SECTION 3. EXHAUST SYSTEMS

8-45. GENERAL. Any exhaust system failure should be regarded as a severe hazard. Depending upon the location and type of failure, it can result in carbon monoxide (CO) poisoning of crew and passengers, partial or complete engine power loss, or fire. Exhaust system failures generally reach a maximum rate of occurrence at 100 to 200 hours' operating time, and over 50 percent of the failures occur within 400 hours.

8-46. MUFFLER/HEAT EXCHANGER FAILURES. Approximately one-half of all exhaust system failures are traced to cracks or ruptures in the heat exchanger surfaces used for cabin and carburetor air heat sources.

a. Failures in the heat exchanger's surface (usually the muffler's outer wall) allow exhaust gases to escape directly into the cabin heat system. The failures are, for the most part, attributed to thermal and vibration fatigue cracking in the areas of stress concentration; e.g., tailpipe and stack, inlet-attachment areas. (See figures 8-13 through 8-16.)

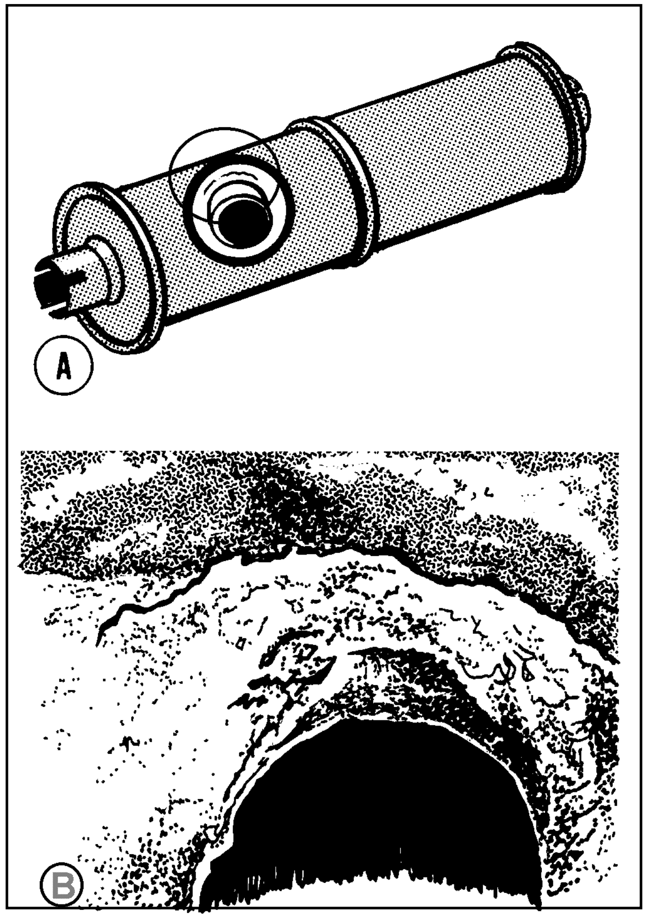

FIGURE 8-13. Typical muffler wall fatigue failure at exhaust outlet. (A. Complete muffler assembly with heat shroud removed; B. Detail view of failure.)

b. Failures of the spot welds which attach heat transfer pins, as shown in figure 8-14A, can result in exhaust gas leakage. In addition to the CO hazard, failure of heat exchanger surfaces can permit exhaust gases to be drawn into the engine induction system and cause engine overheating and power loss.

8-47. MANIFOLD/STACK FAILURES. Exhaust manifold and stack failures are also usually fatigue-type failures which occur at welded or clamped joints; e.g., stack-to-flange, stack-to-manifold, muffler connections, or crossover pipe connections. Although these failures are primarily a fire hazard, they also present a CO problem. Exhaust gases can enter the cabin via defective or inadequate seals at firewall openings, wing strut fittings, doors, and wing root openings. Manifold/stack failures, which account for approximately 20 percent of all exhaust system failures, reach a maximum rate of occurrence at about 100 hours' operating time. Over 50 percent of the failures occur within 300 hours.

8-48. INTERNAL MUFFLER FAILURES. Internal failures (baffles, diffusers, etc.) can cause partial or complete engine power loss by restricting the flow of the exhaust gases. (See figures 8-17 through 8-20.)

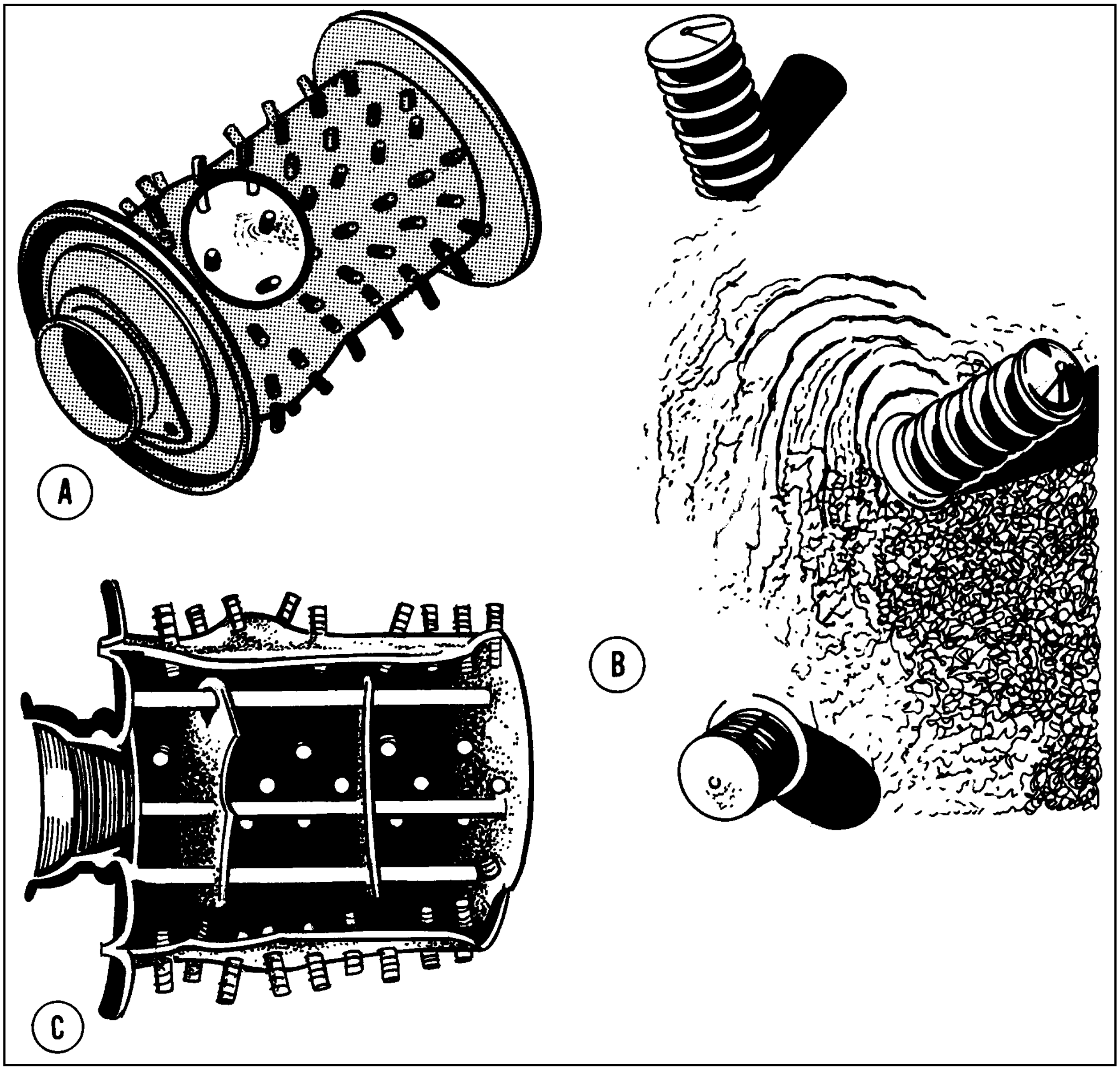

FIGURE 8-14. Typical muffler wall failure. (A. Complete muffler assembly with heat shroud removed; B. Detail view of failure; C. Cross section of failed muffler.)

As opposed to other failures, erosion and carbonizing caused by the extreme thermal conditions are the primary causes of internal failures. Engine after-firing and combustion of unburned fuel within the exhaust system are probable contributing factors.

a. In addition, local hot spot areas caused by uneven exhaust gas flow, result in burning, bulging, and rupture of the outer muffler wall. (See figure 8-14.) As might be expected, the time required for these failures to develop is longer than that for fatigue failures. Internal muffler failures account for nearly 20 percent of the total number of exhaust system failures.

b. The highest rate of internal muffler failures occurs between 500 and 750 hours of operating time. Engine power loss and excessive back-pressure caused by exhaust outlet blockage may be averted by the installation

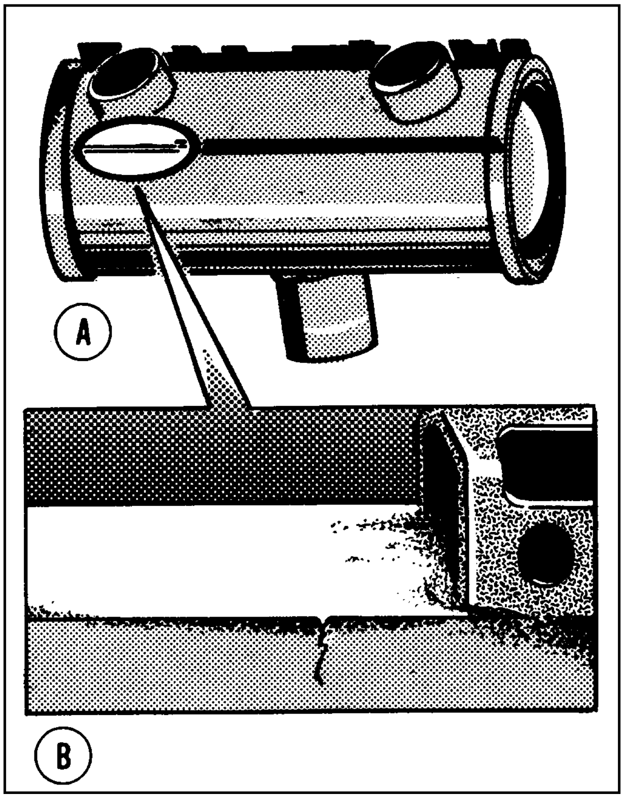

FIGURE 8-15. Typical muffler wall fatigue failure. (A. Complete muffler assembly with heat shroud partially removed; B. Detailed view of failure.)

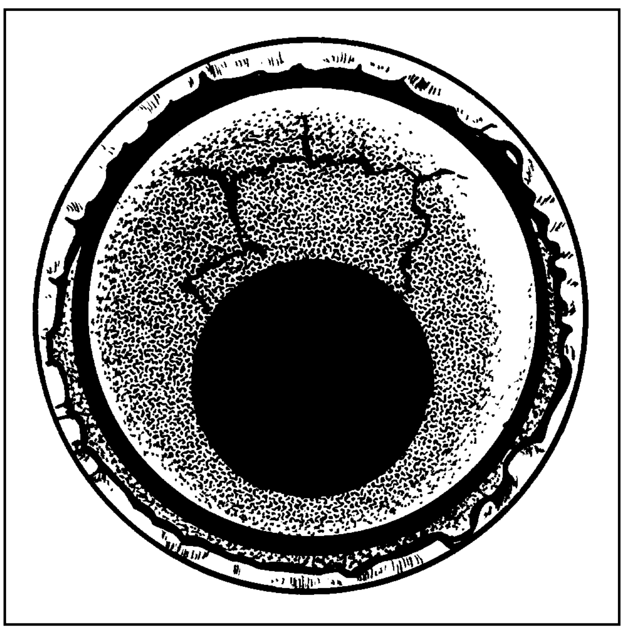

FIGURE 8-16. Typical fatigue failure of muffler end plate at stack inlet.

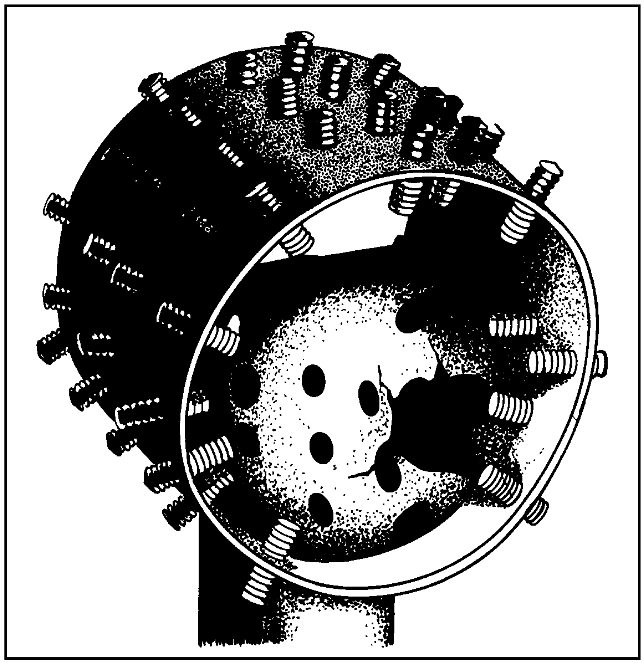

FIGURE 8-17. Section of a muffler showing typical internal baffle failure.

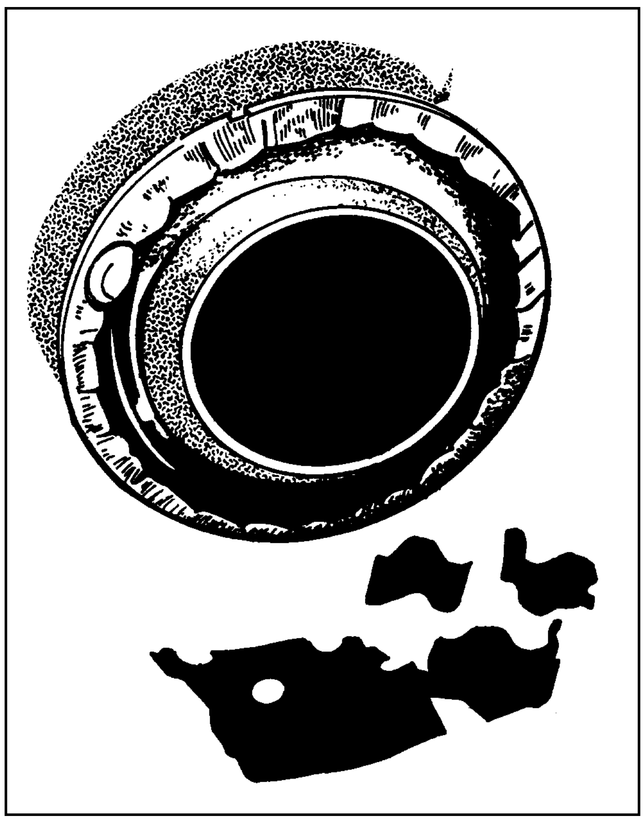

FIGURE 8-18. Loose pieces of a failed internal baffle.

of an exhaust outlet guard as shown in figures 8-21a and 8-21b. The outlet guard may be fabricated from a 3/16-inch stainless steel welding rod.

Form the rod into two "U" shaped segments, approximately 3 inches long and weld onto the exhaust tail pipe as shown in figure 8-21b so that the guard will extend 2 inches inside the exhaust muffler outlet port. Installation of an exhaust outlet guard does not negate the importance of thorough inspection of the internal parts of the muffler or the necessity of replacing defective mufflers.

8-49. INSPECTION. Inspect exhaust systems frequently to ascertain complete system integrity.

CAUTION: Marking of exhaust system parts. Never use lead pencils, carbon based pencils, etc., to mark exhaust system parts. Carbon deposited by those tools will cause cracks from heat concentration and carbonization of the metal. If exhaust system parts must be marked, use chalk, Prussian blue, India ink, or a grease pencil that is carbon-free.

a. Before any cleaning operation, remove the cowling as required to expose the complete exhaust system. Examine cowling and nacelle areas adjacent to exhaust system components for telltale signs of exhaust gas soot indicating possible leakage points. Check to make sure no portion of the exhaust system is being chafed by cowling, engine control cables, or other components. The exhaust system often operates at red-hot temperatures of 1,000 °F or more; therefore, parts such as ignition leads, hoses, fuel lines, and flexible air ducts, should be protected from radiation and convection heating by heat shields or adequate clearance.

b. Remove or loosen all exhaust shields, carburetor and cabin heater muffs, shrouds, heat blankets, etc., required to permit inspection of the complete system.

c. Perform necessary cleaning operations and inspect all external surfaces of the exhaust system for cracks, dents, and missing parts. Pay particular attention to welds, clamps, supports and support attachment lugs, bracing, slip joints, stack flanges, gaskets, flexible couplings, and etc. (See figures 8-22 and 8-23.) Examine the heel of each bend, areas adjacent to welds, any dented areas, and low spots in the system for thinning and pitting due to internal erosion by combustion products or accumulated moisture. An ice pick (or similar pointed instrument) is useful in probing suspected areas. Disassemble the system as necessary to inspect internal baffles or diffusers.

d. Should a component be inaccessible for a thorough visual inspection or hidden by non-removable parts, remove the component and check for possible leaks by plugging its openings, applying approximately 2 psi internal pressure, and submerging it in water. Any leaks will cause bubbles that can be readily detected. Dry thoroughly before reinstallation.

8-50. REPAIRS. It is generally recommended that exhaust stacks, mufflers, tailpipes, and etc., be replaced with new or reconditioned components rather than repaired. Welded repairs to exhaust systems are complicated by the difficulty of accurately identifying the base metal so that the proper repair materials can be selected. Changes in composition and grain structure of the original base metal further complicates the repair. However, when welded repairs are necessary, follow the general procedures outlined in Chapter 4; Metal Structure, Welding, and Brazing; of this AC. Retain the original contours and make sure that

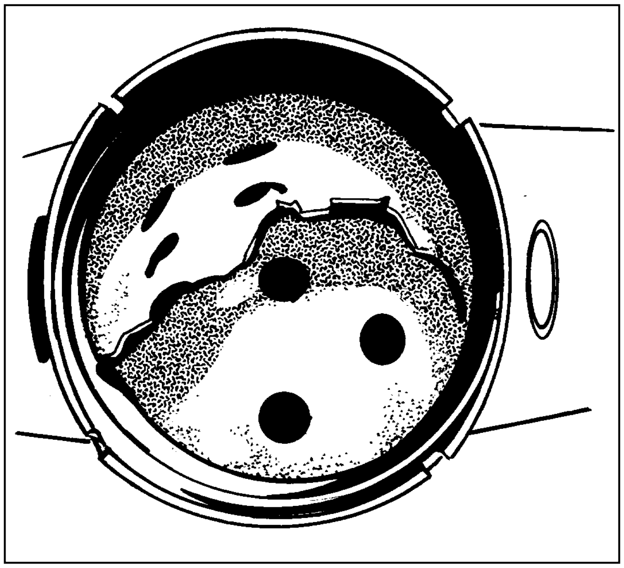

FIGURE 8-19. Failed internal baffle partially obstructing the muffler outlet.

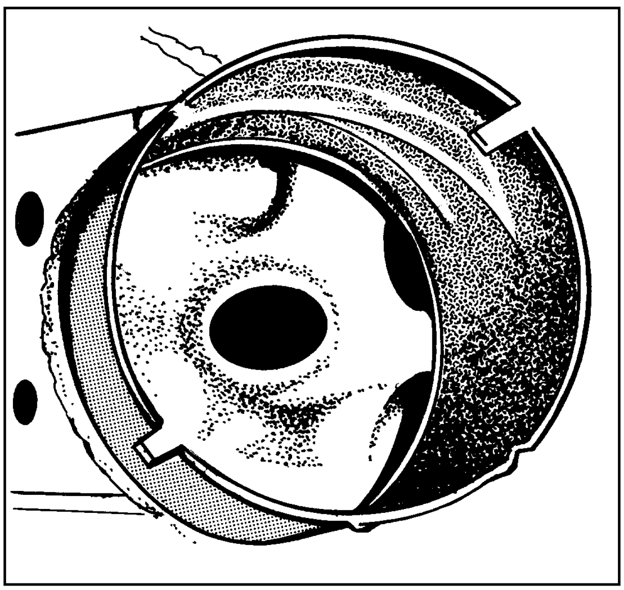

FIGURE 8-20. Failed internal baffle completely obstructing the muffler outlet.

the completed repair has not warped or otherwise affected the alignment of the exhaust system. Repairs or sloppy weld beads, which protrude internally, are not acceptable since they cause local hotspots and may restrict exhaust gas flow. All repairs must meet the manufacturer's specifications. When repairing or replacing exhaust system components, be sure that the proper hardware and clamps are used. Do not substitute steel or low-

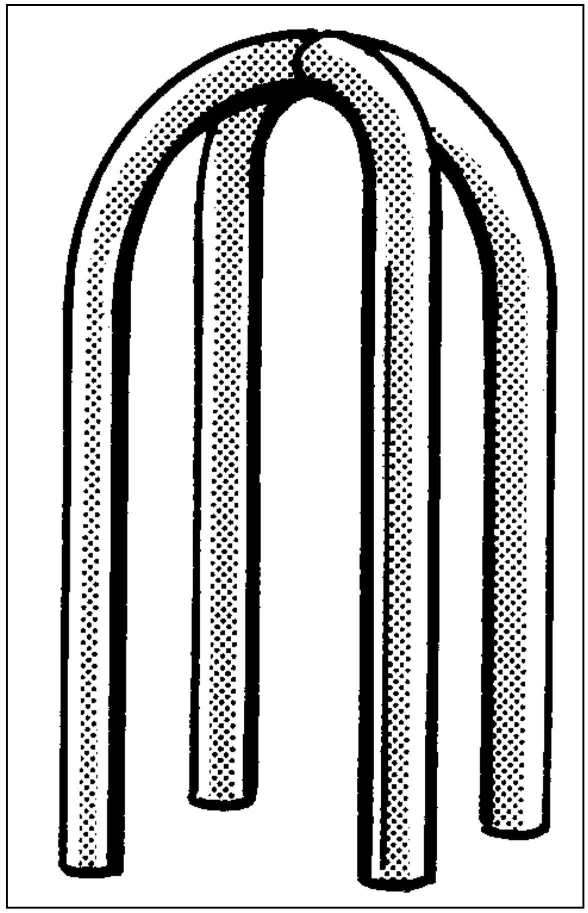

FIGURE 8-21a. Example of exhaust outlet guard.

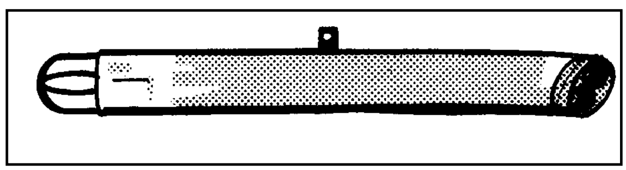

FIGURE 8-21b. Example of exhaust outlet guard installed.

temperature self-locking nuts for brass or special high-temperature locknuts used by the manufacturer. Never reuse old gaskets or old star lock washers. When disassembly is necessary replace gaskets with new ones of the same type provided by the manufacturer.

8-51. TURBO-SUPERCHARGER. When a turbo-supercharger is included, the exhaust system operates under greatly-increased pressure and temperature conditions. Extra precautions should be taken in the exhaust system's care and maintenance. During

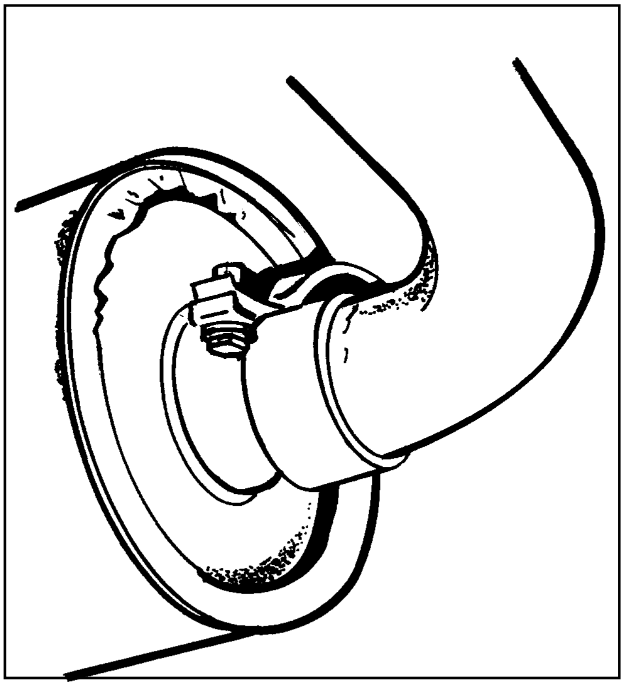

FIGURE 8-22. Effect of improperly positioned exhaust pipe/muffler clamp.

high-altitude operation, the exhaust system pressure is maintained at, or near, sea level values. Due to the pressure differential, any leaks in the system will allow the exhaust gases to escape with a torch-like intensity that can severely damage adjacent structures. A common cause of turbo-supercharger malfunction is coke deposits (carbon buildup) in the waste gate unit causing erratic system operation. Excessive deposit buildups may cause the waste gate valve to stick in the closed position, causing an overboost condition. Coke deposit buildup in the turbo-supercharger itself will cause a gradual loss of power in flight and low deck pressure reading before takeoff. Experience has shown that periodic decoking, or removal of carbon deposits, is necessary to maintain peak efficiency. Clean, repair, overhaul, and adjust turbo-supercharger system components and controls in accordance with the applicable manufacturer's instructions.

8-52. AUGMENTOR SYSTEMS. Inspect augmentor tubes periodically for proper alignment, security of attachment, and general

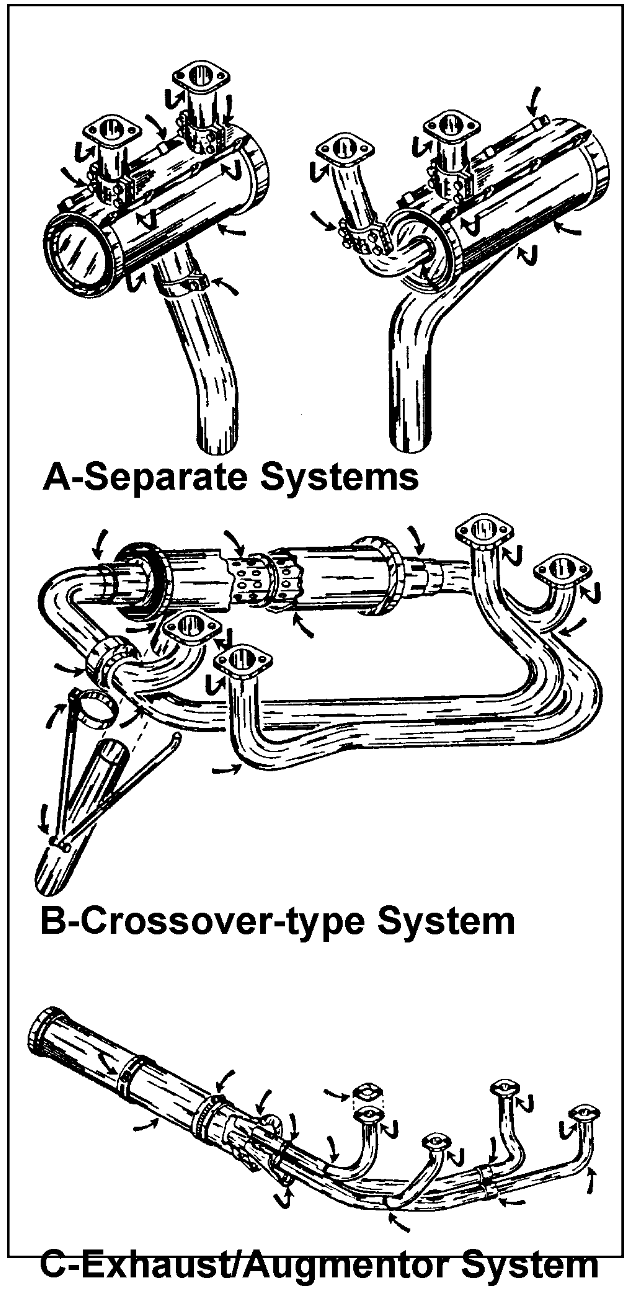

FIGURE 8-23. Primary inspection areas.

overall condition. Regardless of whether or not the augmentor tubes contain heat exchanger surfaces, they should be inspected for cracks along with the remainder of the exhaust system. Cracks can present a fire or CO hazard by allowing exhaust gases to enter nacelle, wing, or cabin areas.

8-53.—8-70. [RESERVED.]