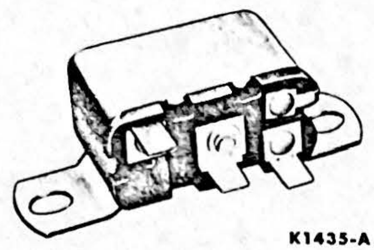


FIG. 1—Engagement Relay

The speed control automatically holds the car speed at any selected setting. It has an operating range of approximately 25 mph to 80 mph. It operates effectively on hills as well as on the level.

When the speed control switch button in the control head on the console is pulled to energize the control, it is held in this position magnetically. It will return to the OFF position only if pushed in manually, or if the ignition is turned off. The large speed adjusting wheel control, also located at the control head, should be turned to the extreme forward position. This provides a controlled speed of approximately 25 mph.

When the car is accelerated to slightly over the speed setting, a click will be heard at the engagement relay (Fig. 1).

When the foot is removed from the accelerator the car will go on automatic speed control. The large speed adjusting wheel control also can be used as a throttle and can be turned until the desired cruising speed is reached. Turning this wheel, rotates a cam in the metering valve (Fig. 2) which varies the spring pressure exerted on a pilot valve.

A low friction sensor pump (Fig. 3), driven by the speedometer cable, converts road speed to pressure which applies a balancing force to the pilot valve.

The sensor pump operates whenever the car is in motion, whether or not the speed control is energized and in operation. Because of this, it is a sealed unit containing a non-volatile lubricant of high viscosity stability. When the car is accelerated to the set speed, pressure from the sensor pump increases to balance the spring pressure exerted on the pilot valve. This causes the vacuum valve to snap open (Fig. 4), and the points in the metering valve unit to close. Manifold vacuum is thus available to the pilot valve which meters it to the servo attached to the throttle linkage (Fig. 5). As the pilot valve is now in equilibrium position, the servo does not move the throttle. If for any reason the sensor pump is removed from the car, it must be kept in its normal vertical position or lubricant will leak out.

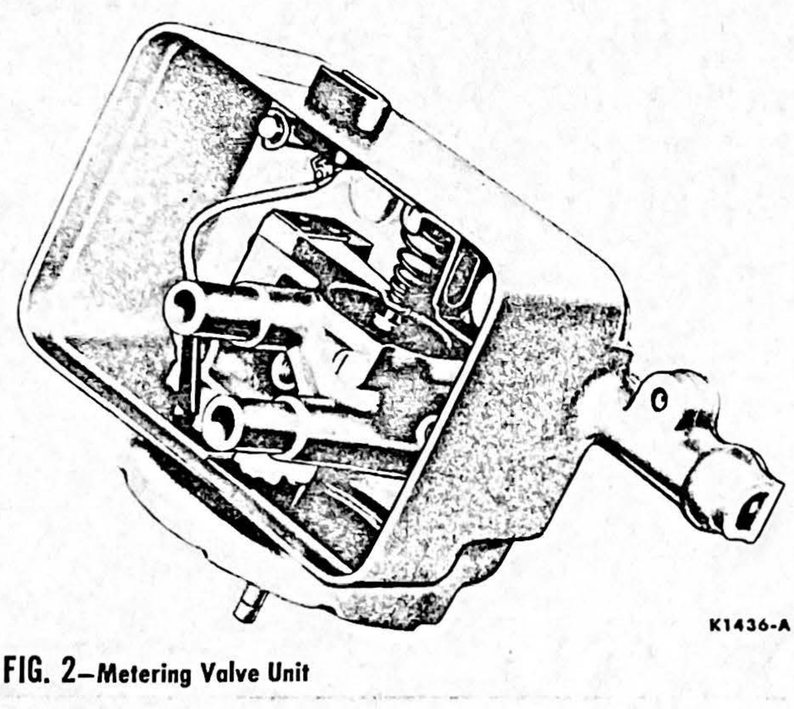


FIG. 2—Metering Valve Unit

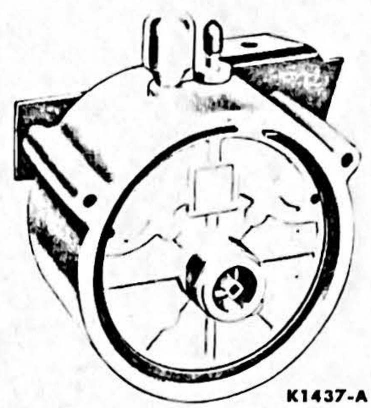


FIG. 3—Sensor Pump

When climbing a hill the car speed and the sensor pump pressure are reduced. This reduces the pressure on the pilot valve. The spring force, which is constant for the set speed, moves the valve which meters more vacuum to the servo. This opens the throttle, accelerating the car until equilibrium force is again reached.

On a downgrade the same principle applies, reversing the action. As the speed rises, so does the pressure of the sensor pump, causing the pilot valve to overpower the set speed spring force. Less vacuum is therefore available to the servo and the

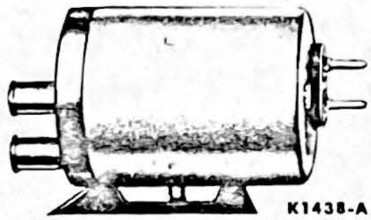


FIG. 4—Vacuum Valve

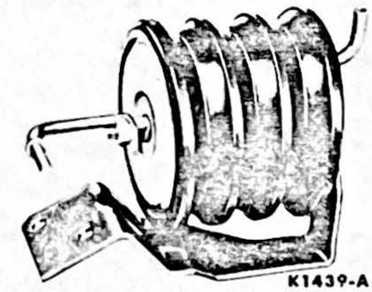


FIG. 5—Servo

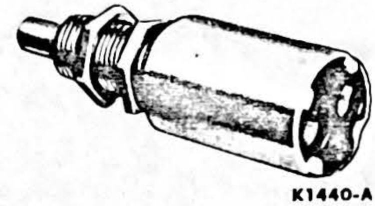


FIG. 6—Brake Switch

throttle closes slightly until the pilot valve forces are again equalized.

If the brake pedal is applied even slightly, the speed control is immediately disconnected. This is done with a small push button switch which remains closed until the pedal is depressed (Fig. 6). The speed control will resume control of the vehicle as soon as it is again accelerated to the set speed. The driver also can turn the control on or off at any speed with the switch in the control head.

2 IN-CAR ADJUSTMENTS AND REPAIRS

Make all adjustments with engine stopped.

BRAKE SWITCH

Adjust the brake switch so the plunger is depressed ¼ inch (Fig. 6) with the brake pedal in the normal released position (See Description and Operation).

METERING VALVE UNIT ADJUSTMENT FOR SET SPEED

Adjustments can be made without removing the metering valve unit (Fig. 2 and Fig. 6, Part 16-1) from the car. The system should be adjusted to engage at approximately two mph above the set speed.

1. Remove the two vacuum hoses from the front face (screen side) of the metering valve unit.

2. Carefully remove the air filter screen from the face of the metering valve unit using a small screwdriver.

3. If the system engages at less than the set speed, rotate the small plastic cam screw slightly clockwise (Fig. 6, Part 16-1), to open the contacts. If the system engages at more than the set speed, rotate the small plastic cam screw slightly counterclockwise to close the contacts.

4. Install the air filter screen.

5. Road test the car by driving on a level road at some definite speed; 35 mph is suggested. Depress the brake pedal lightly to disengage the speed control. Accelerate very gradually until a click is heard. If the adjustment is correct, the speed should be approximately 37 mph. If not repeat steps 1 to 5 above.

SERVO LINKAGE ADJUSTMENT

Make this adjustment with the engine stopped. Be sure the fast idle cam does not hold the throttle open even slightly. Adjust the length of the connecting cable, or rod, between the servo and the throttle linkage so that from ⅛ inch to ¼ inch movement of the servo bellows is allowed before it moves the throttle linkage.

3 REMOVAL AND INSTALLATION

VACUUM SERVO

The vacuum servo is mounted on a bracket which is bolted to the engine (Fig. 7). The servo is linked to the carburetor throttle shaft as shown. The links are held on by the use of snap rings.

METERING VALVE

The metering valve is mounted on the left hand fender well. It is connected to the sensor pump, vacuum valve and servo with vacuum hoses (Fig. 8).

VACUUM VALVE

The vacuum valve is mounted on the left hand fender well. It is connected to the metering valve and the car vacuum system with vacuum hoses (Fig. 8).

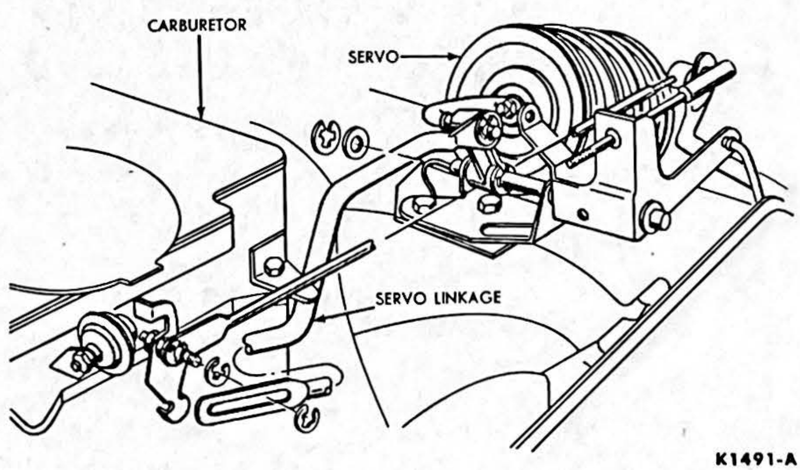


FIG. 7—Servo Linkage

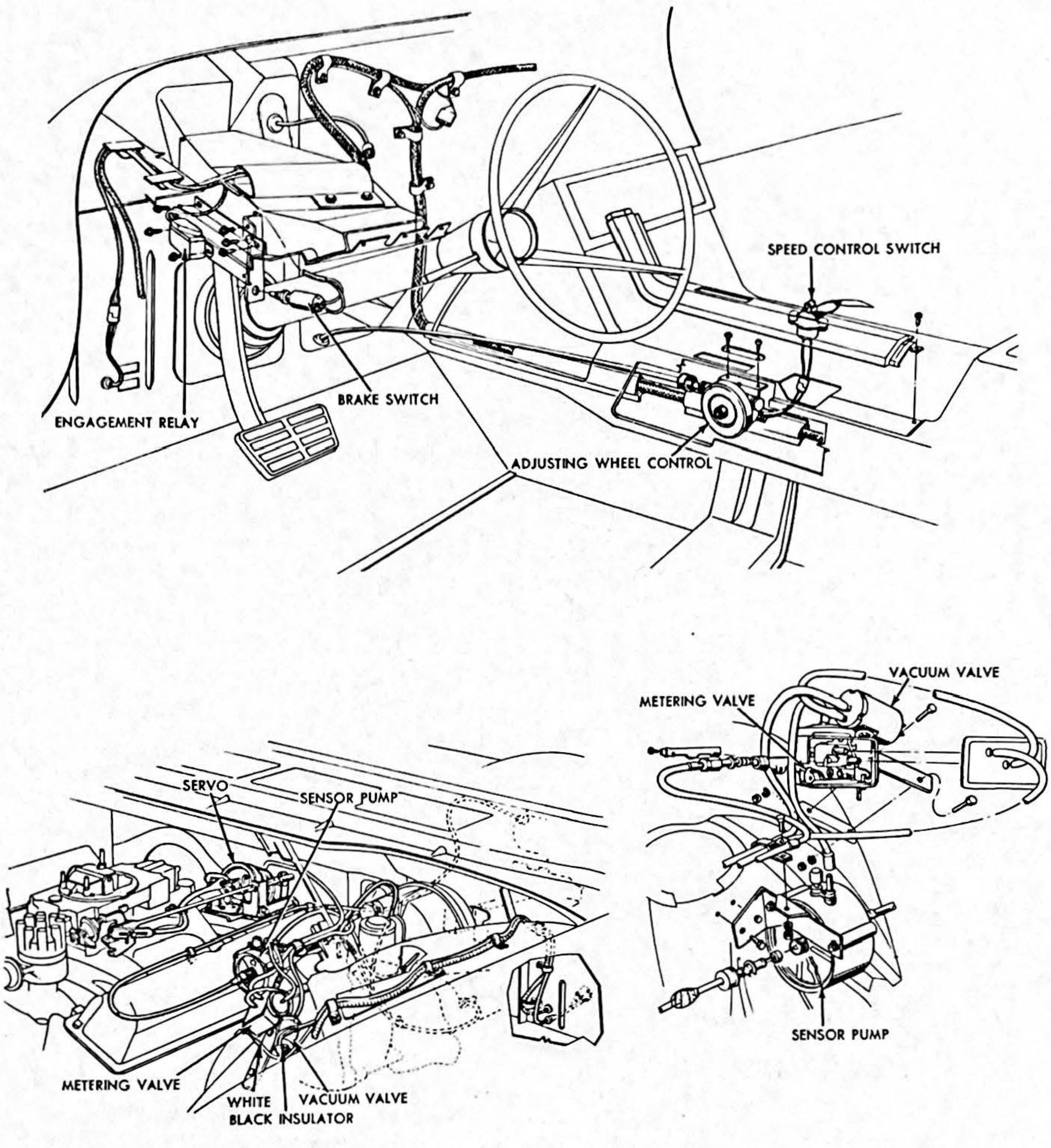


FIG. 8—Speed Control Installation

SENSOR PUMP

The sensor pump is attached to a bracket mounted on the left wheel suspension tower. It is connected by flexible cables to the speedometer and the transmission. It is connected to the metering valve by a hose (Fig. 8).

ENGAGEMENT RELAY AND BRAKE SWITCH

The engagement relay and brake switch are attached to a bracket above the brake pedal (Fig. 8).

SPEED CONTROL SWITCH

The speed control switch is mounted on the tunnel directly behind the adjusting wheel control (Fig. 8).

ADJUSTING WHEEL CONTROL

The adjusting wheel control is mounted on the left side of the tunnel beside the driver's seat (Fig. 8). It is connected by a flexible cable to the metering valve.

INSTALLATION PROCEDURE

SPEED CONTROL

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CAUTION: DO NOT REMOVE SHIPPING COVERS FROM VACUUM PUMP UNTIL PUMP IS INSTALLED.

1. Locate drill dimples and drill two .28"-diameter holes in the left-hand fender apron. See View Z, Sheet 2.

2. Locate drill dimples and drill three .90"-diameter holes in dash panel. See View Z, Sheet 2.

3. Locate drill dimple and drill two .28"-holes in dash panel. See View Z, Sheet 2.

4. Assemble the valve unit to the fender apron as shown in View Z, Sheet 2, and assemble the inhibitor switch to valve unit.

5. Assemble the pump to the dash panel as shown in View Z and W, Sheet 2.

6. Remove the existing speed ometer cable and discard.

7. Cover the speedometer cable hole with cover plate as shown in View Z, Sheet 1.

8. Assemble the actuator to the bottom of the instrument panel, using the existing holes as shown in View Z, Sheet 1.

9. Assemble the pulley and bracket assembly to the lower flange of the instrument panel, using the existing screw shown in View Z, Sheet 1. If the vehicle does not have radio, see View Y.

10. Assembly the servo assembly and brace to the brake pedal support assembly, using existing holes provided. (See View V.)

11. Remove the clevis pin from the acclerator pedal and discard. Insert the stepped clevis furnished and assemble the swivel to the clevis as shown in View Y, Sheet 1.

12. Pass the ball chain from the servo through the pulley and connect it to the swivel assembly. With the carburetor on hot idle, the chain should have (1) ball slack.

13. Install brake switch in the hole provided in the top of the brake pedal support.

14. Remove the rubber bumper from the brake pedal stop and install the actuating bracket with the 1/2 - 20 bolt and nut provided. (See Sheet 1, View W or X.)

15. NOTE: On cars equipped with power brakes, use bracket as furnished with long end toward rear of car. On cars with standard brakes, cut off long end of bracket and install with remaining short end toward rear of car.

16. Adjust switch to open when brake pedal is depressed 1/4" to 1/2", measured at the bottom edge of the pedal. Use test light or ohmmeter to check adjustment.

17. Install relay on brake pedal support as shown, using existing holes. (See Sheet I, View Z.)

18. Install wiring harness as shown.

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19. Install short speedometer cable from transmission to pump as shown. Install long cable from pump to speedometer. (See View Z.)

20. With the control wheel turned all the way left, slow position, remove the cover from the valve assembly. Route the Bowden cable as shown. Make sure the adjusting nut on the end of the Bowden cable is in the center of its travel and the cam stop is approximately 3/16" from the cam follower. Insert the entire rack into the rack housing. Adjust ferrule to obtain a 3/16" gap between the cam follower and the cam stop. Tighten cover plate' on rack housing, and tighten jam nut. Replace cover on valve assembly. Connect hoses as shown.

    NOTE: Clear plastic hose must be clamped at pump and diaphragm with clamps furnished.

21. Recheck control wheel to ensure it is in extreme forward position.

22. Adjust brake switch installed in Step 18 to open when pedal is depressed 1/2" measured at bottom edge of pedal. Use a test light or ohmmeter to check this adjustment. Torque jam nut to 44 - 60 inch-pounds.

23. Make sure accelerator linkage is free (no binds or friction).

24. Test unit in accordance with instruction tag furnished in the kit.

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SHEET 2 OF 2

Ford

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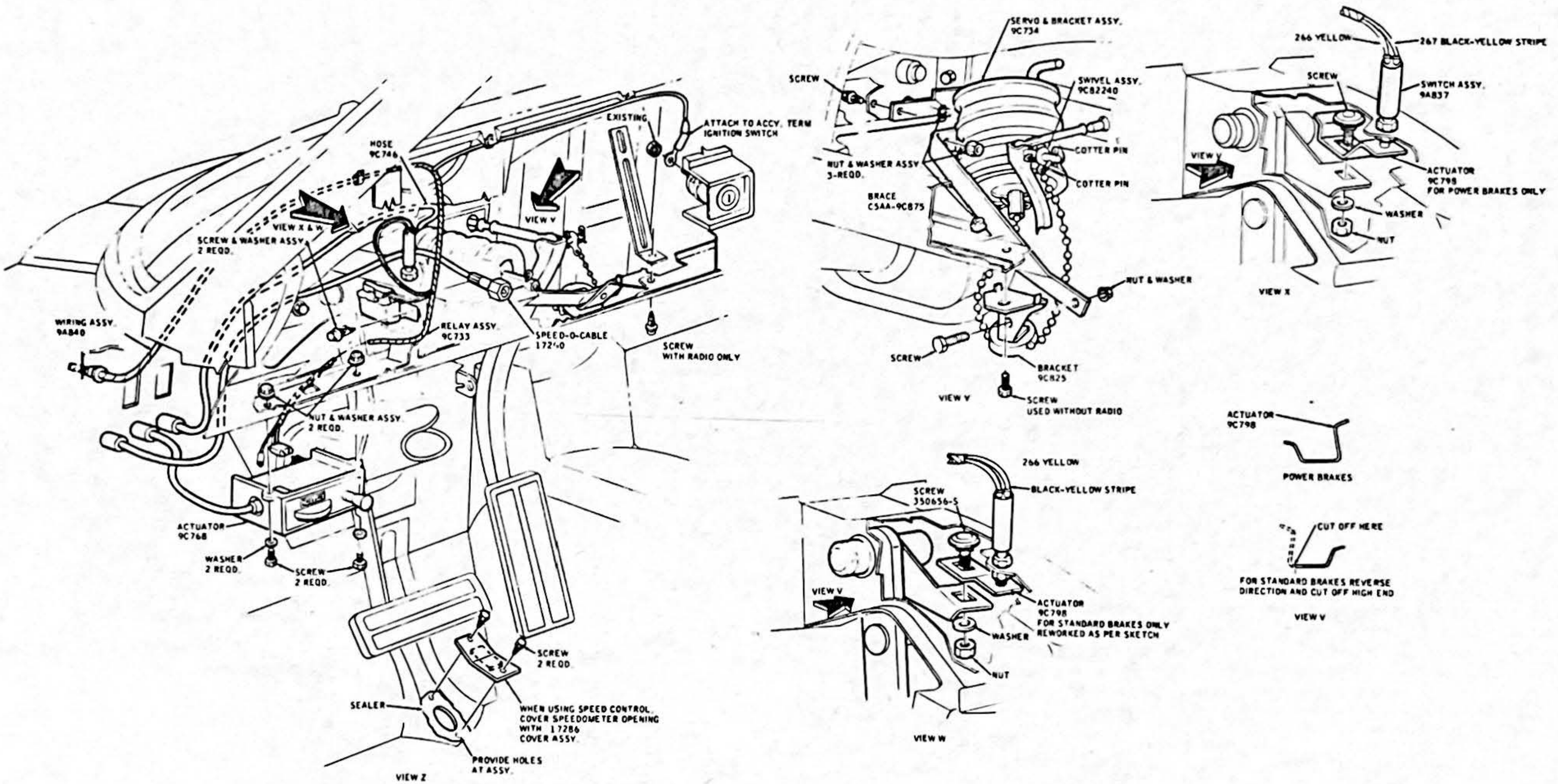

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INSTALLATION - KIT - CONTROL SPEED	
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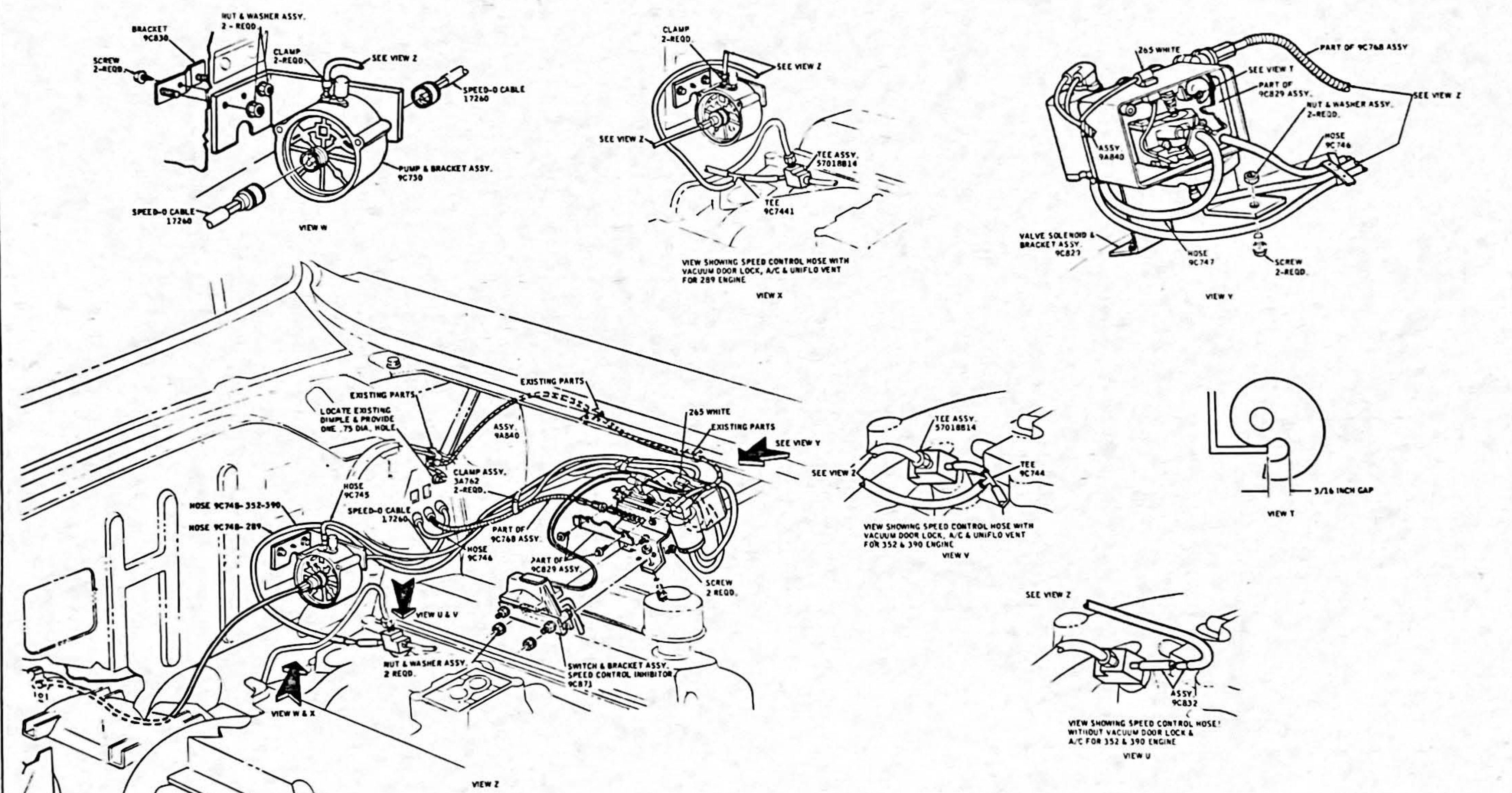

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