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AMSC: N/A

MATERIALS:

1. THE MATERIALS FOR SAFETY-WIRE SHALL BE THOSE MATERIALS LISTED ON MS20995.
2. THE MATERIALS FOR COTTER PINS SHALL BE THOSE MATERIALS LISTED IN MS24665.

GENERAL INSTRUCTIONS FOR THE SELECTION AND APPLICATION OF SAFETY WIRE:

1. THE SELECTION OF MATERIALS SHALL BE MADE FROM MS20995 AND SHALL BE IN ACCORDANCE WITH THE SERVICE LIMITATIONS OUTLINED HEREIN.
 - a. INCONEL (UNCOATED), MONEL (UNCOATED)
THIS WILL BE FOR ALL GENERAL LOCK WIRING PURPOSES. LOCK WIRING IS THE APPLICATION OF WIRE TO PREVENT RELATIVE MOVEMENT OF STRUCTURAL OR OTHER CRITICAL COMPONENTS SUBJECTED TO VIBRATION, TENSION, TORQUE, ETC. MONEL TO BE USED AT TEMPERATURES UP TO 700°F AND INCONEL TO BE USED AT TEMPERATURES UP TO 1500°F.
 - b. COPPER, CADMIUM PLATED AND DYED YELLOW IN ACCORDANCE WITH FED-STD-595, COLOR NOS. 13655, 23655
THIS WILL BE FOR SHEAR AND SEAL WIRING APPLICATIONS ONLY. SHEAR APPLICATIONS ARE THOSE WHERE IT IS NECESSARY TO PURPOSELY BREAK OR 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 OR USE OF A DEVICE WITHOUT INDICATION.
 - c. ALUMINUM-ALLOY ALCLAD 5056, ANODIZED AND DYED BLUE IN ACCORDANCE WITH FED-STD-595, COLOR NOS. 15102 OR 25102
THIS WILL BE USED EXCLUSIVELY FOR SAFETY WIRING MAGNETISM PARTS.
 - d. SURFACE TREATMENT WHICH OBSCURES VISUAL IDENTIFICATION IS PROHIBITED.
NOTE: ALL OF THESE WIRES ARE VISUALLY IDENTIFIABLE BY THE COLOR OF THE FINISH FOR EACH:
MONEL & INCONEL (NATURAL) COPPER (YELLOW) AND ALUMINUM-ALLOY (BLUE).
2. THE SIZE OF THE WIRE SHALL BE IN ACCORDANCE WITH THE FOLLOWING MINIMUM REQUIREMENTS:
 - a. .032 INCH MINIMUM DIAMETER 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 WITH A SPACING BETWEEN PARTS OF LESS THAN 2 INCHES; OR ON CLOSELY SPACED SCREWS AND BOLTS OF 1/4 INCH DIAMETER AND SMALLER.
 - b. COPPER (CY) .020 INCH DIAMETER, SHALL BE USED FOR SHEAR AND SEAL WIRE APPLICATIONS.
 - c. WHEN EMPLOYING THE SINGLE WIRE METHOD OF LOCKING THE LARGEST NOMINAL SIZE WIRE FOR THE APPLICABLE MATERIAL LISTED IN MS20995 WHICH THE HOLE WILL ACCOMMODATE SHALL BE USED.
3. THE DOUBLE-TWIST METHOD OF LOCK-WIRING SHALL BE USED AS THE COMMON METHOD OF LOCK-WIRING. THE SINGLE WIRE METHOD OF SAFETY-WIRING MAY BE USED IN A CLOSELY SPACED, CLOSED GEOMETRICAL PATTERN (TRIANGLE, SQUARE, RECTANGLE, CIRCLE, ETC.), ON PARTS IN ELECTRICAL SYSTEMS, AND IN PLACES THAT WOULD MAKE THE SINGLE-METHOD MORE ADVISABLE. "CLOSELY SPACED SHALL BE CONSIDERED A MAXIMUM OF TWO INCHES BETWEEN CENTERS" CAUTION: SCREWS IN CLOSELY SPACED GEOMETRIC PATTERNS WHICH SECURE HYDRAULIC OR AIR SEALS, HOLD HYDRAULIC PRESSURE, OR USED IN CRITICAL AREAS OF CLUTCH MECHANISMS AND SUPERCHARGERS SHOULD USE THE DOUBLE-TWIST METHOD OF LOCK WIRING. USE SINGLE WIRE METHOD FOR SHEAR AND SEAL WIRING APPLICATIONS. MAKE SURE THAT THE WIRE IS SO INSTALLED THAT IT CAN EASILY BE BROKEN WHEN REQUIRED IN AN EMERGENCY SITUATION. FOR SECURING EMERGENCY DEVICES WHERE IT IS NECESSARY TO BREAK THE WIRE QUICKLY USE COPPER (CY) ONLY.
4.
 - a. PARTS SHALL BE LOCK-WIRE IN SUCH A MANNER THAT THE LOCK-WIRE SHALL BE PUT IN TENSION WHEN THE PART TENDS TO LOOSEN. THE LOCK-WIRE SHOULD ALWAYS BE INSTALLED AND TWISTED SO THAT THE LOOP AROUND THE HEAD STAYS DOWN AND DOES NOT TEND TO COME UP OVER THE BOLT HEAD AND LEAVE A SLACK LOOP. (THIS DOES NOT NECESSARILY APPLY TO CASTELLATED NUTS WHEN THE SLOT IS CLOSE TO THE TOP OF THE NUT, THE WIRE WILL BE MORE SECURE IF IT IS MADE TO PASS ALONG THE SIDE OF THE STUD.) CARE SHALL BE EXERCISED WHEN INSTALLING LOCK WIRE TO INSURE THAT IT IS TIGHT BUT NOT OVER STRESSED.
 - b. IN AN ALTERNATE METHOD, THE SAFETY WIRE SHALL BE INSERTED THROUGH ONE LOCK-WIRE HOLE IN THIN-HEAD BOLTS AND PLUGS OR THROUGH ONE SET OF DIAMETRICALLY OPPOSITE LOCK-WIRE HOLES IN INTERNAL WRENCHING BOLTS. THE LOOP OF THE DOUBLE WIRE SHALL BE TAUT BUT NOT OVER STRESSED AND PASS OVER THE TOP OF THE HEAD.
5. A PIGTAIL OF 1/4 TO 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 IT FROM BECOMING A SNAG.
6. SAFETY-WIRE SHALL BE NEW UPON EACH APPLICATION.
7. WHEN CASTELLATED NUTS ARE TO BE SECURED WITH LOCK-WIRE, TIGHTEN THE NUT TO THE LOW SIDE OF THE SELECTED TORQUE RANGE, UNLESS OTHERWISE SPECIFIED, AND IF NECESSARY, CONTINUE TIGHTENING UNTIL A SLOT ALIGNS WITH THE HOLE.
8. IN BLIND TAPPED HOLE APPLICATIONS OF BOLTS OR CASTELLATED NUTS ON STUDS, THE LOCK-WIRING SHALL BE IN ACCORDANCE WITH THE GENERAL INSTRUCTIONS CONTAINED HEREIN.
9. HOLLOW HEAD BOLTS ARE SAFETIED IN THE MANNER PRESCRIBED FOR REGULAR BOLTS.
10. DRAIN PLUGS AND COCKS MAY BE SAFETIED TO A BOLT, NUT, OR OTHER PART HAVING A FREE LOCK HOLE IN ACCORDANCE WITH THE GENERAL INSTRUCTIONS CONTAINED HEREIN.
11. EXTERNAL SNAP RINGS MAY BE LOCKED IF NECESSARY IN ACCORDANCE WITH THE GENERAL LOCKING PRINCIPLES CONTAINED HEREIN. INTERNAL SNAP RINGS SHALL NOT BE LOCK-WIRED.
12. WHEN LOCKING IS REQUIRED ON ELECTRICAL CONNECTORS WHICH USE THREADED COUPLING RINGS, OR ON PLUGS WHICH EMPLOY SCREWS OR RINGS TO FASTEN THE INDIVIDUAL PARTS OF THE PLUG TOGETHER, THEY SHALL BE LOCK-WIRED WITH .020 INCH DIAMETER WIRE IN ACCORDANCE WITH THE LOCKING PRINCIPLES OUTLINED HEREIN. IT IS PREFERRED TO LOCKWIRE ALL ELECTRICAL CONNECTORS INDIVIDUALLY. DO NOT LOCKWIRE ONE CONNECTOR TO ANOTHER UNLESS NECESSARY.

THIS IS A DESIGN STANDARD. NOT TO BE USED AS A PART NUMBER.

(J) DENOTES CHANGES

P.A. NAVY - AS Other Cust ARMY - AR USAF - 11	TITLE SAFETY WIRING AND COTTER PINNING, GENERAL PRACTICES FOR	MILITARY STANDARD MS33540
PROCUREMENT SPECIFICATION NONE	SUPERSEDES:	
		SHEET 1 OF 4

DD FORM 1 MAR 72 672-1 (Coordinated)

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PROJECT NO. MISC-0053

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APPROVED 6 MAY 53

USER SYMBOLS

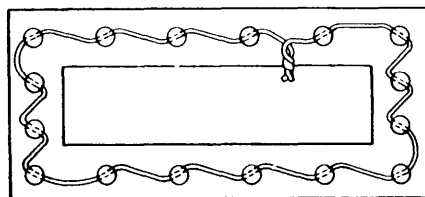
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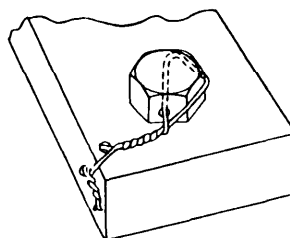
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13. LARGER ASSEMBLIES SUCH AS HYDRAULIC CYLINDER HEADS, SUPER CHARGERS, CLUTCH MECHANISMS, ETC., FOR WHICH LOCK WIRING IS REQUIRED, BUT NOT SPECIFIED, SHALL BE LOCK-WIRED IN ACCORDANCE WITH THE PRINCIPLES OUTLINED HEREIN.
14. DRILLED HEAD BOLTS AND SCREWS NEED NOT BE LOCK WIRED IF INSTALLED INTO SELF LOCKING NUTS IN ACCORDANCE WITH MS33588 OR INSTALLED WITH LOCK WASHERS IN ACCORDANCE WITH AND10476. CASTELLATED NUTS WITH COTTER PINS OR LOCK WIRE ARE PREFERRED ON BOLTS OR STUDS WITH DRILLED SHANKS BUT SELF LOCKING NUTS ARE PERMISSIBLE WITHIN THE LIMITATIONS OF MS33588.
15. FOR NEW DESIGN, LOCK WIRE SHALL NOT BE USED TO SECURE NOR SHALL IT BE DEPENDENT UPON FRACTURE AS THE BASIS FOR OPERATION OF EMERGENCY DEVICES SUCH AS HANDLES, SWITCHES, GUARDS COVERING HANDLES, ETC., THAT OPERATE EMERGENCY MECHANISMS SUCH AS EMERGENCY EXITS, FIRE EXTINGUISHERS, EJECTION SEATS, EMERGENCY CABIN PRESSURE RELEASES, EMERGENCY BOMB RELEASES, EMERGENCY LANDING GEAR DOOR RELEASES AND THE LIKE. HOWEVER, WHERE EXISTING STRUCTURAL EQUIPMENT OR SAFETY OF FLIGHT EMERGENCY DEVICES REQUIRE SHEAR WIRE TO SECURE EQUIPMENT WHILE NOT IN USE, BUT WHICH ARE DEPENDENT UPON SHEARING OR BREAKING OF THE LOCK WIRE FOR SUCCESSFUL EMERGENCY OPERATION OF EQUIPMENT, PARTICULAR CARE SHALL BE EXERCISED TO INSURE THAT WIRING UNDER THESE CIRCUMSTANCES SHALL NOT PREVENT EMERGENCY OPERATION OF THESE DEVICES.
16. THE FOLLOWING ILLUSTRATIONS ARE TYPICAL OF CORRECT LOCK-WIRE APPLICATIONS. LOCK WIRING OF TURNBUCKLES IN ACCORDANCE WITH MS33591 HAS BEEN SUPERSEDED BY MS33736 CLIP LOCKING OF TURNBUCKLES.



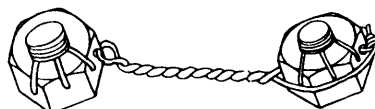
SMALL SCREWS IN CLOSELY SPACED, CLOSED
GEOMETRICAL PATTERN
SINGLE WIRE METHOD



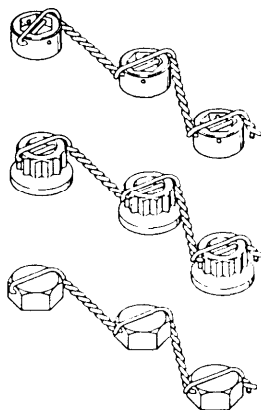
SINGLE FASTENER APPLICATION
DOUBLE TWIST METHOD



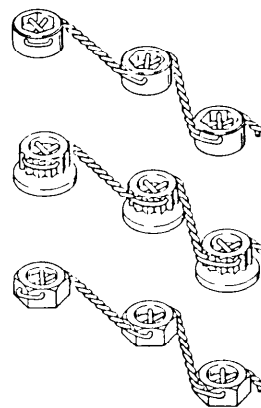
EXTERNAL SNAP RING
SINGLE WIRE METHOD



CASTELLATED NUTS ON UNDRILLED STUDS
DOUBLE TWIST METHOD



MULTIPLE FASTENER APPLICATION
ALTERNATE DOUBLE TWIST METHOD - SINGLE HOLE



MULTIPLE FASTENER APPLICATION
DOUBLE TWIST METHOD - MULTIPLE HOLE

FIGURE 1

(THE FIGURES SHOWN ON THIS STANDARD ARE FOR RIGHT HANDED THREAD APPLICATION.
LOCKING FOR LEFT HANDED THREADS WILL BE OPPOSITE.)

THIS IS A DESIGN STANDARD. NOT TO BE USED FOR PART NUMBER.

REVISED J FOR CHANGES SEE SHEETS 1 AND 3.

APPROVED 6 MAY 53

P.A. NAVY - AS Other Cust ARMY - AR USAF - 11	TITLE SAFETY WIRING AND COTTER PINNING, GENERAL PRACTICES FOR	MILITARY STANDARD MS33540
PROCUREMENT SPECIFICATION NONE	SUPERSEDES:	SHEET 2 OF 4

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17. LOCK-WIRING WIDELY SPACED MULTIPLE GROUPS BY THE DOUBLE TWIST METHOD.

- a. WHEN THE MULTIPLE FASTENERS ARE FROM 4 TO 6 INCHES APART, THREE FASTENERS SHALL BE THE MAXIMUM NUMBER IN A SERIES THAT CAN BE SAFETY WIRED TOGETHER.
- b. WHEN THE MULTIPLE FASTENERS ARE SPACED MORE THAN 6 INCHES APART, THE MULTIPLE FASTENER APPLICATION SPECIFIED IN FIGURE 1 SHALL NOT BE USED UNLESS TIE POINTS ARE PROVIDED ON ADJACENT PARTS TO SHORTEN THE SPAN OF THE WIRE TO LESS THAN 6 INCHES.
- c. WHEN THE MULTIPLE FASTENERS ARE CLOSELY SPACED, THE MAXIMUM NUMBER OF FASTENERS THAT CAN BE SAFETY WIRED TOGETHER SHALL BE THE NUMBER OF FASTENERS THAT CAN BE WIRED WITH A 24-INCH LENGTH OF WIRE.
- d. ONE END OF THE SAFETY WIRE SHALL BE INSERTED THROUGH ONE SET OF LOCKWIRE HOLES IN THE HEAD OF EACH UNIT. THE OTHER END OF THE SAFETY WIRE SHALL BE LOOPED AROUND THE HEAD TO THE NEXT SET OF LOCKWIRE HOLES IN THE SAME UNIT AND INSERTED THROUGH THIS SET OF LOCKWIRE HOLES.
- e. THE STRANDS, WHILE TAUT, SHALL BE TWISTED UNTIL THE TWISTED PART IS JUST SHORT OF THE NEAREST LOCKWIRE HOLE IN THE NEXT UNIT. THE TWISTED PORTION SHALL BE WITHIN 1/8 INCH OF THE HOLES IN EACH UNIT AS SHOWN IN FIGURE 1. CAUTION SHALL BE EXERCISED DURING THE TWISTING OPERATION TO KEEP THE WIRE TIGHT WITHOUT OVER-STRESSING IT OR ALLOWING IT TO BECOME NICKED, KINKED, OR OTHERWISE MUTILATED. ABRASIONS NORMALLY CAUSED BY COMMERCIALY AVAILABLE WIRE-TWISTING PLIERS SHALL BE ACCEPTABLE.
- f. AFTER WIRING THE LAST UNIT, THE WIRE SHALL BE TWISTED TO FORM A PIGTAIL OF THREE TO FIVE TWISTS. THE EXCESS WIRE SHALL BE CUT OFF. THE PIGTAIL SHALL BE BENT IN TOWARDS THE PART TO PREVENT IT FROM BECOMING A SNAG.

- (J) 18. SAFETY WIRE SHALL NOT COME INTO CONTACT WITH ADJACENT PARTS OR ASSEMBLIES WHEN SUCH CONTACT CAN CAUSE DAMAGE OR OPERATIONAL MALFUNCTION TO ADJACENT PARTS, ASSEMBLIES OR SAFETY WIRE.

GENERAL INSTRUCTIONS FOR THE SELECTION AND APPLICATION OF COTTER PINS:

1. THE SELECTION OF MATERIALS SHALL BE MADE FROM MS24665 AND SHALL BE IN ACCORDANCE WITH TEMPERATURE, ATMOSPHERE, AND SERVICE LIMITATIONS OUTLINED HEREIN.
2. THE TEMPERATURE AND SERVICE RESTRICTIONS ARE GIVEN IN TABLE I.

TABLE I		
	TEMPERATURE	SERVICE
MS24665 COTTER PINS CARBON STEEL	AMBIENT TEMPERATURES UP TO 450°F	NORMAL ATMOSPHERES COTTER PINS CONTACTING CADMIUM PLATED BOLTS OR NUTS
MS24665 COTTER PINS CORROSION RESISTANT STEEL	AMBIENT TEMPERATURES UP TO 800°F	NON-MAGNETIC REQUIREMENTS COTTER PINS CONTACTING CORROSION RESISTANT STEEL BOLTS OR NUTS CORROSIVE ATMOSPHERES

3. COTTER PINS SHALL BE NEW UPON EACH APPLICATION.
4. WHEN NUTS ARE TO BE SECURED TO THE FASTENER WITH COTTER PINS, TIGHTEN THE NUT TO THE LOW SIDE (MINIMUM) OF THE APPLICABLE SPECIFIED OR SELECTED TORQUE RANGE, UNLESS OTHERWISE SPECIFIED, AND IF NECESSARY, CONTINUE TIGHTENING UNTIL THE SLOT ALIGNS WITH THE HOLE: BUT DO NOT EXCEED THE HIGH SIDE (MAXIMUM) TORQUE RANGE.
5. CASTELLATED NUTS MOUNTED ON BOLTS MAY BE SAFETIED WITH COTTER PINS OR LOCK-WIRE. THE PREFERRED METHOD IS ILLUSTRATED IN FIGURE 11. AN ALTERNATE METHOD WHERE THE COTTER PIN IS MOUNTED NORMAL TO THE AXIS OF THE BOLT MAY BE USED WHERE THE COTTER PIN IN THE PREFERRED METHOD IS APT TO BECOME A SNAG.
6. WHEN MORE THAN 50 PERCENT OF THE COTTER PIN DIAMETER IS ABOVE THE NUT CASTELLATION, A WASHER SHALL BE USED UNDER THE NUT OR A SHORTER FASTENER SHALL BE USED. A MAXIMUM OF TWO WASHERS MAY BE PERMITTED UNDER A NUT.

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P.A. NAVY — AS Other Cust ARMY — AR USAF — 11	TITLE SAFETY WIRING AND COTTER PINNING, GENERAL PRACTICES FOR	MILITARY STANDARD	
		MS33540	
PROCUREMENT SPECIFICATION NONE	SUPERSEDES:	SHEET 3	OF 4

DD FORM 1 MAR 72 672-1 (Coordinated)

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7. THE LARGEST NOMINAL DIAMETER COTTER PIN LISTED IN MS24665 WHICH THE HOLE AND SLOTS WILL ACCOMMODATE SHALL BE USED; BUT IN NO APPLICATION TO A NUT, BOLT OR SCREW SHALL THE PIN SIZE BE LESS THAN THE SIZES LISTED IN TABLE II.
8. THE FOLLOWING ILLUSTRATIONS ARE TYPICAL OF CORRECT COTTER PIN APPLICATIONS.

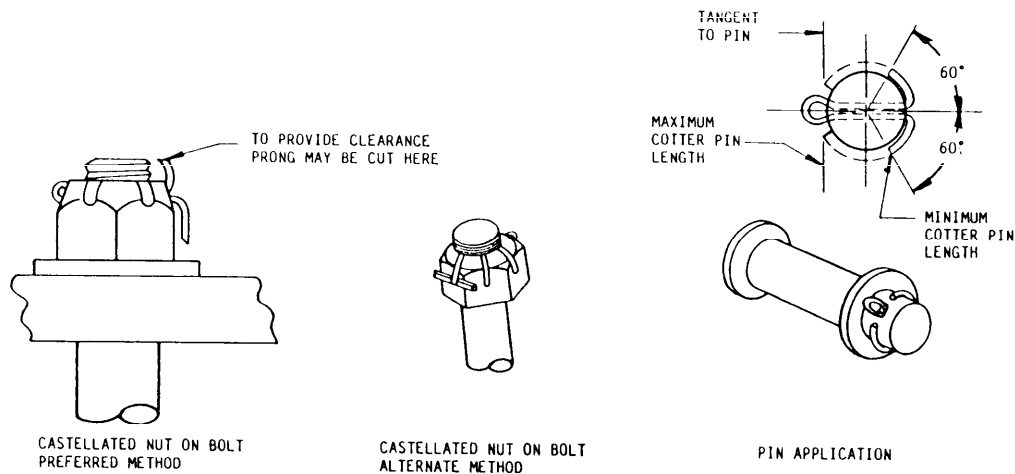


FIGURE II

9. INSTALL THE COTTER PIN WITH THE HEAD FIRMLY IN THE SLOT OF THE NUT WITH THE AXIS OF THE EYE AT RIGHT ANGLES TO THE BOLT SHANK. BEND PRONGS SO THAT THE HEAD AND UPPER PRONG ARE FIRMLY SEATED AGAINST THE BOLT.
10. IN PIN APPLICATIONS INSTALL THE COTTER PIN WITH THE AXIS OF THE EYE PARALLEL TO THE SHANK OF THE CLEVIS PIN OR ROD END. BEND THE PRONGS AROUND THE SHANK OF THE PIN OR ROD END.

TABLE II

THREAD SIZE	MINIMUM PIN SIZE
6	.028
8	.044
10	.044
1/4	.044
5/16	.044
3/8	.072
7/16	.072
1/2	.072
9/16	.086
5/8	.086
3/4	.086
7/8	.086
1.0	.086
1-1/8	.116
1-1/4	.116
1-3/8	.116
1-1/2	.116

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