BENDIX CRUISE CONTROL TRAINING PROGRAM
OUTLINE

Contents

Written by: J. D. Chambers 7/87
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I. INTRODUCTION

To the driver, the operation of the Bendix Cruise Control for heavy vehicles is similar to that of a passenger car with the additional features of Throttle Mode and Shift Through. Throttle mode allows the engine RPM to be adjusted and held while the vehicle is parked. Shift Through allows the gears to be changed while in Cruise mode, automatically re-engaging the Cruise Control after the shift is made.

HIGHLIGHTS

* Increase/decrease set vehicle speed
* Resume set speed after disengagement
* Ability to use various speed signal sources
* Programmable for various engine (governor) types
* Programmable Top Set Limit
* Vary and hold engine RPM while stationary, (Throttle Mode)
* Allows gear changes while in Cruise mode

II. BASIC SYSTEM OPERATION

MODES OF OPERATION

CRUISE CONTROL MODE:

While vehicle is moving, the system maintains a set speed by reading the current wheel speed and adjusting the throttle accordingly. The set speed can be increased by depressing and holding the Resume switch, or decreased by depressing and holding the Set switch. The approximate vehicle speed should be between 20 MPH and the Top Set Limit (TSL) for the Cruise Control to engage. The system will not respond to a "set" if speed is less than 20 MPH. If the speed is over the Top Set Limit when a "set" occurs, the vehicle will coast down to the Top Set Limit speed and the system will maintain it. If the vehicle speed drops more than 20 MPH below the set speed, the system will disengage. This drop out will occur if there is inadequate horsepower to maintain the set speed on steep upgrades. Activating Resume will resume the original speed.

It is possible to change gears without resetting the Cruise Control, (Shift Through). The Clutch will temporarily disengage the system while the clutch pedal is depressed. Once it is released, the system will automatically resume and maintain the set vehicle speed in the new gear.

The Brake acts on the system in two ways. A light brake application will activate the Stop Lamp Switch. This electrical signal disengages the Cruise Control; Set or Resume is required to re-engage. If for some reason the brake electrical signal is not available to the CA-1 there is a pneumatic back up.

Sufficient pressure on the brake pedal will cause the TR-3 Inversion Valve to open, releasing the air pressure from the CC-5 Actuator. This pneumatic backup only exhausts the Actuator pressure while the brake is being applied.

THROTTLE CONTROL MODE: (Programmable Option)

The stationary Throttle mode is intended for adjusting the engine RPM while the vehicle is parked. The engine RPM can be increased by repeatedly pressing the Resume switch. Likewise, repeated pressings of the Set switch reduces the engine RPM. Holding the switches in is ineffective. It is the number of momentary actuations which controls the throttle. The controller will increase or decrease the throttle position until the potentiometer in the CC-5 reads a particular value. This value is determined by the number of Set or Resume actuations made. This potentiometer value corresponds to a throttle position, not necessarily to RPM. Therefore, once the position is set, the RPM may vary over time due to the governor or engine temperature. This throttle position is maintained by the controller so that air leakage will not decrease it. There are a fixed number of discrete throttle positions possible in Throttle mode. Therefore the system cannot always select an exact engine RPM, unless it coincides with one of the possible throttle positions.

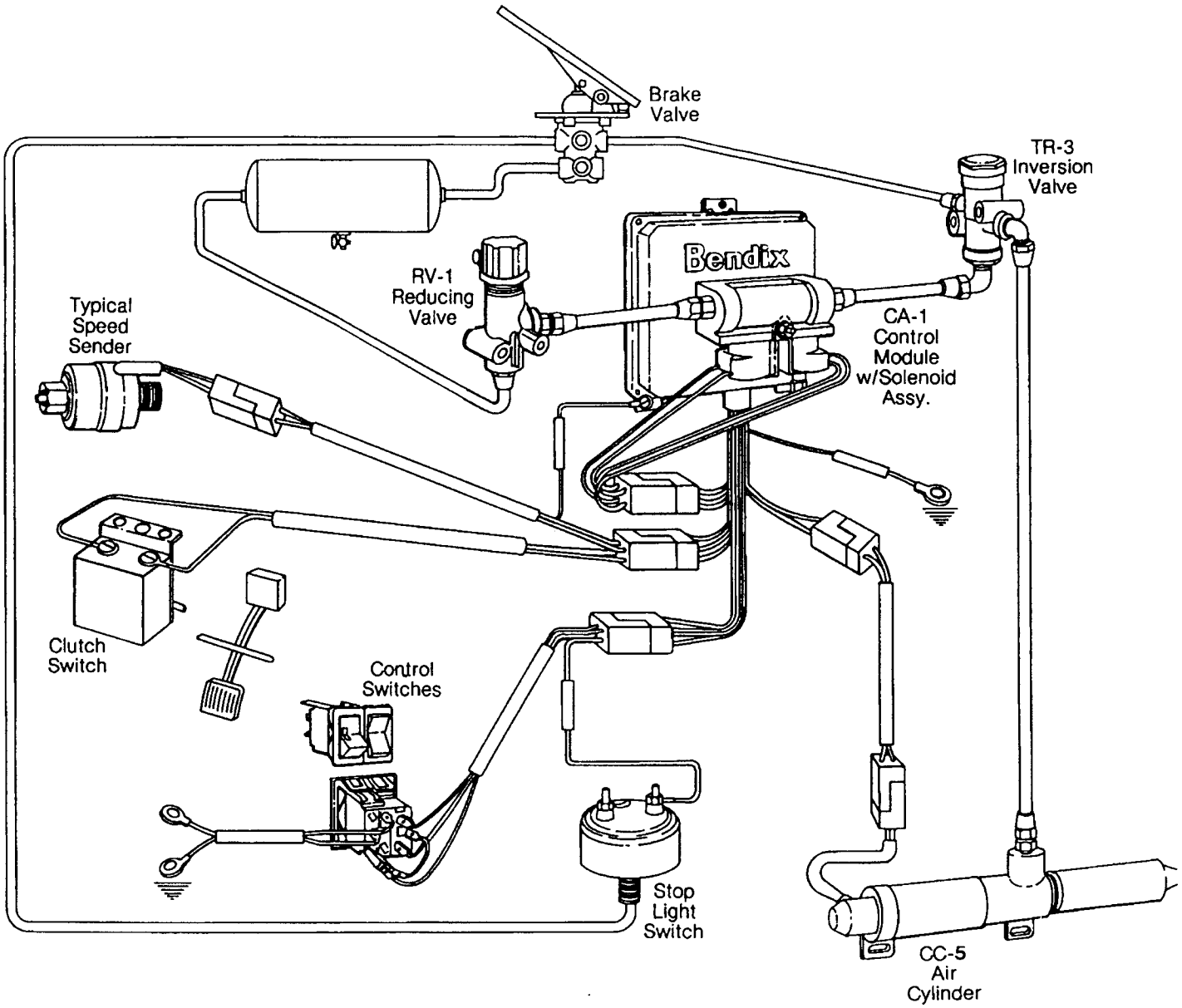
When in Throttle mode, the CA-1 controller monitors the clutch pedal and vehicle speed. If the clutch pedal is depressed or the vehicle moves Throttle mode will be permanently disengage. The brake electrical signal does not affect Throttle mode. The pneumatic brake sensing (TR-3), however, will disengage the system while the brake is being applied. Once the brake is released, the throttle will return to the previous position.

Stationary Throttle mode should not be used with automatic transmissions. This is to avoid the chance of the vehicle lurching if it is put into gear while throttle mode is being used. Since there is no clutch switch input, the Throttle mode would not release until the speed signal is sensed.

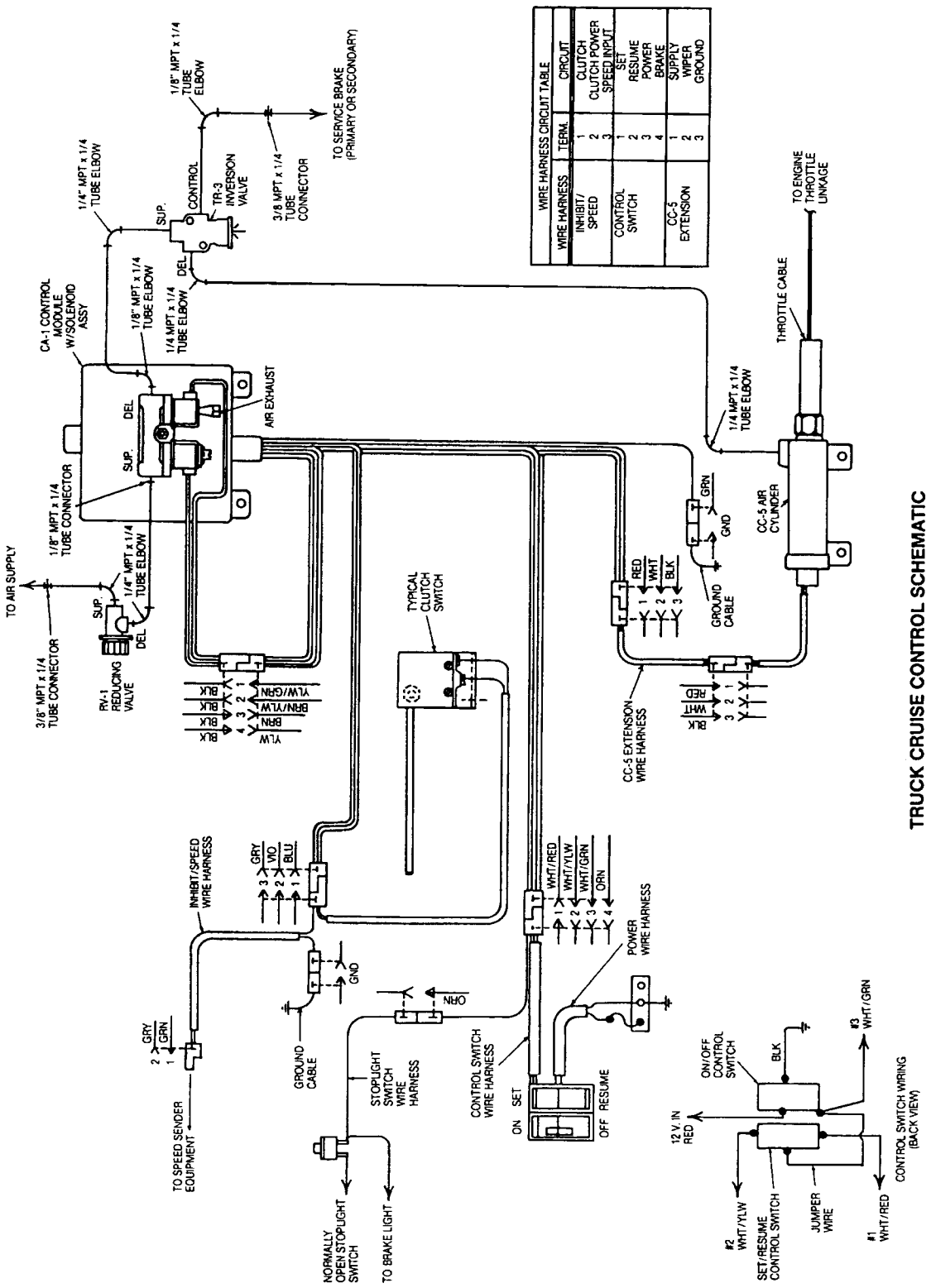
III. BASIC COMPONENTS/FUNCTIONS/LOCATIONS

The basic Cruise Control system is shown on the next page. It is really a very simple system. The number of components are few, and their functions are easy to understand. A brief description of each component in the system follows. Locations of the components on the vehicle can vary widely between installations. Some typical and recommended locations are given.

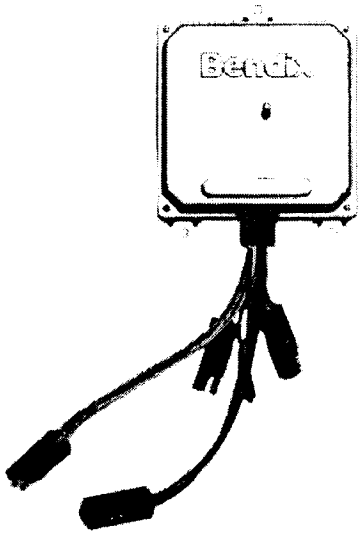
Typical Truck Cruise Control System



Typical Cruise Schematic



TRUCK CRUISE CONTROL SCHEMATIC



CA-1 Control Module

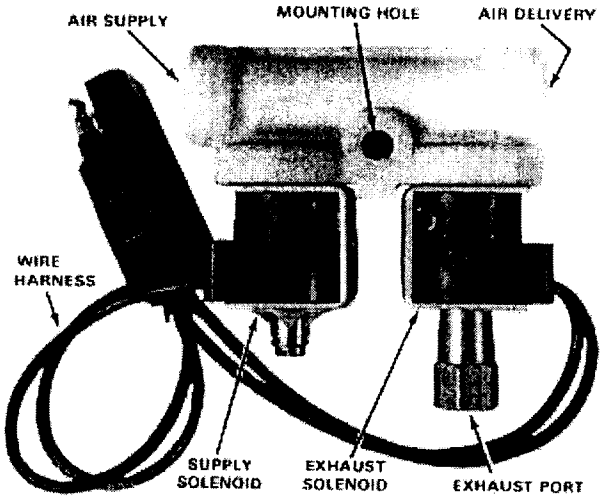
This is the Microprocessor based module which is the heart of the system. This module responds to inputs from the speed signal, the switches (power, clutch, brake, control), and CC-5 Actuator. The CC-5 in turn moves the throttle linkage.

The CA-1 is programmable. DIP switches inside the module are used to select engine type (governor), Throttle mode, speed signal rate (Hertz rate), and Top Set Limit. All modules are waterproof and contain DIP switches for programming. Although the field programmable unit is most popular, there are some pre-programmed units available which have the enclosures riveted together and are not intended to be reprogrammed. Programming and part numbers of the various CA-1s are given near the end of this book.

The part number of the CA-1 is stamped into the narrow end of the enclosure. It indicates the type and programming of the CA-1. The part number which is printed in ink on the bottom cover of earlier units does not give any indication of the programming.

CA-1s are available with molded rubber connectors in 12 volt and 24 volt versions. They are also available with Packard 56 series connectors for 12 volt systems. A red grommet where the wire harness enters the enclosure indicates a 24 volt unit; black grommets are used for 12 volt units.

Versions with the Packard 56 series connectors should be located in a moisture protected environment. Versions with molded rubber connectors can be located in numerous places on the vehicle. Although the circuit board is waterproof, the enclosure is not. If there is a chance that moisture may enter the enclosure, it should be mounted with the grommet end down so that any liquid can drain out. It should also be mounted so that it is not exposed to direct road spray; avoid wheel wells and underneath sleepers. The engine compartment is acceptable, but never mount the CA-1 on the engine.

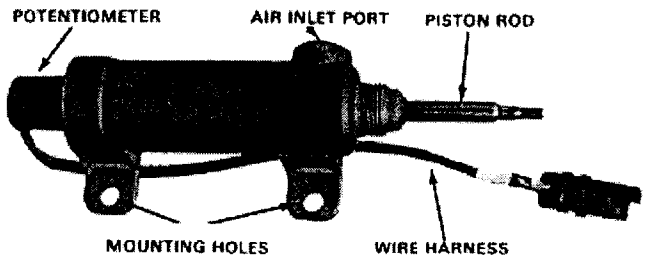


* Solenoids

The solenoid package consist of two solenoids which are used to control the air pressure in the CC-5 Air Cylinder. When the system power switch is on, the CA-1 provides constant power (12 volts) to one side of each solenoid. The CA-1 momentarily grounds the other side of the supply solenoid to allow air to enter the CC-5, (increase throttle). The Exhaust solenoid is grounded through the CA-1 to maintain air pressure within the system. To exhaust air, (decrease throttle), the CA-1 momentarily removes the connection to ground. These solenoids are pulsed as needed to adjust the throttle position.

Solenoid assemblies are available in 12 or 24 volt molded connector types, or 12 volt with Packard 56 series connectors. The 24 volt type is identified by black and red coil leads. The 12 volt type has all black leads. The connector and voltage type of the solenoid assembly must match the particular CA-1 that it is intended to be used with.

Although it is not necessary, solenoid assemblies are generally mounted on a stud which protrudes from the CA-1 cover, (when provided). Solenoids should be mounted where they will not be heard by the driver, since the exhaust pulses can be annoying. The solenoid can also be exhausted through an air line to reduce the noise. Solenoids should be mounted so that direct road spray is avoided and the exhaust port aims downward. If the Packard 56 connector type is used, the solenoids must be in a moisture proof location. Solenoids are never to be mounted on the engine.



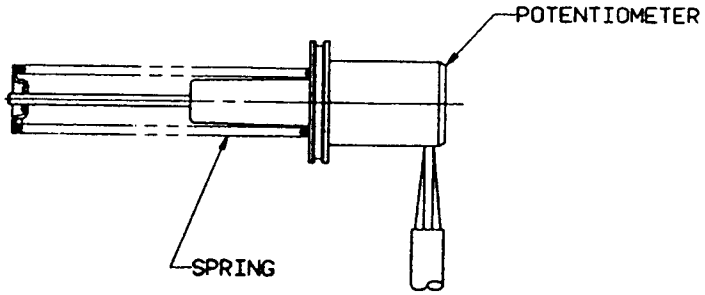
* CC-5 Actuator

This is a pneumatic cylinder which controls the throttle position. When the air pressure within this cylinder increases, the shaft is pulled inward. The solenoid assembly controls the air pressure to this cylinder. The CC-5 contains a potentiometer, which feeds necessary position information back to the CA-1, (potentiometer described below).

CC-5s vary by internal spring strength, (2 types, stronger for a truck, weaker for a bus), and by the type of connector, (2 types), on the potentiometer. The particular connector style must match the CA-1. Whenever there is excessive resistance to throttle movement due to the throttle return spring or linkage, the bus CC-5 should be used.

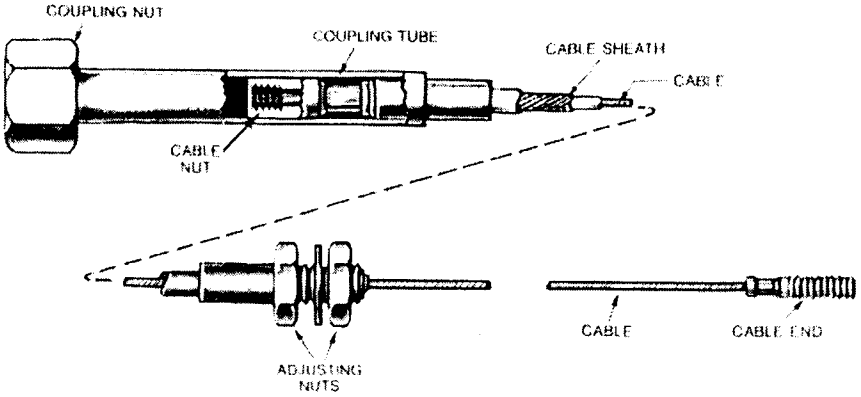
The full stroke of the CC-5 is approximately 1.5" and approximately 45 PSI is required to pull it to full stroke. The exact pressure varies with the type of CC-5 and the throttle return spring.

The CC-5 can be installed anywhere on the vehicle except on the engine. If the molded connector type is not used, the CC-5 should be installed in a moisture proof environment.



* Potentiometer

The potentiometer is contained in the CC-5 assembly. It is used to feed throttle positional information back to the CA-1. Without this information the system will not function in either Cruise or Throttle mode. The CA-1 supplies a fixed 2.8 volts across the resistive element of the potentiometer. The potentiometer wiper voltage is greatest when the CC-5 is compressed, (pressurized).

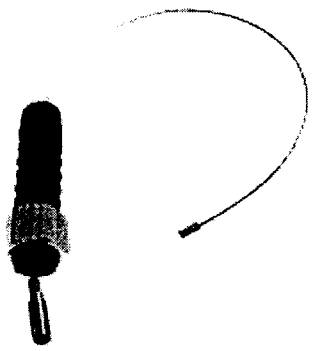


* Throttle Cable

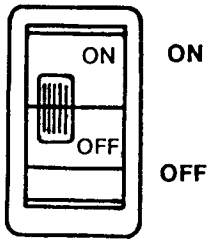
The Throttle Cable connects the CC-5 to the throttle linkage. The various types of throttle brackets, which are contained in the Engine Kits, are also required to make this connection. The actuator cable must pull on the linkage in a straight line, (+/- 4 degrees), to avoid cable damage and binding of the linkage, and it also must not have any slack to take up before pulling on the throttle linkage. The sheathed part of the cable cannot be bent in a radius of less than 6" or binding will result. Due to the limited range of the CC-5, the lever arm of the throttle linkage must allow idle to full throttle with a 1.5 inch stroke.

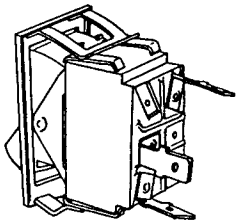
There are two types of Throttle lever cables available, depending on the end, (bead or swivel). Both types are sheathed. The unsheathed type, which was offered in the past, should no longer be used.

THROTTLE CABLE WITH BALL SWIVEL



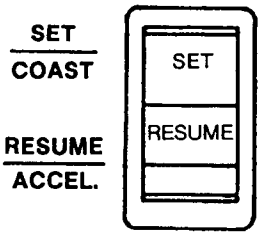
THROTTLE CABLE WITH BUTTON

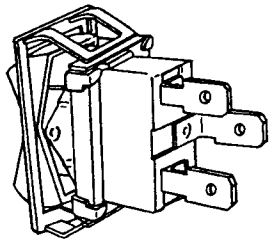




* Power Switch – this lighted rocker switch turns power to the system on/off. All previously stored set speeds are cleared when power is removed. The supply to this switch should be fused to at least 2 amps but less than 8 amps.

This switch is located next to the Set/Resume switch. Both switches are to be mounted where they are easily accessible to the driver.





* Set/Resume Switch (Control Switch)

This is a momentary two-way rocker switch. When it is actuated, power is connected to either the Set or Resume input of the CA-1. This switch serves various functions in the Cruise Control system, as described below.

While Driving (CRUISE MODE):

SET – While depressed, vehicle coasts. When it is released, the present vehicle speed is put into system memory and this speed is maintained. This switch is used to initially set the Cruise Control. It can also be used to reduce the previously set speed by depressing and holding the switch until the vehicle coasts down to the desired speed, then released.

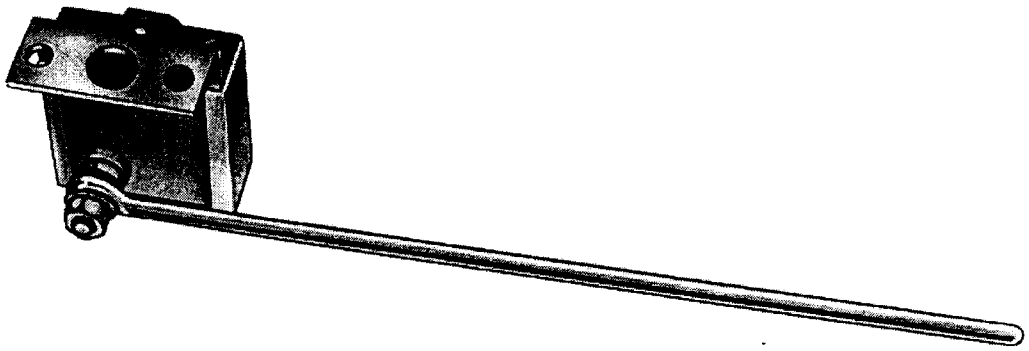
RESUME – Momentarily depressing this switch sets the Cruise Control to the last speed which was loaded into the system memory. Holding this switch in causes the vehicle to accelerate, when it is released this new speed is put into system memory and is maintained.

While Stationary (THROTTLE MODE):

SET – Each time the Set switch is momentarily depressed, the throttle decrements slightly. This throttle position, (not necessarily RPM), is then maintained.

RESUME – The Resume switch increments the throttle position slightly each time it is momentarily depressed. This position is then maintained.

This switch is to be located next to the Power switch and in reach of the driver. Power is supplied to it via a short jumper wire from the Power switch.

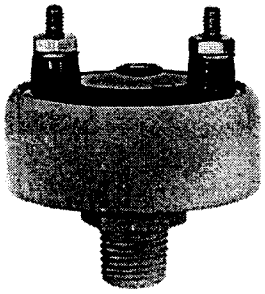


* Clutch Switch

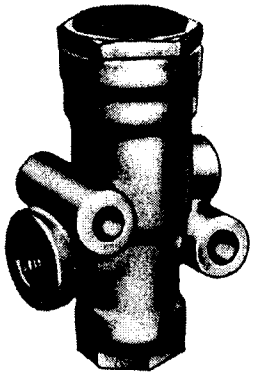
This is a momentary switch, which is held in the closed position when the clutch pedal is at rest. The CA-1 supplies 12 volts to the switch, it is returned through the switch. Pushing the clutch pedal opens the switch and the system is disengaged. If the system is in Cruise mode, the disengagement only occurs while the clutch pedal is pressed, (Shift Through). If the system is in stationary throttle mode, the system will remain disengaged.

The rubber boot/plunger type clutch switch, which was originally used, has been replaced. The type with the aluminum rod which replaced it, and which is presently shown in the catalog has also been replaced. The newest version is a momentary toggle switch with a spring shaft and a nylon tip. The new type maintains its adjustment better and is easier to install.

The Clutch switch must be installed such that it makes reliable contact with the clutch pedal and cycles as the pedal is pressed.



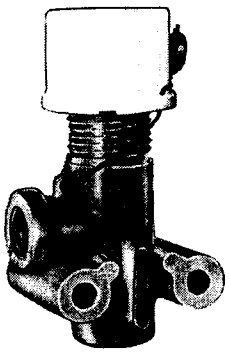
* Brake Switch the CA-1 ties in with the existing Stoplight switch circuit such that when the brake is applied, 12 volts is connected to the CA-1 Brake input. If the system is in Cruise mode, a brake signal will permanently disengage the system. If in Stationary Throttle mode, the stoplight signal is not active. The brake signal is backed up by the operation of the TR-3 Inversion Valve, (description follows).



* TR-3 Inversion Valve

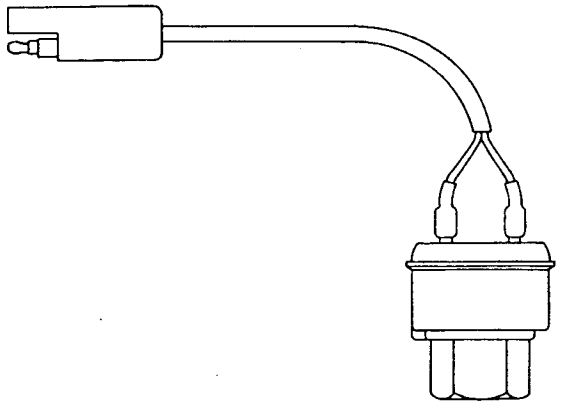
This valve provides pneumatic back up to the electrical brake signal, (stop light switch). The trip pressure is higher than the stop light switch so it takes a harder brake application to operate it. Whenever the brake pedal is depressed enough to put approximately 14 PSI into the brake system, the inversion valve will open and exhaust air from the actuator (CC-5). Once the brake pedal is released, the TR-3 closes allowing the system to regain pressure. Since the brake electrical signal is ignored in Throttle mode, system disengagement only occurs during the time that the brake pedal is depressed.

The location of the TR-3 is not critical so long as it does not get excessive road spray. It should be mounted with the rubber exhaust seal pointing downward. It also must not be mounted on the engine. The TR-3 is often located near the CA-1.



* RV-1 or RV-3 Pressure Reducing Valve

This serves to reduce the system supply pressure to either 60, 80 or 100 PSI. If pressure exceeds 100 PSI, the solenoids can lock up. A setting of 60 PSI is generally used, but higher pressures may be necessary if there is unusually high resistance to throttle movement. This can be due to a very strong throttle return spring, for example.

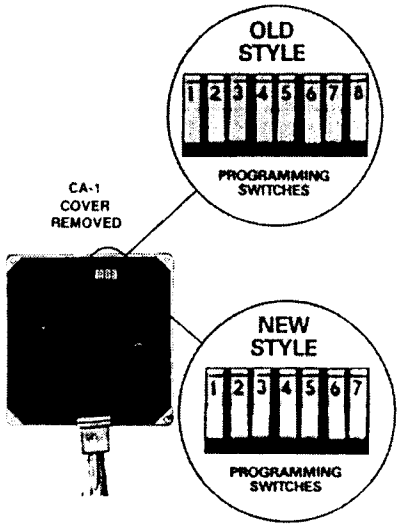


* Speed Sender

Various speed signal sources are compatible with the system. Any device which can supply a signal between 4 Hz/MPH and 18 Hz/MPH with amplitude from 1 to 100 volts peak to peak will suffice. Above ground signals as well as those which swing above and below ground are acceptable. The particular shape of the waveform is not important either, so long as it is clean, (not modulated by noise or other signals).

Magnetic or the mechanical generator type senders, which are driven from transmission ports, are generally used. Driveshaft and drive wheel sensing is also acceptable. If a generator type is used (MINI-GEN), it should be driven directly. Driving it remotely through a cable can result in problems caused by cable wrap up. If it is mounted on the output of a ratio corrector or splitter, the weight and vibration can cause the coupling to break off. The MINI-GEN is available in a feed through and a non-feed through version. Splitters or extension sleeves are only required if space limitations will not allow the use of the feed through type. Also since Hertz rates do not need to be exact for Cruise Control, the slight correction obtained from the use of a ratio connection obtained from the use of a ratio corrector seldom is required. The magnetic pickup is preferred due to the reliability, (no mechanical wear), and ease of installation. For optimum adjustment, a magnetic sensor should be backed out 1/2 to 1-1/4 turns from touching the transmission gear.

The speed signal can be shared with other devices on the vehicle. The CA-1 has a fairly high input impedance (47 K Ohm), to minimize loading of the speed signal when it is shared by other devices. A dual output sender is recommended for optimum signal separation.



IV. DETAILS/PROGRAMMING

NOTE: THE FOLLOWING PROGRAMMING INSTRUCTIONS ARE FOR BOTH THE 8 STATION DIP SWITCH. AND THE 7 STATION DIP SWITCH. THE 7 STATION DIP NUMBERS WILL BE ***(BOLD)***

All CA-1s currently built contain a DIP switch for programming the Speed Signal (Hertz) rate, Top Set Limit, Throttle Mode Select, and Engine (Governor) type. The metal CA-1 enclosure must be removed before programming. Units intended for field programming will have the enclosure assembled with screws and nuts. There is a clear plastic waterproof cover over the switches, which must remain intact. It is flexible so each switch can be set with the cover in place. The field programmable CA-1s will have all switch positions, (except #1), put in the "on" position when received. Details of programming are given below. An instruction sheet, BWS-904 is also included with each programmable unit.

Turn the power to the CA-1 off while programming. The switches are only read on initial power up. Changing the switch setting while the system is powered will have no effect until the power is cycled off and on.

NOTE: On the 8 position DIP Switch position 1 is not used, its setting does not affect operation.

SPEED SIGNAL/HERTZ RATE, SWITCHES 5 ***(5)*** AND 6 ***(4)***

Vehicle speed information is fed to the CA-1 as a frequency that varies with speed. The range of frequencies varies between vehicles depending on factors such as tire size, the rear end ratio and the transmission. The speed signal rate for a given vehicle is generally given in Hertz/MPH or pulses/mile.

Calculations: $\frac{\text{PULSES/MILE}}{3600} = \text{HERTZ/MPH}$

In the formulas below:

T = Number of tire revolutions per mile, (drive wheel)
R = Rear end ratio (drive revs/driven revs)
G = # of teeth in the gear that passes the magnetic pick up

D = The ratio of the # of teeth-drive gear to the # of teeth-pencil gear (MINI-GEN)
P = # of poles in signal generator (30 for MINI-GEN)
C = Ratio of connector (drive revs/driven revs) if used, (1.0 if not used)
3600 = # of seconds in an hour

For a Magnetic Transmission Pick up: $\frac{TxRxG}{3600}$ = Hertz/MPH

Example: T= 475 revs/mile, R= 3.65, G= 16

$$\frac{475x3.65X16}{3600} = 7.7 \text{ Hz/MPH}$$

For a Mini Gen:

$$\frac{TxRxDxP}{Cx3600} = \text{Hertz/MPH}$$

Example: T= 475, R= 3.65, D= 7/14, P= 30, C= 1.012

$$\frac{475x3.65X7/14x30}{1.012x3600} = 7.14 \text{ Hz/MPH}$$

For a MINI-GEN, often the number of revolutions per mile is known for the transmission port (speedometer drive). This is usually 1,000 revs./mile for speedometer compatibility. Therefore, if there are 30 poles on the MINI-GEN and it is rotated 1,000 revs./mile, then there are (30 x 1,000) or 30,000 pulses per mile. Dividing by 3600 gives 8.33 Hertz/MPH.

For other sensing schemes, calculate the number of pulses that will occur in a mile. Remember, ratios are generally given in input revs/output revs., or (drive revs/driven revs). Knowing this will help determine whether to multiply or divide by the ratio. Mechanical drive pencil gears rations are usually given as # of teeth (drive gear) to # of teeth (driven gear). This is the inverse of drive revs/driven revs ratio.

Remember - $\frac{\text{\# of teeth drive gear}}{\text{\# of teeth driven gear}}$ = driven (output) revolutions / drive (input) revolutions

In the MINI-GEN calculation example above, 7/14 is the (# of teeth drive gear/# of teeth driven gear). Therefore there are 7 output revs for every 14 input revs, or the driven gear is going half as fast as the drive gear.

Testing for Hertz Rate:

If the Hz rate cannot be calculated due to missing information, it can be arrived at by road testing. To do this it is necessary to note the lowest speed that the system will take a set at and the Hz rate that the CA-1 is programmed for.

The Minimum Set Frequency is:
84 Hz if CA-1 is set at 4.2 Hz/MPH

168 Hz if CA-1 is set at 8.4 Hz/MPH
336 Hz if CA-1 is set at 16.8 Hz/MPH

Example: The CA-1 is programmed for 8.4 Hz/MPH and it is found that the system will not take a set below 29 MPH.

Solution: Per the information above, 8.4 Hz/MPH corresponds to a minimum set frequency of 168 Hertz.

$$\frac{168 \text{ Hz}}{29 \text{ MPH}} = 5.8 \text{ Hz/MPH}$$

Therefore, since 5.8 is closer to 4.2 than 8.4, 4.2 Hz/MPH should be selected.

Programming:

Switches 5 ***(4)***and 6 ***(5)***control the Hertz rate selection. Select the Hertz rate that is closest to the actual Hertz rate of the vehicle. The table below gives the switch settings for the three rates which may be selected.

HERTZ RATE (HERTZ/MPH)	4.2	8.4	16.8
SWITCH 5 ***(4)***	OFF	ON	ON
SWITCH 6 ***(5)***	OFF	ON	OFF

It is important to select the proper Hertz rate. The CA-1 is based on an 8.4 Hz/MPH rate. If 16.8 Hz/MPH is selected, the first thing the Microprocessor does is to divide the input frequency by two. If the rate programmed is significantly wrong, problems can result such as surging, hunting or slow response.

TOP SET LIMIT, SWITCHES 2 ***(1)***, 3 ***(2)*** AND 4 ***(3)***

The Top Set Limit is not the highest speed that the vehicle can travel at, it is the highest speed that the Cruise Control can be set at. If the vehicle is exceeding the Top Set Limit when a Set is made, the CA-1 will recognize the Set, but it will not affect the Throttle until the vehicle speed has coasted down to the Top Set speed. The system will then maintain this speed.

There are 8 different Top Set Limits that can be programmed into the CA-1. These TSL's are actually maximum frequencies that the CA-1 will set at. Therefore, if the exact Hertz rate is known, the exact TSL in MPH can be calculated. Depending on the Hertz rate programmed into the CA-1, these 8 possible TSL frequencies will be different. With the table below it is very easy to find the actual TSL.

TOP SET LIMIT, SWITCHES 2 *(1)*, 3 *(2)* AND 4 *(3)*

SW4 *(SW3)*	SW3 *(SW2)*	SW2 *(SW1)*	CA-1 SET AT 4.2 HZ/MPH	CA-1SET AT 8.4 HZ/MPH	CA-1 SET AT 16.8 HZ/MPH	APPROX. SPEED
ON	ON	ON	402.0	804.0	1608.0	95.7 MPH
ON	ON	OFF	271.5	543.0	1086.0	64.6 MPH
ON	OFF	ON	262.5	525.0	1050.0	62.5 MPH
ON	OFF	OFF	252.0	504.0	1008.0	60.0 MPH
OFF	ON	ON	246.0	492.0	984.0	58.6 MPH
OFF	ON	OFF	232.5	465.0	930.0	55.3 MPH
OFF	OFF	ON	225.0	450.0	900.0	53.5 MPH
OFF	OFF	OFF	215.0	430.0	860.0	51.2 MPH

* Note: The frequencies are exact for a given Hertz rate and TSL programming. The APPROX SPEED column will be the exact Top Set Limit if the true vehicle Hertz rate is the same as the programmed value.

To find the exact Top Set Limit speed, divide the appropriate TSL frequency by the actual vehicle Hertz Rate.

EXAMPLE:

SW4 *(3)*-ON, SW3 *(2)*-OFF, SW2- *(1)* ON, and the CA-1 is programmed for 16.8 Hz/MPH. The actual vehicle Hertz Rate is 15.4 Hz/MPH.

$$\frac{\text{(From chart) } 1050.0}{\text{(known) } 15.4} = 68.18 \text{ MPH (true TSL)}$$

ENGINE TYPE/GOVERNOR, SWITCH 8 *(7)*

The CA-1 has the provision to be programmed for two different engine governor types. This feature is necessary because of the different engine responses between the two types. A brief description of their difference follows.

Switch 8 *(7)* ON – Min/Max Governor (CUMMINS and DDAD engines)

A Min/Max governor controls the minimum and maximum RPM that the engine can run by regulating fuel flow. If the normal operating RPM is between these limits, only the throttle, (not the governor), will affect the engine RPM and hence the vehicle speed.

These types of engines are easier to control in Cruise Control mode than the All Speed governor. However, under no load conditions, such as Throttle mode, these types of engines can run up against the maximum RPM with very little throttle movement. This makes it difficult to make fine adjustments at the higher RPMs.

Switch 8 *(7)* OFF – All Speed Governor (CAT and MACK engines)

An All Speed governor tries to maintain a given engine RPM based on throttle position, throughout the operating range. As the load on the engine increases, the governor will increase fuel flow to the engine in an attempt to

maintain the engine speed. Similarly, the Cruise Control increases throttle position, (fuel flow), as the load on the engine increases.

The All Speed governor and the Cruise Control can tend to either fight or assist each other if not accounted for in the design. Setting switch 8 ***(7)*** to the All Speed position dampens the response of the Cruise Control system to compensate for the affects of the governor.

System Response Differences:

Since the All Speed Cruise Control response is dampened in comparison to the Min/Max response, if the CA-1 is programmed for the wrong governor type, the Cruise Control will not respond correctly. For example, if a CA-1 programmed for All Speed is used with a Min/Max governor, the response may be sluggish and tight speed control will be difficult to maintain. On the other hand, if a CA-1 programmed for Min/Max is used with an All Speed governor, the system may respond too fast and overshoot. This can result in surging and hunting for the correct speed.

THROTTLE MODE SELECT, SWITCH 7 ***(6)***

When switch 7 ***(6)*** is in the ON position, the Stationary Throttle mode option will be selected.

V. MALFUNCTIONS/TROUBLESHOOTING

The purpose of this manual is to teach a basic understanding of the Cruise Control system. If this is accomplished, logical decisions can be made and steps taken to troubleshoot Cruise Control system in an efficient, successful manner. Merely following a series of steps without an understanding of the problem can be a waste of time and effort. If you do not know where to begin however, the procedure below can be used as a guideline for testing the entire system. It gives some simple checks to narrow the problem down quickly.

What You Need For Troubleshooting

A few basic items are listed below which will help make troubleshooting easier.

- This manual and/or SD-10-1. The "Bendix Cruise Control Application Data" booklet may also be of use.
- A hand held Volt/Ohm meter with probes
- At least one pair of clip leads
- A 12 volt, programmable CA-1 module with molded connectors, (550072)
- A 12 volt solenoid pack with molded connectors (101927)
- A Truck CC-5 with molded connectors (101950)
- A feed through MINI-GEN (102053)

The 12 volt, molded connector versions of the CA-1, CC-5 and Solenoids are most prevalent in the field. These can be used for temporary replacements to narrow down or confirm faulty components. But even if the system is 24 volt

or uses Packard 56 connectors, the system troubleshooting procedure described below may still be used with the exception of changing the CA-1 and Solenoids.

When changing components, be certain that the CA-1 and Solenoid voltages are the same as the vehicle voltage. 24 volt CA-1s have red grommets, 24 volt solenoids have red and black wires, and observe the following warning.

WARNING – NEVER SWAP CA-1s WITHOUT DOING THE FOLLOWING

When changing CA-1s, be aware that if the clutch switch circuit is shorted to ground due to a pinched wire or faulty clutch switch, the replacement CA-1 will also be damaged. Damage to the replacement CA-1 can also result if either solenoid coil is shorted. The sequence below will test for this.

1. Disconnect the inhibit/speed connector. On the truck harness side, check the resistance from pin 1 to ground and from pin 2 to ground with an ohm meter. They should be open circuits, (very high resistance).
2. Disconnect the solenoid connector. Check the resistance between socket 1 and pin 4, also between socket 2 and pin 3 of the solenoid package. Both these coil readings should be roughly 20 ohms (100 for 24 volt type). They must not be shorted or an open circuit.
3. A different CA-1 can now be connected without risking immediate damage.

System Troubleshooting

Remember the basic requirements for operation, and the functions of each component as described earlier. If there is power to the CA-1 and control switches, a good ground to the CA-1, a complete circuit through the clutch switch, no voltage on the brake input and a speed signal, the system should work. The procedures, which follow, can troubleshoot a system that does not operate at all. Incorrect operation is covered in a later section.

* Most of the system can be checked in Throttle mode, (if it is programmed). The vehicle does not need to be running to check Throttle mode. Watching the throttle linkage move and hearing the solenoids cycle is enough indication.

If the CA-1 is not programmed for Throttle mode, either reprogram the CA-1 to include it, swap CA-1s with the test unit (Note: warning above on swapping CA-1s), or follow the procedure below for systems with inoperative Throttle mode.

********** If Throttle mode works but Cruise Control does not **********

1. Check the presence of speed signal. Rolling the vehicle while the throttle is advanced can do this. Any speed input will disengage the Throttle mode. It may be easier to check this by seeing if Throttle mode works while the vehicle is being driven. If multiple Resumes slowly increase the throttle while driving, then you can be sure that there is no speed signal input.

If this is the case, check the sender with an ohm meter by disconnecting the Inhibit/Speed connector and measuring the resistance to ground from pin 3 (wire harness side). It should be roughly between 100 and 3,000 ohms. Be certain that it is not a shorted or open circuit. Raise the rear of the vehicle. With a voltmeter between pin 3 and ground (AC position), rotate the tire and see that the meter shows some deflection. The amplitude read will vary with the sender type, speed of rotation, and the meter used. It should show some deflection

however, if there is a speed signal present. If an Oscilloscope is available, confirm that there is at least 1 volt peak-peak.

If the resistance reads correctly but there is still no signal, check the following. Note the air gap if a Magnetic sensor is used. Screw the sensor in until it touches the gear in the transmission, then back it off 1/2 to 1-1/4 turns. If a MINI-GEN is being used, see that the drive tang is not damaged or missing.

2. Recall that a constant brake electrical signal will disable Cruise mode but not Throttle mode. If it is determined that the speed signal is correct, then verify that there is not a false brake signal. Disconnect the Control connector (refer to connector diagrams at end). If power is present when the brake pedal is not depressed then check the vehicle brake circuit.

********** If neither Cruise nor Throttle modes work **********

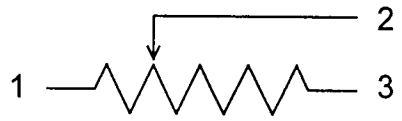
Note: If the throttle does not move, but you can hear the solenoids cycle, see step 8. If Throttle works erratically, refer to step 9.

1. Does the power switch light up. Maybe the fuse is open or a connection is broken. If the fuse or circuit breaker is open, find out why before replacing or resetting it. Follow the procedure outlined above in the warning about changing CA-1s. Check to see if the clutch circuit has an intermittent short by moving the wire harness and tapping on the clutch switch. If that procedure indicates that the clutch circuit and Solenoids are normal, replace the fuse or reset the breaker. If they open again then try replacing the CA-1.
2. If the power switch lights and the CA-1 is programmed for throttle mode, perhaps the Set and Resume wires are reversed. This can be tested by testing to see if the switches work in reverse for Throttle mode, (SET – increase, RESUME – decrease).
3. Check to see that all connectors are fully seated.
4. Verify that the green wire to the CA-1 has a good connection to vehicle ground. An ohm meter can be used to check the wire harness ground to the vehicle ground. It should be no more than a couple ohms.
5. Visually check the clutch switch to see that it is actuated when the clutch pedal is relaxed. Disconnect the Inhibit/Speed connector at the CA-1. With an ohm meter, verify that there is low resistance through the clutch circuit, (from pins 1 and 2-wire harness side), when the pedal is at rest. With the power switch on, verify that there is power on socket 2 (clutch switch electrical power) on the CA-1 side of Inhibit/Speed connector. Clutch switch power from the CA-1 also confirms that the power switch circuit is intact. Refer to the connector diagrams at the end for pin/connector identification.
6. Disconnect the Control connector. On the wire harness side, check for power on socket 4 (brake/stop lamp); it should not be there unless the brake pedal is being pressed. See that there is power on pin 1 (Set) while the Set switch is being pressed, and power on socket 2 (Resume) while the Resume switch is being pressed, (wire harness side). If neither has power, the jumper form the power switch to the control switch is probably disconnected.
7. Disconnect the solenoids from the CA-1. Check the resistance from socket 1 to pin 4, and the resistance from socket 2 to pin 3 of the solenoid connector. If either reading is less than 15 ohms or greater than 150 ohms, replace the

solenoids. If the coil resistance is normal and the solenoids are still suspect, use clip leads to apply power to pins 3 and 4. Ground sockets 1 and 2. The throttle should move to full stroke. If you cannot hear each solenoid cycle when power is applied and the throttle does not move, replace the solenoids. If you can hear the solenoids cycle but the throttle still does not move, see step 8.

This procedure can also be used to test for excessive air leaks in the system by removing the power from the supply solenoid, pin 4 and seeing how long the CC-5 stays pulled in. Power must be uninterrupted to the exhaust solenoid to keep air in the system.

8. If the solenoids are cycling but the throttle still does not move, perhaps the actuator cable is disconnected from the CC-5. Remove the rubber sheath and nut from around the CC-5 Actuator cable coupling. Verify that the inside cable nut is connected to the shaft. If it is connected, and the solenoids were checked, then the air system must be faulty. See that there is air pressure from the RV-1, and that the TR-3 valve is not exhausting to atmosphere.
9. If one hit on the resume switch results in full stroke pull, or if the Throttle mode is erratic, then check the CC-5 potentiometer. Refer to the connector/pin diagram at the end of this manual and use an ohm meter to check the following, (CC-5 not compressed).
   - Resistance between sockets 1 and 3 is 3600-4400 ohms
   - Resistance between sockets 2 and 3 is 1080-1320 ohms
   - Resistance between sockets 1 and 2 is 4320-5280 ohms



As the CC-5 is compressed, the resistance between sockets 1 and 2 should decrease, changing in a smooth manner. Any rapid changes in resistance indicate intermittent operation and the potentiometer should be replaced. Potentiometer must be ordered separately along with maintenance kit PN 102315.

10. If the steps above do not identify the problem, then replace the CA-1 with the test unit. Note: It is generally not a faulty CA-1 that causes this problem. See typical problems listed below.

Improper Operation/Typical Problems

This section discusses some of the more common problems in which the system is functional but operation is not quite normal.

* Surging

There are a couple types of problems, which often are described as surging. Two common examples are described below.

Rapid, erratic surging/drop out

This type of surging is erratic and seems more like the system is momentarily dropping out rather than hunting for the set speed. It can be caused by an intermittent speed, clutch or potentiometer signal. Since it does not disengage permanently, it is not caused by the brake or power signals. Verify that the wiring is intact to the speed sender. Also check for a faulty or misadjust clutch switch, (often it is out of adjustment). Since an intermittent potentiometer signal from the CC-5 can cause this problem. Verify that the resistance between sockets 1 and 2 of the potentiometer connector varies in a smooth, continuous manner as the CC-5 is compressed.

Occasionally this symptom can be caused by a speed signal, which is modulated. Modulation can be caused if the plates such as those used with a driveshaft speed sensor are warped, or the holes are not symmetric. Using a cable between the transmission port and the MINI-GEN, or a fault MINI-GEN or drive tang can also cause this.

Slower, heavy surging/hunting

This type of surge may be associated with coming off of a grade or bobtail operation. Often the throttle pedal will move up and down as it surges. The Controller responding too quickly and overshooting when it adjusts the throttle position causes this type of surging. By increasing the damping to the system, this problem can be solved. Engines with All Speed governors, (CAT and MACK) are especially prone to this type of surge, especially if they have high horsepower. Refer to the governor description in the programming section of this manual for reasons behind this.

Having the CA-1 programmed for Min/Max when it is used on an All Speed governor engine can cause this type of surge. Having insufficient air line length between the Solenoids and the CC-5 can also cause it. With an All Speed governor, a minimum of 8 feet of ¼" diameter air line is recommended. A 2 feet minimum is suggested for Min/Max governors.

The larger the volume (length and diameter) of the airline between the Solenoids and the CC-5, the greater the damping.

Increasing the throttle return spring force an also help dampen the system and may help this problem. Be certain that the correct CC-5 is being used, (truck vs. bus).

A slight surge of this type can occur if the CA-1 hertz rate is programmed lower than the vehicle's actual hertz rate. Programming at the next higher hertz rate setting will sometimes help this problem, although this will change the upper and lower set limits.

Excessive air pressure to the solenoid supply can contribute to surging. Reducing the air pressure by adjusting the RV-1 valve may improve the situation.

* Slow response/sloppy regulation

A slow, sloppy response, which allows the vehicle speed to change more than +/- 1 MPH from the set speed, is usually caused by the system having too much damping. Opposite from the surging problem above, this can be caused if the CA-1 is programmed for an All Speed governor and a Min/Max is used. Too long of a line length can also cause this problem, although this can generally only occur in buses. Excessive throttle return spring, or wrong CC-5 spring force can contribute to this.

If the CA-1 is programmed for a hertz rate, which is higher than the actual vehicle hertz rate, this problem can result. Changing the programming to the next lower Hertz rate may help.

If the Throttle cable is damaged, or bent in a tight radius, the increased resistance to movement can cause the response to be sluggish.

This response can also be caused if the system supply pressure is too low or if there is a restriction in the air system.

* Speed increase over time

This problem rarely occurs, but it is usually associated with the use of a device which causes noise on the power supply, such as air conditioning or a CB radio. This problem will not occur if the Cruise Control system ground has a good connection to the vehicle power ground.

* Lower than programmed top set limit

This can result if the Top Set Limit is programmed wrong or if the Hertz rate is programmed lower than it should be. The most common cause of this problem is slack in the Actuator (throttle) cable. If there is too much slack, the 1.5" stroke of the CC-5 cannot pull the linkage to full throttle, and therefore cannot achieve high speeds.

VI. KITS/PART NUMBERS

This section lists all the component part numbers that will normally be needed. ~~If a line has been drawn through the part it is no longer available~~.

The kit concept was created to simplify the ordering of the parts. Bendix Parts Catalog 10-A-1 is an excellent source for ordering the common kits. It clearly explains which kits to order for a particular vehicle.

There are some special kits created for the OE. These exist since OEMs do not always require all the hardware or some of the components that we include in the Universal kits. Some of the parts used in these kits are only for special applications and have low usage. Even if an OE has special requirements, the parts contained in the Universal kits should be used (they can be ordered separately) whenever possible.

There are many different part numbers for pre-programmed CA-1s. The field programmable versions should always be used when possible to simplify ordering and to reduce the variety of part numbers that a customer must stock. They come with an instruction sheet, which explains the programming procedure. Also, the field programmable versions tend to have better availability due to their

increased usage. Only field programmable versions are available in the After-market.

* CA-1s

The list on the next page has all currently available CA-1 module that are in the system.

In the table below, column "V" is the operating voltage of the CA-1. "LABEL" indicates that the CA-1 has an OE label applied to it; the particular OE is shown in the column. The type of connector used is indicated in the column "CONN"; letter "A" is the molded rubber type, letter "B" is the plastic Packard 56 series connector. The column labeled "STUD" refers to whether the enclosure has a stud provided for mounting solenoids.

The "TSL" column is the programmed Top Set Limit in MPH if the vehicle Hertz rate is exactly as programmed, (refer to the programming section for TSL if actual Hertz rate differs). Units labeled as "FIELD PROGRAMMABLE" have screws to hold the enclosures together, others have rivets. Part number 550179 has screws for field programming but instead of having all programming. Switches "on" before shipment, it has the ENGINE GOVERNOR switch preset to "off" for an All Speed Governor.

P/N	V	LABEL	CONN.	STUD	TSL	GOVERNOR	HZ/MPH	THROT
102718	24	-	A	Yes	No	M/M	8.4	No
102721	12	-	A	Yes	No	M/M	4.2	No
102722	12	-	A	Yes	No	M/M	8.4	Yes
102723	12	-	A	Yes	No	Allspd	8.4	Yes
103233	24	-	A	Yes	No	Allspd	8.4	Yes
103234	24	-	A	Yes	No	M/M	4.2	No
103235	12	-	B	Yes	No	M/M	8.4	No
103236	12	-	B	Yes	No	M/M	8.4	Yes
103237	12	-	B	Yes	No	Allspd	8.4	Yes
103238	12	-	A	Yes	58.6	M/M	8.4	No
103242	12	-	A	Yes	64.6	M/M	4.2	No
550021	24	-	A	Yes	51.2	M/M	8.4	No
550028	12	-	A	Yes	No	Allspd	8.4	No
550032	24	-	A	Yes	No	M/M	16.8	No
550034	12	-	A	Yes	No	M/M	8.4	No
550037	12	-	A	Yes	55.3	M/M	8.4	Yes
550040	12	-	A	Yes	62.5	Allspd	8.4	Yes
550043	12	-	A	Yes	No	M/M	16.8	Yes
550048	12	-	A	Yes	No	M/M	4.2	Yes
550050	12	-	A	Yes	62.5	M/M	8.4	Yes
550068	24	-	A	Yes	No	Allspd	4.2	Yes
550072	12	-	A	Yes	--------FIELD PROGRAMMABLE—Service 065072------			
550073	24	-	A	Yes	--------FIELD PROGRAMMABLE- Service 065073-------			
550106	12	FL	A	Yes	No	M/M	8.4	Yes
550107	12	FL	A	Yes	No	Allspd	8.4	Yes
550129	12	FL	A	No	No	M/M	8.4	Yes
550130	12	FL	A	No	No	Allspd	8.4	Yes

102421	12	-	A	No	No	M/M	8.4	Yes
102422	12	-	A	No	No	Allspd	8.4	Yes
101657	12	IH	B	No	No	M/M	8.4	Yes
101830	12	IH	B	No	No	M/M	16.8	Yes
101941	12	IH	B	No	No	Allspd	16.8	Yes
102866	12	-	B	No	No	M/M	8.4	Yes
102867	12	-	B	No	No	Allspd	8.4	Yes
550092	12	IH	B	No	No	Allspd	8.4	Yes
550179	12	-	A	Yes	FIELD PROG, SET TO ALL SPD			

* CA-1s with Solenoids

This section lists the CA-1/Solenoid assemblies if there is a part number established. The part number of the CA-1 and the solenoid is given for each CA-1/Solenoid assembly.

CA-1/SOLN ASSY P/N	CA-1 P/N	SOLENOID P/N
102156	102722	102221
102076	102718	102074
102220	102723	102221
102523	103233	102074
102684	102721	101927
102700	103234	102074
102703	102722	102927
102704	102723	101927
104336	102723	101927
104359	550068	102074
550015	103238	101927
550017	103242	101927
550019	550021	102074
550029	550028	101927
550030	550034	101927
550033	550032	102074
550036	550037	102221
550039	550040	101927
550042	550043	101927
550045	550048	101927
550047	550050	101927
550070	550072	101927 (Field Prog)
550071	550073	102074 (Field Prog)
550178	550179	101927 (Field Prog)
102307	103235	101832
102521	103236	101832
102522	103237	101832

* Solenoids

101927- Service 065030 12 volt molded rubber connector

102074- 24 volt molded rubber connector

102625- Service 065029 12 volt Packard 56 connector

~~101832- 12 volt Packard 56 connector (IHC label)~~

~~550105- 12 volt molded rubber connector (Freightliner Label)~~

~~102221- same as 102927 with elbows (294622) on parts~~

* CC-5s

101950- Molded rubber connector for trucks

~~101833- Packard 56 connector for trucks, (has IH label)~~

~~106389- Packard 56 connector for trucks~~

~~102261- Molded rubber connector for buses~~

Note: Cab Kit part number 209930 is the same as 209917 except it contains a bus CC-5 instead of a truck type.

CC-5 rebuild kit is 102315.

* Switches

  101955- Set/Resume switch

  101954- Control (power) switch, 12V

  102101- Control (power) switch, 24V

  294639- Switch cover plat

* Valves

  282811- RV-1 Pressure Reducing Valve

  101781- TR-3 Inversion Valve

* Brackets

  The bracketry included in the engine kits listed in catalog SD-10-1 should be used.

* Speed Senders

  102622- Non-feed-through MINI-GEN

  ~~102053- Feed through MINI-GEN~~

  ~~550112- Feed through MINI-GEN (Metric couplings)~~

  ~~296680- Magnetic sensor, (Wabash "G" Type)~~

  102832- T-Adapter for Non-feed through MINI-GEN if feed through version does not fit due to space limitations.

* MINI-GEN Drive Tangs

  Dual ear drive tangs must be used with the MINI-GEN. These are floating tangs and do not side load the MINI-GEN. Premature failure will occur if standard drive tangs are sued. Available part numbers are:

  ~~294451- .192 square male~~

  ~~294452- .152 round male~~

  294453- .185 round male

294454- .203 round male

~~294455- .203 round male 2.3" (special application)~~

~~294488- .185 round male 2.3" (special application)~~

~~294459- .197 square female~~

294460- .161 round female

~~294461- .191 round female~~

294462- .213 round female

* 'T' Adapter to Transmission Drive Tangs

  Refer to catalog page 10-A-10 for individual drive tang part numbers. Tangs are generally supplied by outside sources such as Stewart-Warner or S.S. White.

* Clutch Switch

  ~~260704- This kit contains a switch (spring shaft), bracket, hardware and installation instructions.~~

* Actuator Cables

  102735- 4-foot length, swivel end, rubber boot, clamp bracket interface – (used in Cummins Kit)

  102298- 4-foot length, beaded end, threaded nut bracket interface (used in DDAD and CAT engine kits)

  ~~550110- 4-foot length, swivel, clamp bracket interface clamp (used in MACK engine kit)~~

* Interconnect Cables

  The list and diagrams below are the wire harnesses for the Cab Kit 209917. These common cables should be used whenever possible.

Wiring Harness Pc. No.	Figure No	Connection		A Length (Approx.) In.	Wire Color
		To	From		
102238	1	Control Switch	Vehicle Power & Ground	60	Red & Black
102240	2	Control Switch	Set/Resume Switch	6	White
102244	3	CA-1 Controller	CC-5 Cylinder	182	Red, White, Black
102736	4	Control Switches & 102545 Harness	CA-1 Controller	155	White/Green, White/Yellow
102252	5	Vehicle Ground	CA-1 Controller	12	Green
102252	5	Vehicle Ground	102256 Harness	12	Green
102256	6	Speed Sensor & Cl. Switch	CA-1 Controller	A120/B180	Blue, Gray, Green & Violet
102545	7	Stop Light Switch	102736	120	Orange

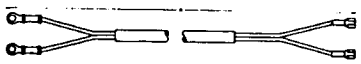


Fig. 1

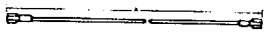
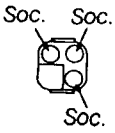


Fig. 2



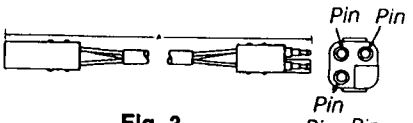
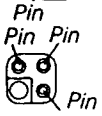


Fig. 3



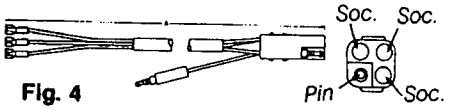


Fig. 4

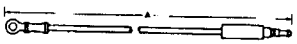


Fig. 5

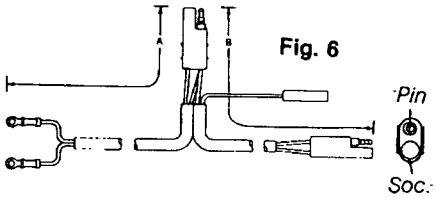


Fig. 6

Wiring Harnesses

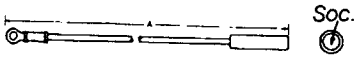
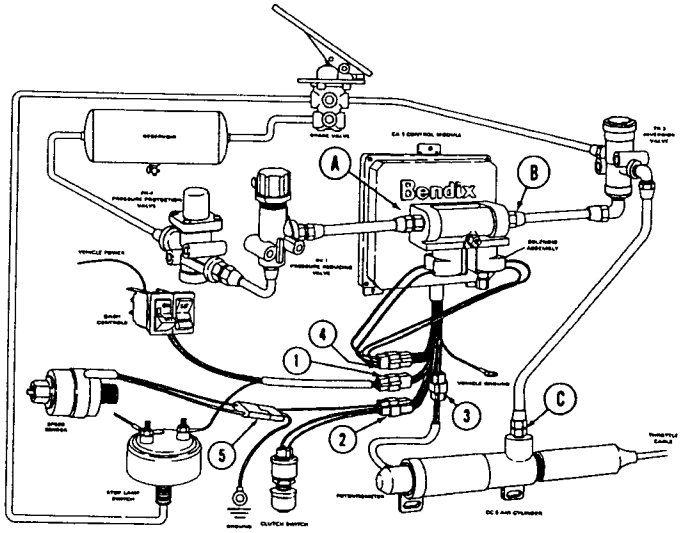


Fig. 7

The ground jumper wire 102252 will be obsolete soon. A ring terminal will replace the molded connector on all speed sender/clutch switch harnesses. This ring terminal can connect directly to ground, making the use of the 102252 jumper unnecessary.

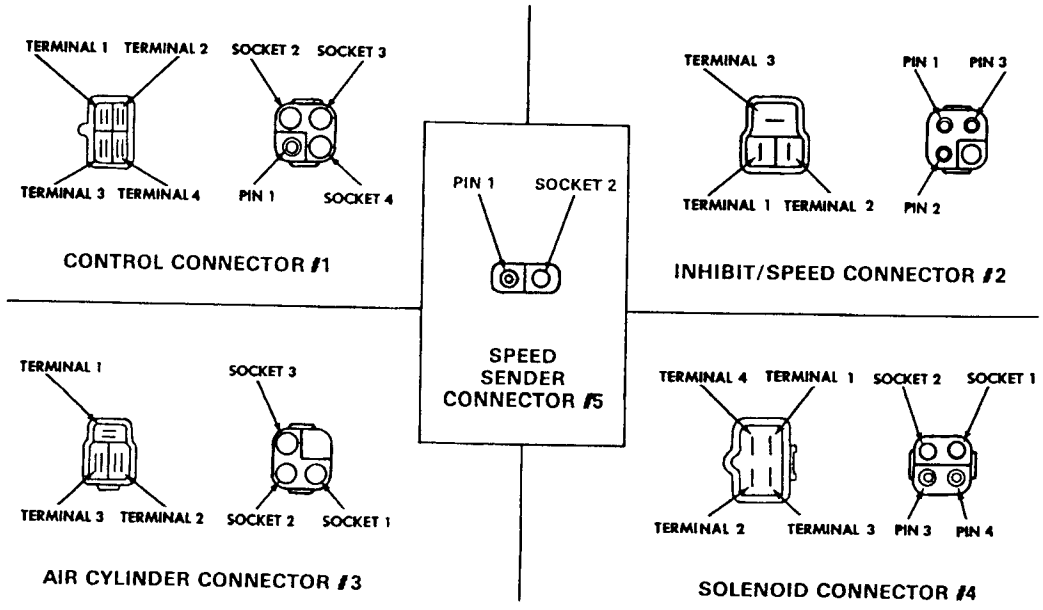


VII. CONNECTOR/WIRING DIAGRAMS

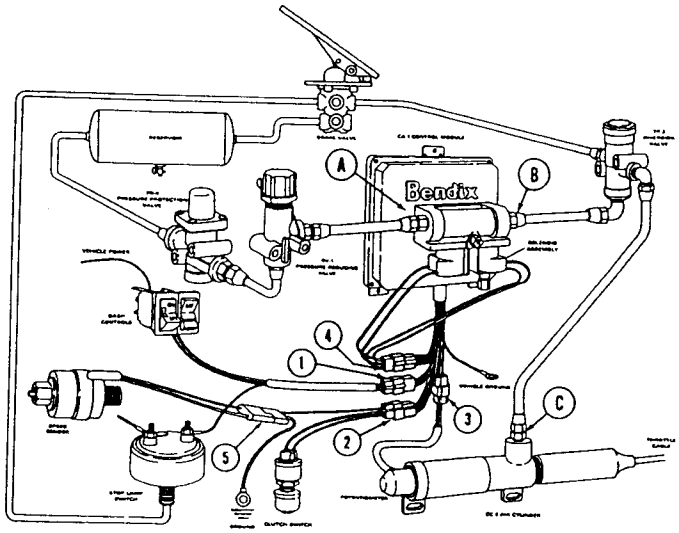
The following diagrams identify each of the system wiring connectors. The tables give the connector number and name, as well as the wire color, connection number and purpose of each circuit in the connector.

CONNECTOR NUMBER/NAME	TERMINAL SOCKET, OR PIN #	WIRE COLOR	SOCKET CIRCUIT
#1 Control	1	WHITE/RED	SET SWITCH
	2	WHITE/YELLOW	RESUME SWITCH
	3	WHITE/GREEN	ELECT. POWER
	4	ORANGE	STOP LAMP
#2 INHIBIT/SPEED	1	BLUE	CLUTCH SWITCH
	2	VIOLET	PWR TO CLUTCH SW.
	3	GRAY	SPEED INPUT
#3 AIR CYLINDER	1	RED	POTENT. SUPPLY
	2	WHITE	POTENT. WIPER
	3	BLACK	POTENT. GROUND
#4 SOLENOID	1	YELLOW/GREEN	SUPPLY SOLENOID
	2	BROWN/YELLOW	EXHAUST SOLENOID
	3	BROWN	EXHAUST SOL. POWER
	4	YELLOW	SUPPLY SOL. POWER

THIS SHOWS THE CONNECTORS ON THE VEHICLE WIRE HARNESS SIDE, (NOT THE CA-1 SIDE).



BENDIX CRUISE CONTROL TRAINING PROGRAM



CONNECTOR NUMBER/NAME	TERMINAL SOCKET, OR PIN #	WIRE COLOR	SOCKET CIRCUIT
#1 Control	1	WHITE/RED	SET SWITCH
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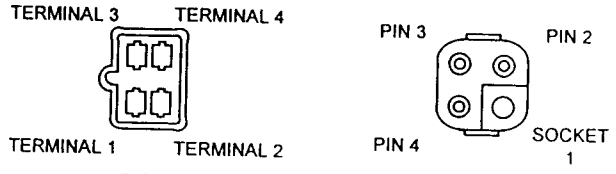
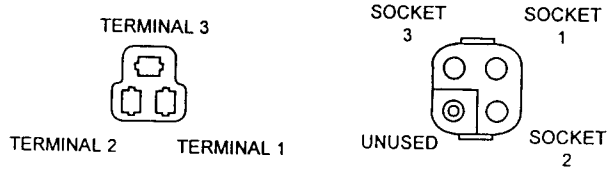
#2 INHIBIT/SPEED	1	BLUE	CLUTCH SWITCH
	2	VIOLET	PWR TO CLUTCH SW.
	3	GRAY	SPEED INPUT
#3 AIR CYLINDER	1	RED	POTENT. SUPPLY
	2	WHITE	POTENT. WIPER
	3	BLACK	POTENT. GROUND
#4 SOLENOID	1	YELLOW/GREEN	SUPPLY SOLENOID
	2	BROWN/YELLOW	EXHAUST SOLENOID
	3	BROWN	EXHAUST SOL. POWER
	4	YELLOW	SUPPLY SOL. POWER

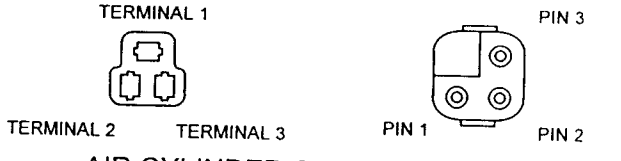
THIS SHOWS THE CONNECTORS ON THE CA-1 CONTROLLER (NOT THE VEHICLE WIRE HARNESS SIDE)



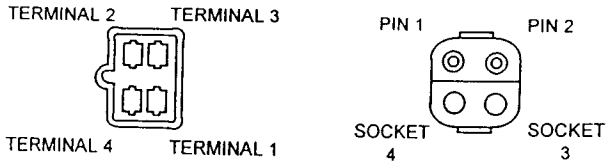
CONTROL CA-1 CONNECTOR #1



INHIBIT / SPEED CONNECTOR #2



AIR CYLINDER CC-5 CONNECTOR #3



SOLENOID CONNECTOR #4

Bendix

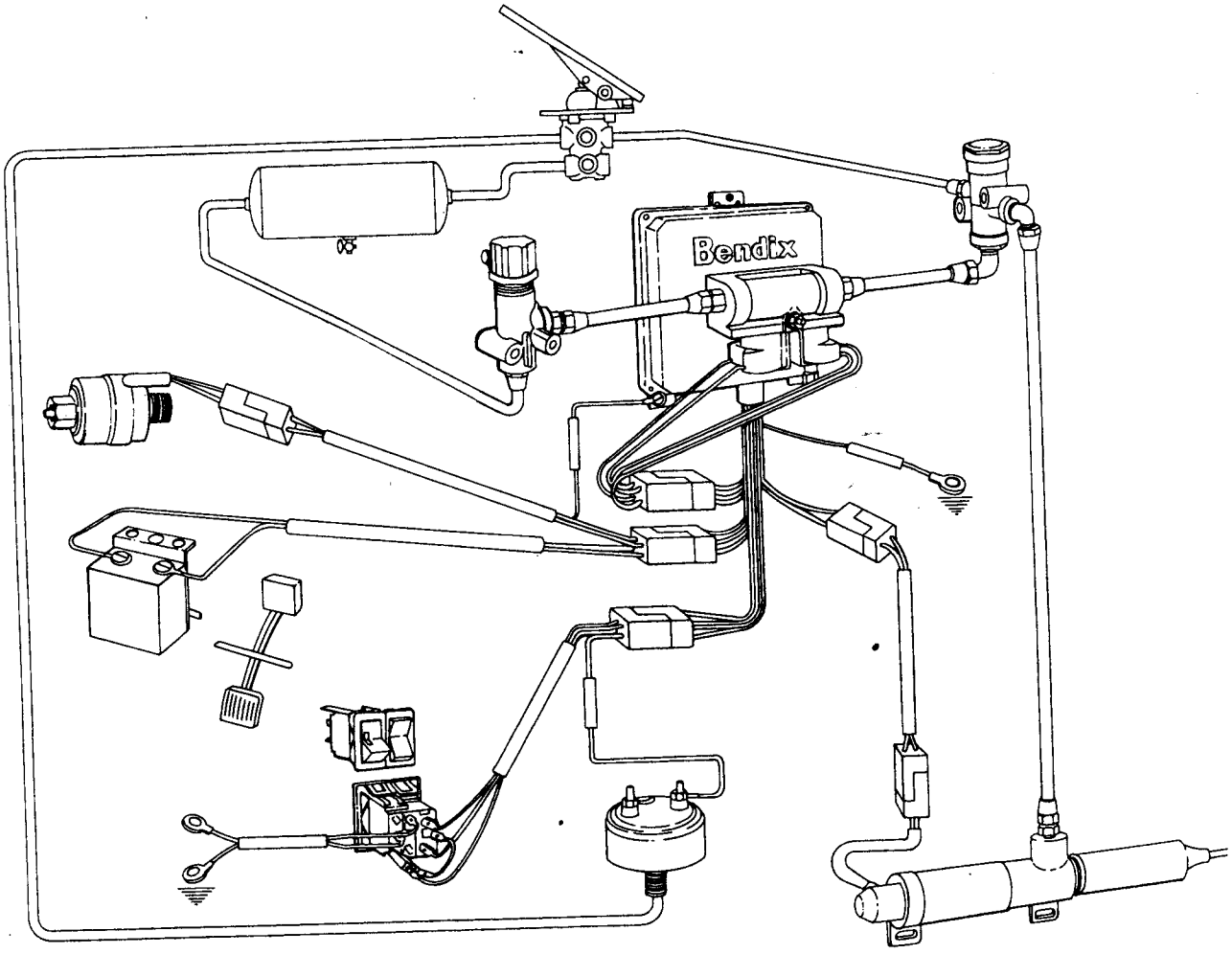
Heavy Vehicle
Systems Division

Bendix Parts Catalog

CATALOG 10-A-1

Universal Truck Cruise Control Installation Kits

CRUISE CONTROL INDEX

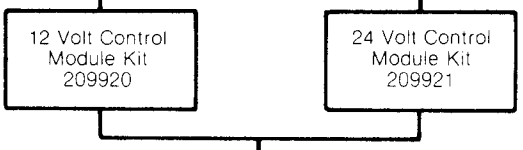


Typical Truck Cruise Control System

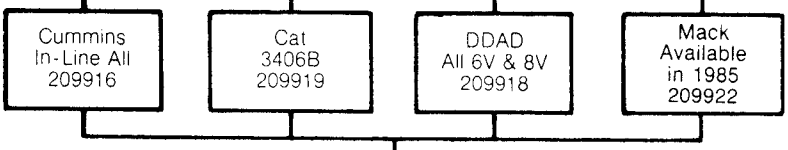
FOUR(4) KITS ARE REQUIRED TO INSTALL THE BENDIX UNIVERSAL CRUISE CONTROL:

SELECT

SELECT ONE



SELECT ONE



SELECT ONE

SPEEDOMETER TYPE	KIT PC. NO.
Mechanical — Cable driven from transmission speedometer output port.	209867*
Electronic — Gear driven speed signal generator externally mounted at speedometer output port of transmission.	209867*
Electronic — Speed signal obtained from magnetic pick-up mounted into transmission non-gear driven.	209890
Electronic — Speed signal obtained from magnetic pick-up inside drive-wheel. If pick-up is not in drive wheel, use kit 209867 instead of 209890	209890

*NOTE: Kit 209867 can be used with all popular transmissions with the exception of the following Fuller models RT-610, RTO-610 & RTO-6610.

CAB KIT

The universal cab kit is designed to accommodate both C.O.E. and conventional cab configurations. Contents of the cab kit are presented on catalog page 10-A-4 for reference.

CONTROL MODULE KITS

Select the appropriate control module kit by determining the vehicle accessory voltage. The control module contained in these kits are user programmable for: engine make, stationary throttle control, speed signal source (electronic and mechanical speedometers), and top set limit. Contents of the control module kits are presented on catalog page 10-A-5 for reference.

ENGINE KITS

Select the appropriate engine kit by determining the engine make and model in use. The universal cruise control may be installed on the newer Caterpillar 3406-B engine but not the older 3406. Contents of the engine kits are presented on catalog pages 10-A-6 to 10-A-9 for reference.

SPEED SENDER KITS

The speed sender kits will accommodate automatic and manual transmissions as well as mechanical and electronic speedometers. Choose the appropriate kit by determining the type of speedometer and the method by which it obtains vehicle speed information. Contents of the speed sender kits are presented on catalog pages 10-A-10 to 10-A-11 for reference.

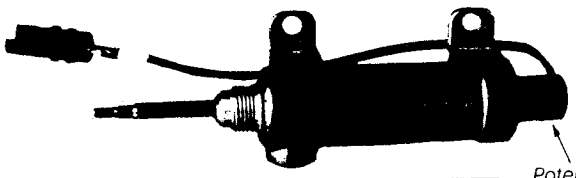
GENERAL

1. Service parts replacement and maintenance kit part numbers for all major cruise control components presented on catalog pages 10-A-4 to 10-A-11.
2. For operation and troubleshooting information, consult Bendix Service Data sheet SD-10-1, furnished in the cab kit. This publication is also available separately upon request.
3. The universal cruise control kits are designed to accommodate all popular engine, transmission and cab combinations noted in the guide above. In some cases where unusual or special equipment is installed on the vehicle, modifications to the cruise control kits or their instruction may be required. In the event that an installation difficulty cannot be resolved, contact your local Bendix sales representative for assistance.

CATALOG
10-A-4

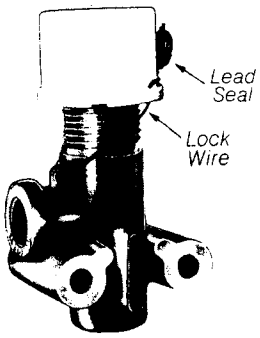
UNIVERSAL TRUCK CRUISE CONTROL

CAB KIT 209917

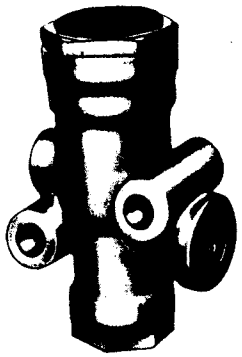


CC-5 AIR CYLINDER/POTENTIOMETER ASSY. PC. NO.	POTENTIOMETER ASSY. PC. NO.
101950	101951

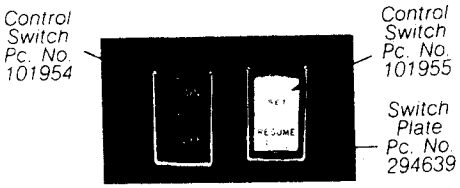
Maint. Kit Pc. No. 102315



RV-1
Pressure Reducing Valve
Pc. No. 282811



TR-3 Inversion Valve
Pc. No. 101781



WIRING HARNESSES AND CONNECTORS

WIRING HARNESS PC. NO.	FIG. NO.	CONNECTION TO	CONNECTION FROM	A LENGTH (APPROX.) IN.	WIRE COLOR
102238	1	Control Switch	Vehicle Power & Ground	60	Red & Black
102240	2	Control Switch	Set/Resume Switch	6	White
102244	3	CA-1 Controller	CC-5 Cylinder	182	Red, White, Black
102736	4	Control Switches & 102545 Harness	CA-1 Controller	155	White/Green, White/Yellow White/Red, Orange
102252	5	Vehicle Ground	CA-1 Controller	12	Green
102252	5	Vehicle Ground	102256 Harness	12	Green
102256	6	Speed Sender & Cl. Switch	CA-1 Controller	A120/B180	Blue, Gray, Green & Violet
102545	7	Stop Light Switch	102736 Harness	120	Orange

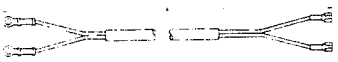


Fig. 1

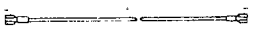


Fig. 2

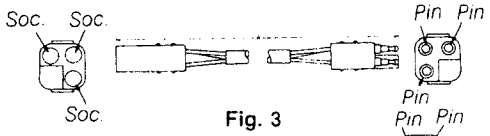


Fig. 3

Fig. 4

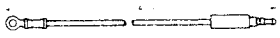


Fig. 5

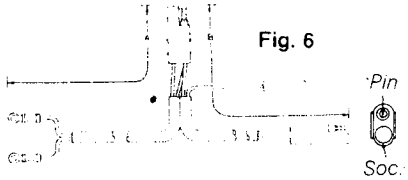


Fig. 6

Wiring Harnesses

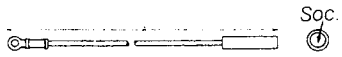


Fig. 7

MISCELLANEOUS HARDWARE ITEMS

CAB KIT NO. 209917 ADDITIONAL PARTS NOT LISTED ABOVE

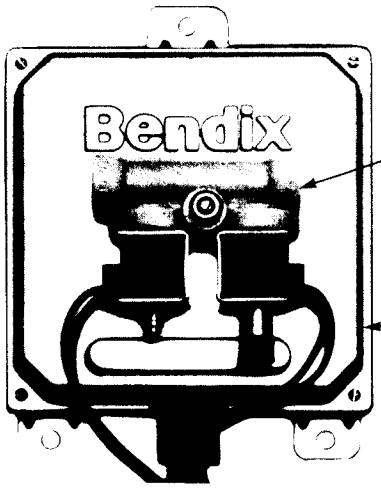
DESCRIPTION	QUANTITY
1/4 Lockwasher	7
1/4 Hex Nut	7
Tubing Conn	1
Tubing Elbow	2
Tubing Elbow	5
1/4 Cap Screw	3

DESCRIPTION	QUANTITY
Brass Insert	12
Tubing Conn	2
1/4 Cap Screw	4
# 6 Screw	4
Nylon Tubing	1

CONTROL MODULE KITS 209920, 209921

UNIVERSAL TRUCK CRUISE CONTROL

CATALOG 10-A-5

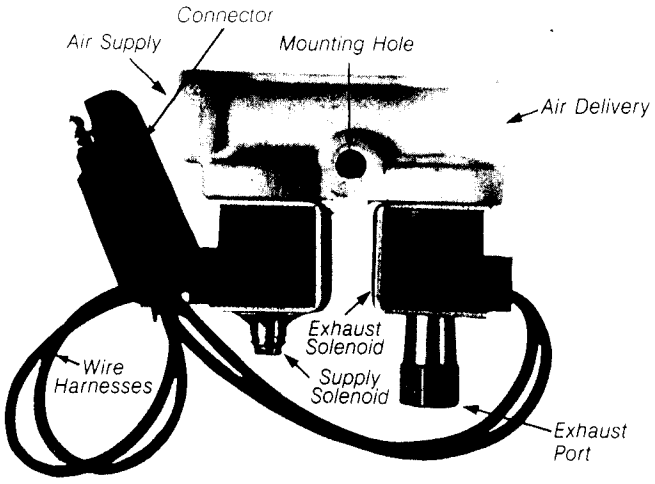


CA-1 Control Module

CA-1 CONTROLLER/ SOLENOID ASSY. PC. NO.	VOLTAGE	CONNECTOR FIG. NO.
209920	12V	1
* 209921	24V	1

* A 24V on/off control switch, Pc. No. 102101, is furnished with this kit to replace the 12V switch contained in Cab Kit 209917.

SERVICE REPLACEMENT PARTS



Solenoid Assembly

SOLENOID ASSY. SERVICE PC. NO.	VOLTAGE	CONNECTOR FIG. NO.
065030	12V	1
065031	24V	1
065029	12V	2

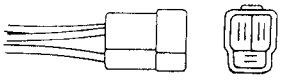


Figure 2

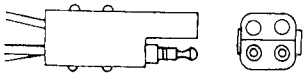
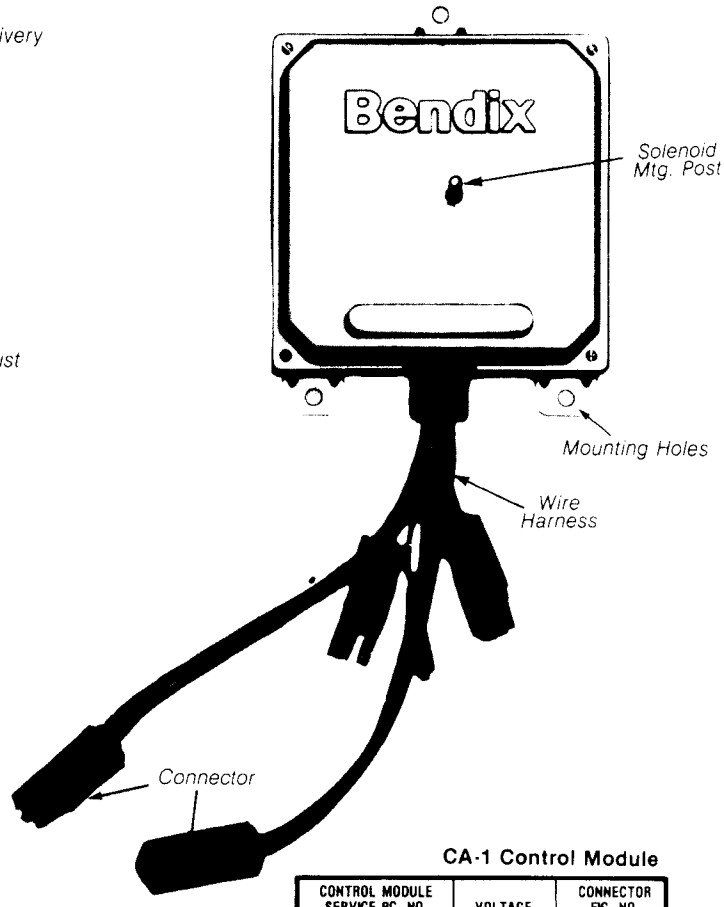


Figure 1

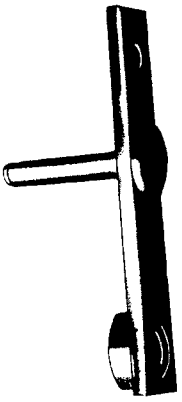
Connector Styles



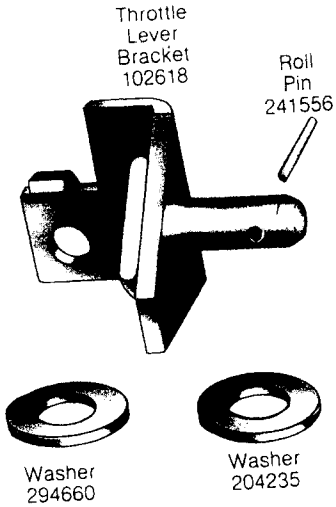
CA-1 Control Module

CONTROL MODULE SERVICE PC. NO.	VOLTAGE	CONNECTOR FIG. NO.
065072	12V	1
065073	24V	1
065022	12V	2

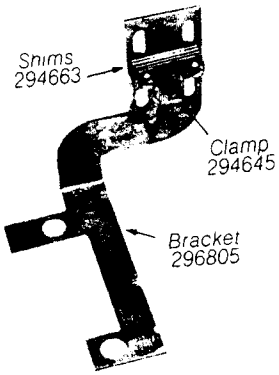
ENGINE KIT 209916
INLINE CUMMINS



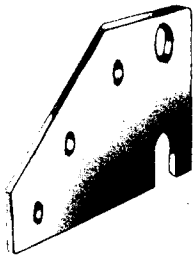
Throttle Lever
Pc. No. 102617



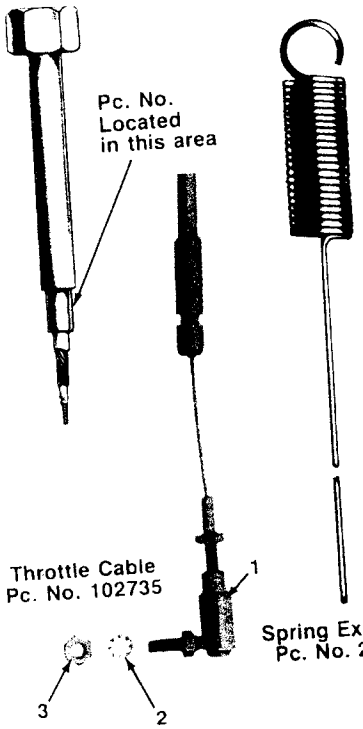
Throttle Lever
Pc. No. 102737



Throttle Cable
Bracket Assembled

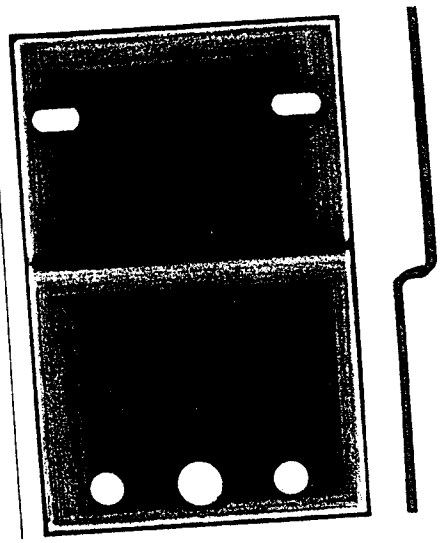


Throttle Lever
Pc. No. 560136



Throttle Cable
Pc. No. 102735

Spring Extension
Pc. No. 296257



Mounting Bracket
Pc. No. 294850

MISCELLANEOUS HARDWARE ITEMS

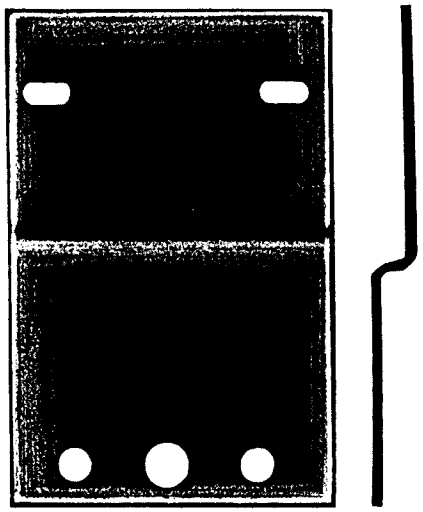
MISCELLANEOUS HARDWARE ITEMS FURNISHED IN KIT 209916

DESCRIPTION	QUANTITY
5/16 Lockwasher	2
1/2 Lockwasher	2
1/2 Washer	2
5/16 Hex Nut	2
Plate Washer	2
1/2 Cap Screw	2

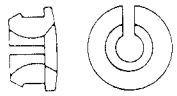
DESCRIPTION	QUANTITY
# 10 Lockwasher	2
1/2 Hex Nut	2
5/16 Cap Screw	2
# 10 Hex Nut	2
# 10 Mach. Screw	2

BALL SWIVEL KIT 104708 CONSISTS OF:

KEY NO.	QTY.	DESCRIPTION
1	1	Ball Swivel Assy.
2	1	#10 Lockwasher
3	2	#10 Hex Nut



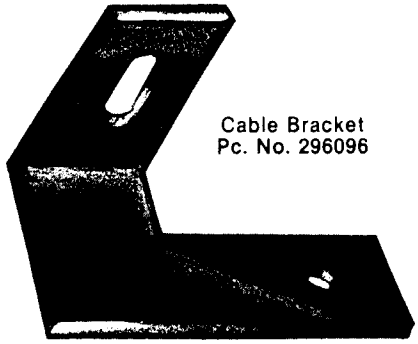
Mounting Bracket
Pc. No. 294850



Retainer
Pc. No. 294419

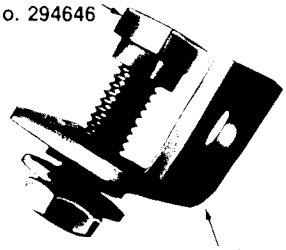
Throttle Lever
Pc. No. 560159

Cable Bracket
Pc. No. 560156

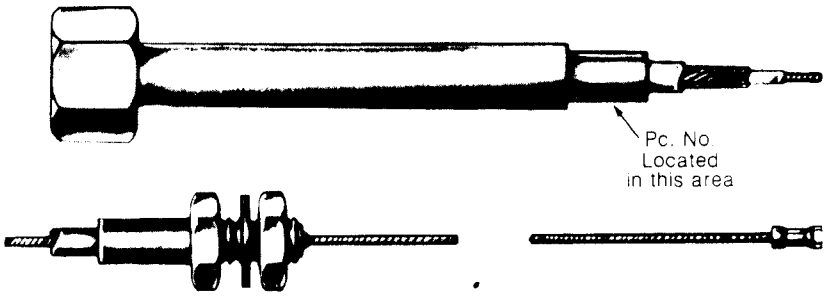


Cable Bracket
Pc. No. 296096

Shoulder Bolt
Pc. No. 294646



Throttle Lever
Pc. No. 296004



Pc. No
Located
in this area

Throttle Cable
Pc. No. 102298

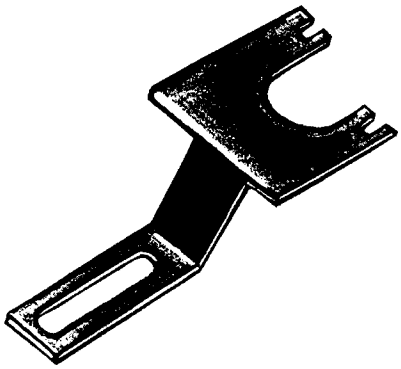
MISCELLANEOUS HARDWARE ITEMS

ENGINE KIT NO. 209918 ADDITIONAL PARTS NOT LISTED ABOVE

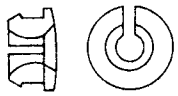
DESCRIPTION	QUANTITY
5/16 Hex Nut	1
5/16 Cap Screw	1
5/16 Cap Screw	2
5/16 Hex Nut	2
5/16 Lockwasher	3
1/2 Cap Screw	2
1/2 Lockwasher	2

DESCRIPTION	QUANTITY
1/2 Plate Washer	2
# 8-32 Machine Screw	1
# 8 Internal Lockwasher	1
# 8-32 Hex Nut	1
# 8 Steel Plate Washer	1
1/2 Hex Nut	2

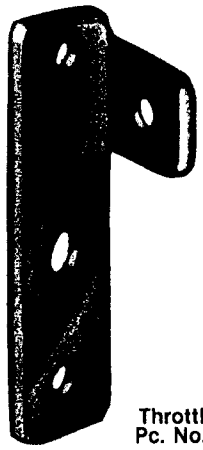
ENGINE KIT 209919
CATERPILLAR 3406B



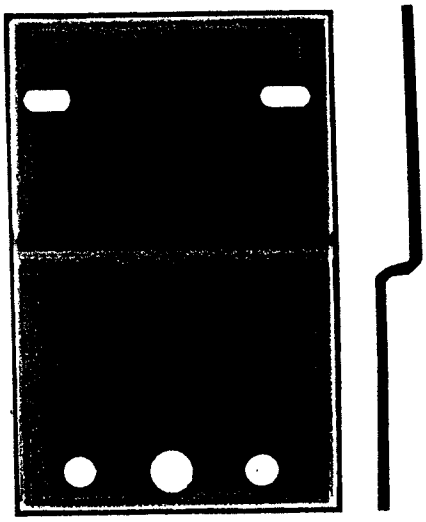
Throttle Cable Bracket
Pc. No. 560158



Retainer
Pc. No. 294419



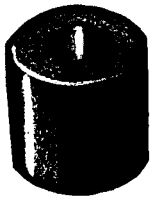
Throttle Lever
Pc. No. 560157



Mounting Bracket
Pc. No. 294850

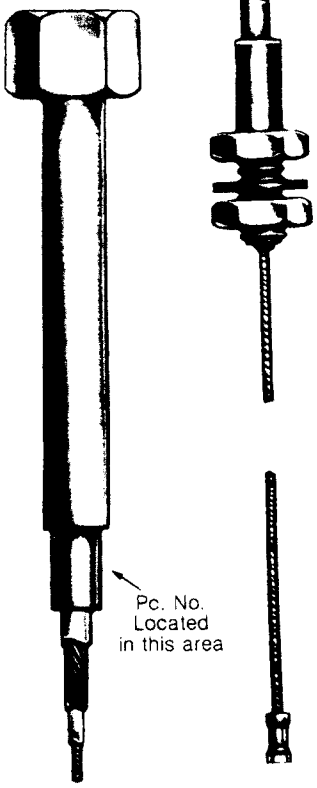
Shoulder
Bolt
560155

Lock-
washer
297509



Spacer
Pc. No. 560154

Throttle Cable
Pc. No. 102298



Pc. No.
Located
in this area

MISCELLANEOUS HARDWARE ITEMS

ENGINE KIT NO. 209919 ADDITIONAL PARTS NOT LISTED ABOVE

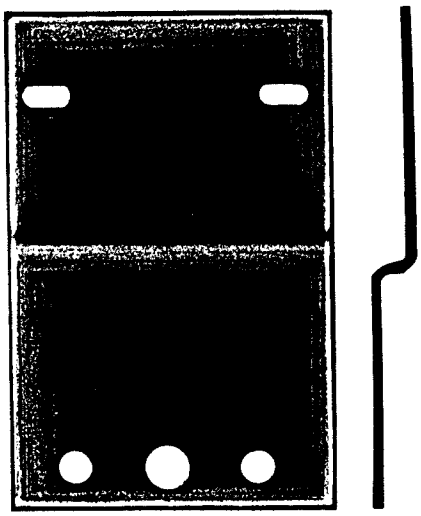
DESCRIPTION	QUANTITY
1/4 Cap Screw	1
1/4 Cap Screw	1
1/4 Lockwasher	2
1/4 Hex Nut	2
5/16 Cap Screw	2
5/16 Hex Nut	2

DESCRIPTION	QUANTITY
5/16 Lockwasher	2
1/2 Cap Screw	2
1/2 Lockwasher	2
1/2 Plate Washer	2
1/2 Hex Nut	2
1/4 Cap Screw	1

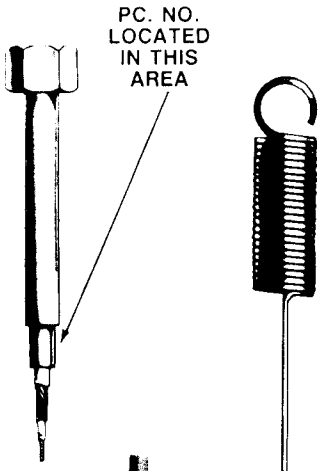
ENGINE KIT 209922
MACK TRUCK

UNIVERSAL TRUCK
CRUISE CONTROL

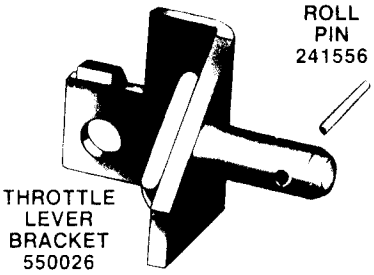
CATALOG
10-A-9



MOUNTING BRACKET
294850

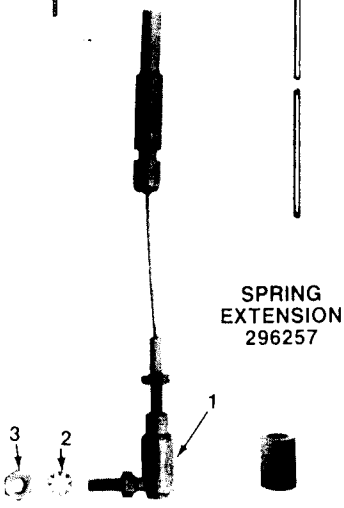


THROTTLE
LEVER
550108



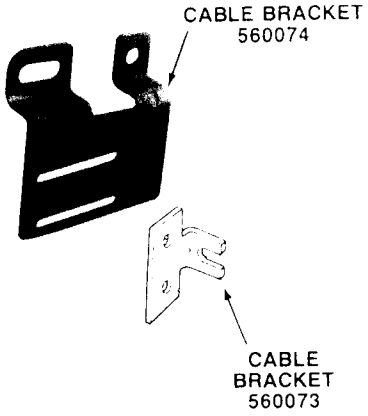
NYLON
WASHER
294660

METAL
WASHER
204235



THROTTLE
CABLE
550110

SPACER
560076



MISCELLANEOUS HARDWARE ITEMS

ENGINE KIT 209922
ADDITIONAL PARTS NOT LISTED ABOVE

DESCRIPTION	QUANTITY
5/16 Lockwasher	2
1/2 Lockwasher	2
1/2 Washer	2
5/16 Hex Nut	2
Plate Washer	2
1/2 Cap Screw	2
3/8 Cap Screw	1

DESCRIPTION	QUANTITY
#10 Lockwasher	2
1/2 Hex Nut	2
5/16 Cap Screw	2
#10 Hex Nut	2
#10 Mach. Screw	2

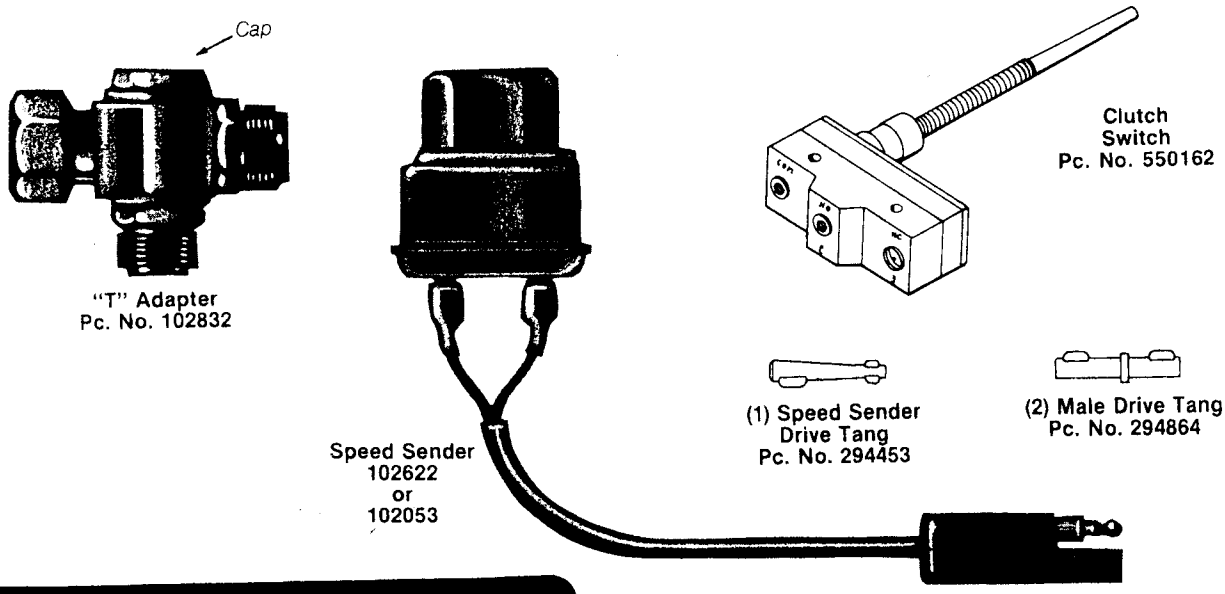
BALL SWIVEL KIT
104708 CONSISTS OF:

KEY NO.	QTY.	DESCRIPTION
1	1	Ball Swivel Assy.
2	1	#10 Lockwasher
3	2	#10 Hex Nut

CATALOG
10-A-10

UNIVERSAL TRUCK
CRUISE CONTROL

SPEED SENDER KIT 209867



IMPORTANT INFORMATION

General

This kit will accommodate vehicles equipped with electronic and cable driven speedometers that require a mechanical (gear driven) connection to the transmission speedometer output port. Specifically, included are speed signal generators (speed senders) for electronic speedometers that are externally mounted on the transmission at the speedometer port and direct cable driven speedometers.

1. This kit will accommodate all transmissions **except** the following Fuller transmissions:

   RT-6610 RTO-6610
   RT-610 RTO-610

   Vehicle equipped with these transmissions cannot be fitted with cruise control.

2. If the vehicle speedometer ratio corrector (mounted on transmission) has a non-removable drive tang that is other than .187" round, the entire ratio corrector must be replaced.

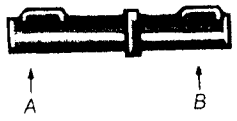
3. If a transmission mounted ratio adapter is not installed and the speedometer cable is mounted directly to the transmission, remove the cable and check the tip size. If the cable tip size is other than .187" round, it will be necessary to procure the proper components to adapt the cable to the .187" round socket of the "T" adapter furnished in this kit.

4. If the speedometer driven gear in the transmission has other than a .203" round socket drive, it will be necessary to replace the two male drive tangs furnished in this kit. Replacement drive tangs must have a .187" round drive on one end to accommodate the "T" adapter and must be obtained from a local sales outlet for Stewart Warner or S.S. White. The chart below lists the sizes and part numbers of drive tangs available from these companies.

A	B	STEWART WARNER	S.S. WHITE
.187" RD.	.152" RD.	101451	2701-3020
.187" RD.	.187" RD.	101452	2701-3021
.187" RD.	.203" RD.	101453	2701-3022
.172" RD.*	.104" SQ.	101454	2701-3018
.172" RD.*	.150" SQ.	428798	2701-3019
.172" RD.*	.183" SQ.	810654	Not Available

*Will Accomodate a .187" Round Socket

Male Drive Tang

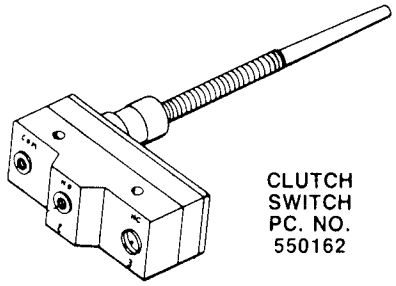


MISCELLANEOUS HARDWARE ITEMS

SPEED SENDER KIT 209867 ADDITIONAL PARTS NOT LISTED ABOVE

DESCRIPTION	QUANTITY
1/4 Lockwasher	2
1/4 Hex Nut	2
1/4 Cap Screw	2
#6 Lockwasher	6
#6 Mach Scr Nut	2
#6 Mach Screw	2
Clutch Sw Brkt	1

SPEED SENDER KIT 209890



CLUTCH SWITCH PC. NO. 550162

IMPORTANT INFORMATION

General

This kit will accommodate vehicles equipped with electronic speedometers that **do not have** externally mounted (gear driven) speed signal generators installed in the speedometer output port of the transmission.

Kit should not be used when the electronic speedometer speed signal is obtained from an in-wheel, speed sending unit on a **non-powered** wheel. For example; steering, tag or pusher axle wheels.

The electronic speedometer must be operating correctly to insure proper cruise control operation.

MISCELLANEOUS HARDWARE ITEMS

SPEED SENDER KIT 209890
ADDITIONAL PARTS NOT LISTED ABOVE

DESCRIPTION	QUANTITY
1/4 Lockwasher	2
1/4 Hex Nut	2
1/4 Cap Screw	2
#6 Lockwasher	6
#6 Mach Scr Nut	2
#6 Mach Screw	2
Clutch Sw Brkt	1
Ring Terminal	2

Typical Truck Cruise Control System