



Technical Note

For Engines Produced in Accordance with ASTM F2339

Title: **Safety Lockwire Practices**

TN No.: **10-3**

Page: 1 of 8

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Technical portions are approved by Airmotive Engineering Corp.



1. APPLICATION

The use of lock wire or safety wire is not a means of obtaining or maintaining torque, it is a safety device to prevent the disengagement or movement of screws, nuts, bolts, snap rings, oil caps, drain cocks, valves, or other parts.

2. WIRE MATERIALS

1. STAINLESS STEEL – This will be for all general lock wiring purposes. Lockwire for use up to 700°F must be a corrosion resistant steel such as AMS-5685. Lockwire for use up to 1800°F must be a corrosion and heat resistant steel such as AMS-5687.
2. COPPER – This will be for shear and seal wiring applications only. Shear applications are those where it is necessary to break or to shear the wire to permit operation or actuation of emergency devices. Seal applications are those where the wire is used with a lead seal to prevent tampering.

3. WIRE SIZE

1. .032 inch minimum diameter wire shall be used for general purpose lock wiring except that .020 inch diameter wire may be used on parts having a nominal hole diameter of less than .045 inch, on parts having a nominal hole diameter between .045 and .062 inches with a spacing of less than 2 inches, or on closely spaced screws or bolts of ¼ or smaller.
2. Copper wire with a .020 diameter shall be used for shear and seal wire applications.

4. COMMON SAFETY-WIRING PRACTICES

There are many different combinations of safety-wiring with certain basic rules common to all applications. These rules are as follows.

1. When bolts, screws or other parts are closely grouped, it is more convenient to wire them in series. The number of bolts, nuts, screws, etc. that may be wired together depends upon the application.
2. Dilled boltheads and screws do not need to be safety-wired if installed with self-locking nuts.
3. To prevent failure due to rubbing or vibration, safety wire must be tight after installation.
4. Safety wire must be installed in a manner that will prevent the tendency of the part to loosen.



5. Safety wire must never be overstressed. Safety wire will break under vibration if twisted too tightly. Safety wire shall be pulled taut when twisted, and maintain a light tension when secured.
6. The ends of the safety wire must be bent under and inward toward the part to avoid sharp or projecting ends, which might present a safety hazard.
7. Safety wire inside a duct or tube must not cross over or obstruct a flow passage when an alternate routing can be used.

5. METHODS

1. SINGLE WIRE METHOD – The single wire method of safety-wiring shall be used on screws, bolts, and/or nuts in a closely spaced (2 inches or less between centers) or closed geometrical pattern such as a triangle, square, rectangle, square, or circle except when the closed geometric pattern is used to seal hydraulic or air seals, hold hydraulic pressure, or used in critical areas of clutch mechanisms and superchargers. This method shall be used for all shear and seal wiring applications. The single wire method may also be used on parts in electrical systems and in places that are difficult to reach. See Figure 1 and Figure 2.
2. DOUBLE TWIST METHOD – The double twist method of safety-wiring shall be used as the common method of lock wiring. All safety wire applications excluded from the single wire method shall employ the double twist method.

6. SAFETY WIRE PROCEDURES

1. Check the units to be safety wired to ensure that they have been correctly torqued, and that the wiring holes are properly aligned with each other. When there are two or more units, it is desirable that the holes be aligned with each other. Never overtorque or loosen to obtain proper alignment of the holes.
2. To prevent mutilation of the twisted section of wire when using pliers, grasp the wire at the ends. Safety wire must not be kinked, nicked or mutilated. Never twist off the wire ends with pliers, and when cutting wire ends, ensure that at least four to six complete turns are left after the loop ($\frac{1}{2}$ to $\frac{5}{8}$ inches of wire).
3. A pigtail of $\frac{1}{4}$ to $\frac{1}{2}$ inch (3 to 5 twists) shall be made at the end of the wiring. This pigtail shall be bent back or under to prevent snagging.
4. The illustrations in Figure 3, Figure 4, and Figure 5 depict examples of common safety wire applications and the method in which they are to be wired.

7. TWISTING WITH SPECIAL TOOLS

1. Grip the wire in the jaws of the wire twister and slide the outer sleeve down with the thumb to lock the handles or lock the spring loaded pin.
 2. Pull the knob, and the spiral rod spins around and twists the wire.
 3. Squeeze handles together to release the wire.
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8. SECURING OIL CAPS, DRAIN COCKS, AND VALVES

1. When securing oil caps and drain cocks, the safety wire shall be anchored to an adjacent fillister-head screw.
 2. When securing valve handles in the vertical position, the wire is looped around the threads of the pipe leading into one side of the valve, double-twisted around the valve handle, and anchored around the threads of the pipe leading into the opposite side of the valve.
 3. When securing castellated nuts with safety wire, tighten the nut to the low side of the selected torque range, unless otherwise specified, and if necessary, continue tightening until a slot lines with the hole, being careful not to overtorque the nut.
 4. Examples of safety wired oil cap, valve, and drain cock are seen in Figure 6.
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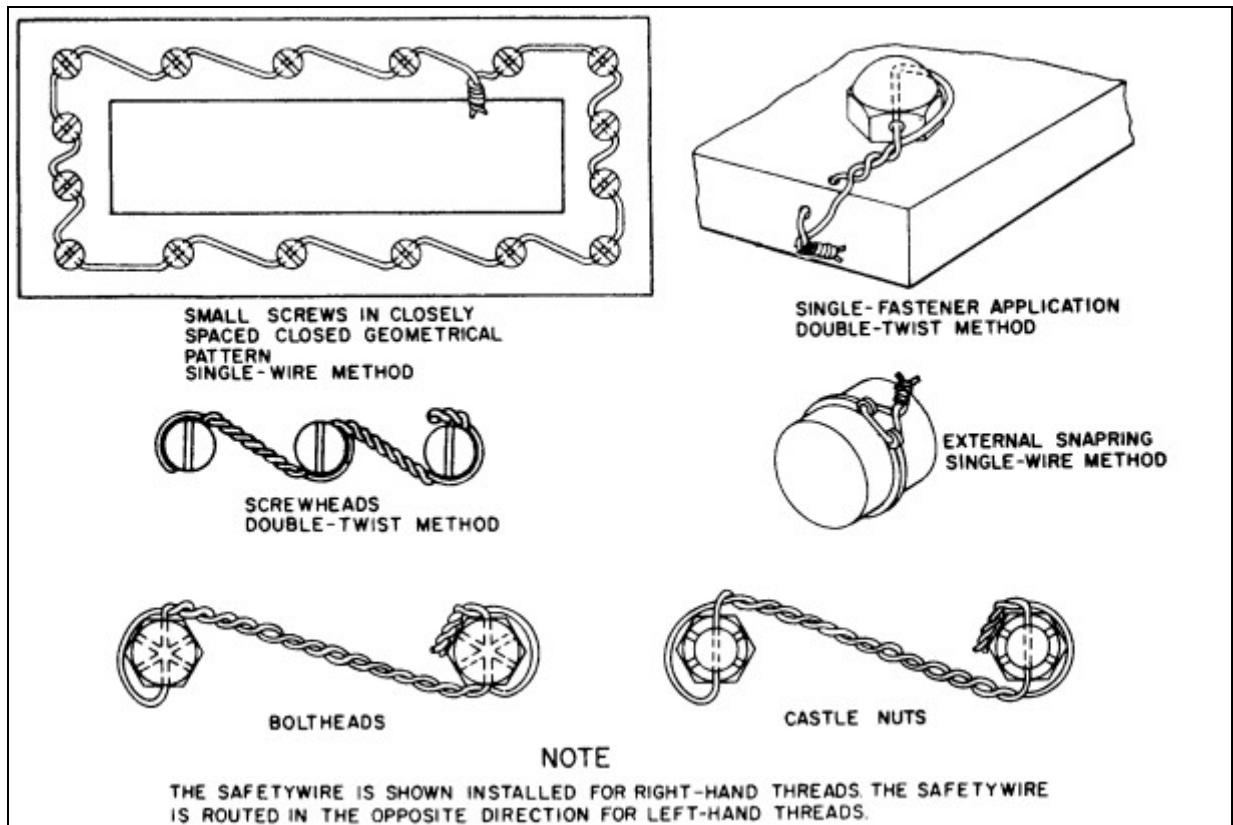


Figure 1 - Single Wire and Double Twist Applications

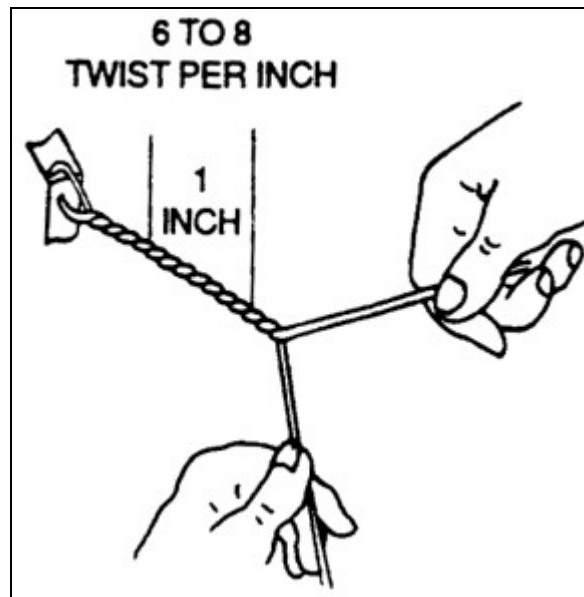
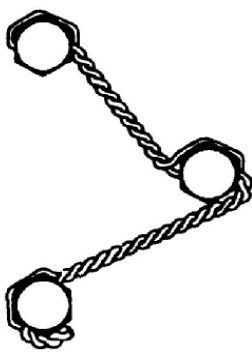


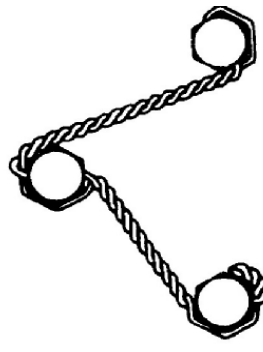
Figure 2 - Double Twist Method by Hand



EXAMPLE 1



EXAMPLE 2



EXAMPLE 3



EXAMPLE 4

Examples 1, 2, 3, and 4 apply to all types of bolts, fillister-head screws, square-head plugs, and other similar parts which are wired so that the loosening tendency of either part is counteracted by tightening of the other part. The direction of twist from the second to the third unit is counterclockwise in examples 1, 3, and 4 to keep the loop in position against the head of the bolt. The direction of twist from the second to the third unit in example 2 is clockwise to keep the wire in position around the second unit. The wire entering the hole in the third unit will be the lower wire, except example 2, and by making a counterclockwise twist after it leaves the hole, the loop will be secured in place around the head of that bolt.



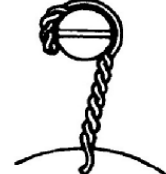
EXAMPLE 5



EXAMPLE 6



EXAMPLE 7



EXAMPLE 8

Examples 5, 6, 7, & 8 show methods for wiring various standard items, NOTE: Wire may be wrapped over the unit rather than around it when wiring castellated nuts or on other items when there is a clearance problem.



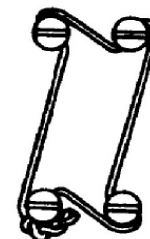
EXAMPLE 9

Example 9 shows the method for wiring bolts in different planes. Note that wire should always be applied so that tension is in the tightening direction.



EXAMPLE 10

Hollow-head plugs shall be wired as shown with the tab bent inside the hole to avoid snags and possible injury to personnel working on the engine.



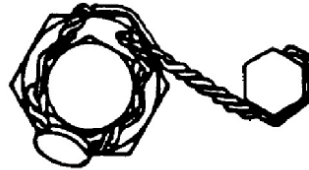
EXAMPLE 11

Correct application of single wire to closely spaced multiple group.

Figure 3 - Common Safety Wire Applications



EXAMPLE 12



EXAMPLE 13

Examples 12 and 13 show methods for attaching lead seal to protect critical adjustments.



EXAMPLE 14

Example 14 shows bolt wired to a right-angle bracket with the wire wrapped around the bracket.



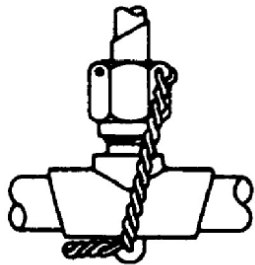
EXAMPLE 15

Example 15 shows correct method for wiring adjustable connecting rod.



EXAMPLE 16

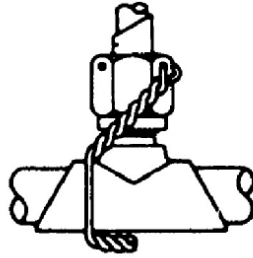
Example 16 shows correct method for wiring the coupling nut on flexible line to the straight connector brazed on rigid tube.



EXAMPLE 17



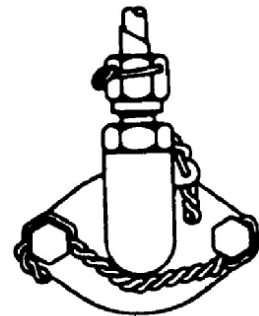
EXAMPLE 18



EXAMPLE 19



EXAMPLE 20

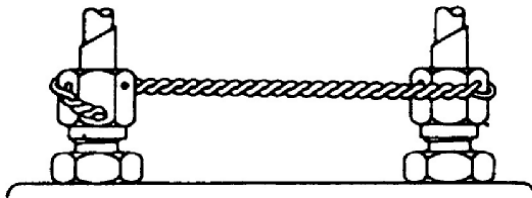


EXAMPLE 21

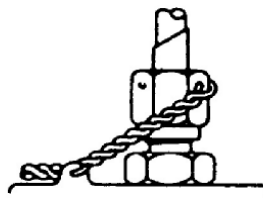
Fittings incorporating wire lugs shall be wired as shown in Examples 17 and 18. Where no lock-wire lug is provided, wire should be applied as shown in examples 19 and 20 with caution being exerted to ensure that wire is wrapped tightly around the fitting.

Small size coupling nuts shall be wired by wrapping the wire around the nut and inserting it through the holes as shown.

Figure 4 - Common Safety Wire Applications

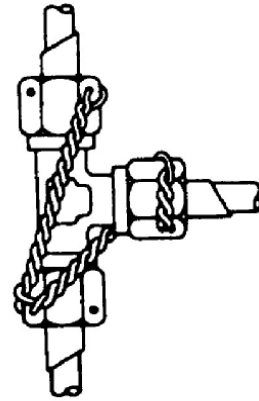


EXAMPLE 22



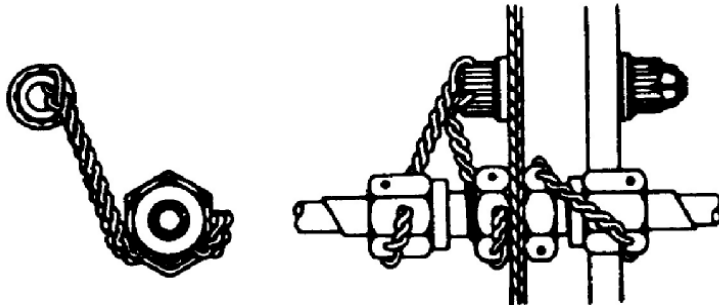
EXAMPLE 23

Coupling nuts attached to straight connectors shall be wired as shown, when hex is an integral part of the connector.



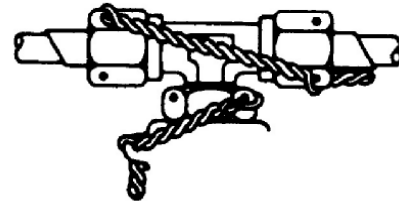
EXAMPLE 24

Coupling nuts on a tee shall be wired, as shown above, so that tension is always in the tightening direction.



EXAMPLE 25

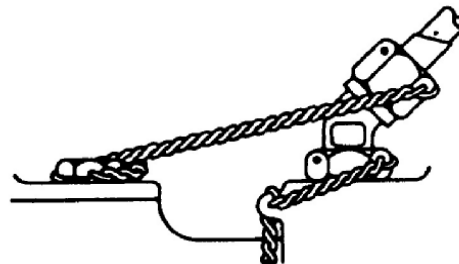
Straight Connector (Bulkhead Type)



EXAMPLE 26



EXAMPLE 27



EXAMPLE 28

Examples 26, 27, and 28 show the proper method for wiring various standard fittings with checknut wired independently so that it need not be disturbed when removing the coupling nut.

Figure 5 - Common Safety Wire Applications

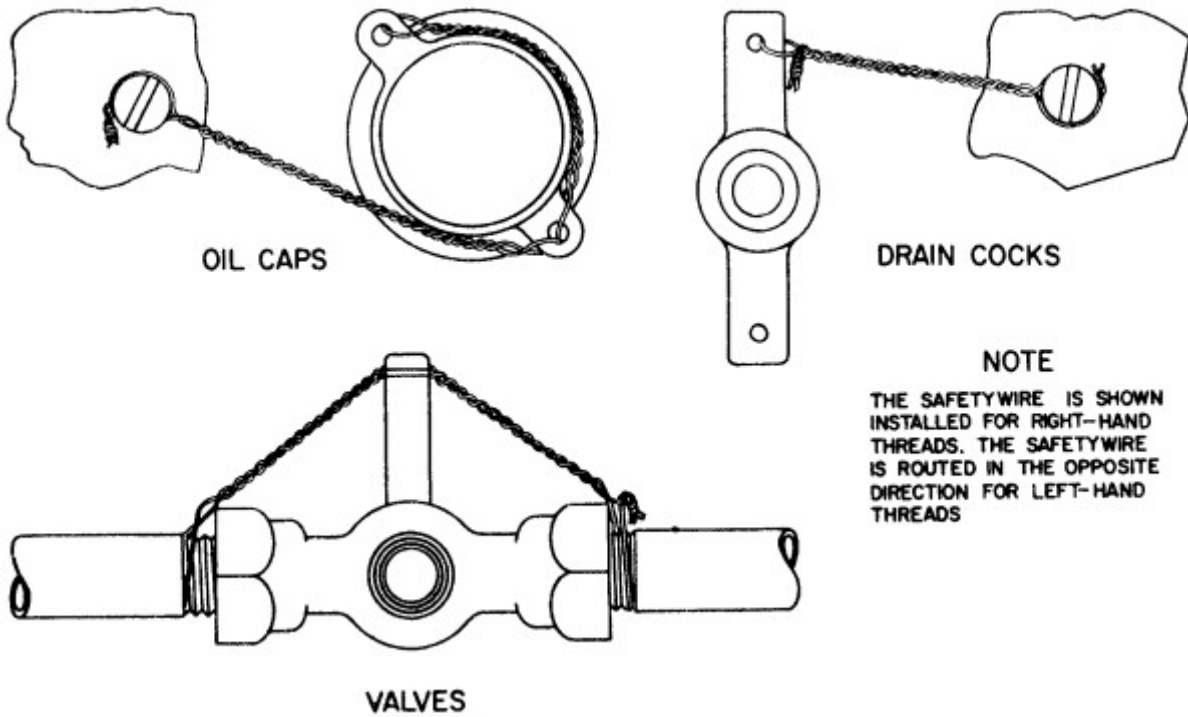


Figure 6 - Safety Wired Oil Cap, Valve, and Drain Cock