# Heat Treatment

## Nitriding:

- *It is a process of introducing ( $N_2$ ) into a solid Ferrous alloy by holding at a suitable Temp. ( $T^o$ ) below ( $A_1$ ) [ 500 – 590 ºC ], for Ferritic Steels for enough time ( 40 – 100 hour ) in contact with nitrogenous material usually ( $NH_3$ ) or another Cyanide of appropriate composition:*

$$NH_3 \longrightarrow 3H + (N)$$

- *Quenching is not requested to produce a Hard Case in this process.*

- *Advantages:*
  - → *No Crack.*
  - → *high hardness [ $H_v$ (Vickers hardness ) = 1150 ].*
  - → *improve corrosion resistance.*
  - → *improve Fatigue resistance.*
  - → *hardness is un-affected by heating below ( 50 ºf ).*
  - → *clean ( no Carbon produced ).*

- *Disadvantages:*
  - → *Cost.*
  - → *long cycle required.*
  - → *technical control required.*
  - → *loss hardness if reheated for enough time.*

## Cyaniding:

- It is a process of introducing ( C + $N_2$ ) into a solid ferrous alloy by holding above ( $A_1$ ) ( 1400-1600 ºf ), in contact with molten Cyanide of suitable composition ( 30% NaCN + 40% $Na_2CO_3$ + 30% NaCl ) or by use gas atmosphere [Carbonitriding ( gas contains ( C + $N_2$ ) ].
- The Carbon percent content in the Case is lower than in Carburizing ranging from ( 0.5 – 0.8 )% C with 0.5% $N_2$ .
- Molten Cyanide decomposes in the presence of Air as follows:

$$NaCN + O_2 \longrightarrow 2\,NaNCO$$

$$4\,NaNCO \longrightarrow Na_2CO_3 + 2\,NaCN + CO + 2\,N$$

## Flame Hardening:

- It is suitable for Steel which is ( 0.3 – 0.6 )% C.
- Don't change the chemical composition of the Steel.
- Shallow hardening method.
- Selected areas of the surface of Steel are heated into ( $\gamma$ ) range and then quenched to form ( M ).
- Heat may be applied by a single Oxy- acetylene torch [ see fig. ( 22 ) below ].
- Depth of the hardened zone may be controlled by:
  - → adjustment of flame intensity.
  - → heating time.
  - → speed of travel.
- Methods used for flame hardening are:
  - → stationary ( both torch + work are stationary ).
  - → progressive [ torch moves over a stationary work piece ( W/P ) ].
  - → spinning ( torch is stationary while ( W/P ) rotating.
  - → progressive spinning ( torch moves over a rotating (W/P).

❖ Advantages of Flame hardening:
- adaptability.
- portability.
- ability to treat component after surface finishes since there is little ( Scaling, Distortion & Decarburizing ).

❖ Disadvantages of Flame hardening:
- possibility of overheating & thus damage the parts.
- difficulty in producing hardened zone < 1/16" in depth.

## Induction hardening:

❖ *It is similar to Flame Hardening except heating is produced by currents induced in a metal placed in a rapidly changing magnetic field [ see fig. ( 23 ) below ].*

❖ *When high frequency alternating currents passes through the work coil, high frequency magnetic field induces high frequency eddy currents and hysteresis currents in the metal piece.*

❖ *Heating results from the resistance of the metal piece to the passage of these currents.*

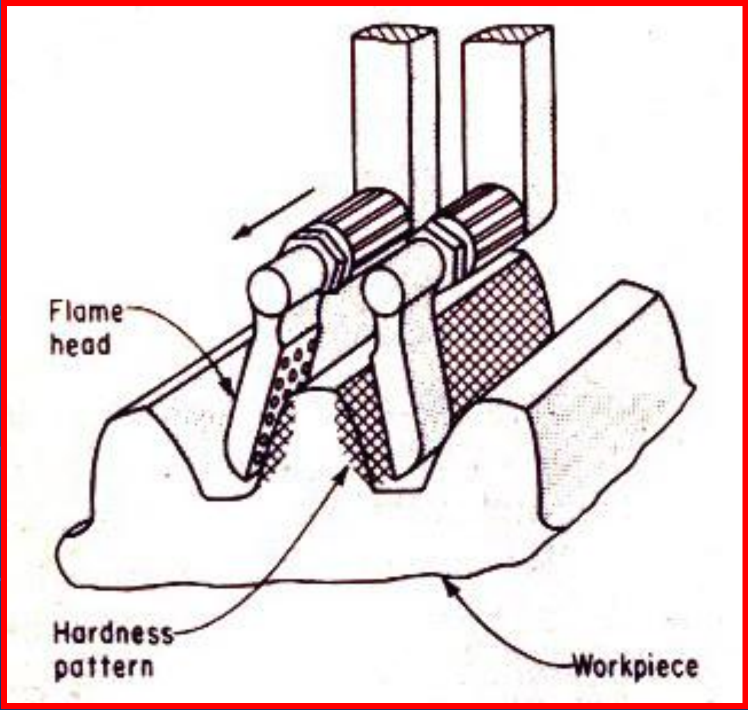


Fig. ( 22 ): Method of Flame hardening

❖ Advantages
- min. case depth with max. surface hardness.
- ability to fit the equipment directly in the production line.
- it is done automatically with unskilled labors.

❖ Disadvantages:
- Cost.

❖ Part that have been produced by induction – hardening are ( piston rods, pump shaft, spur gear & cams.

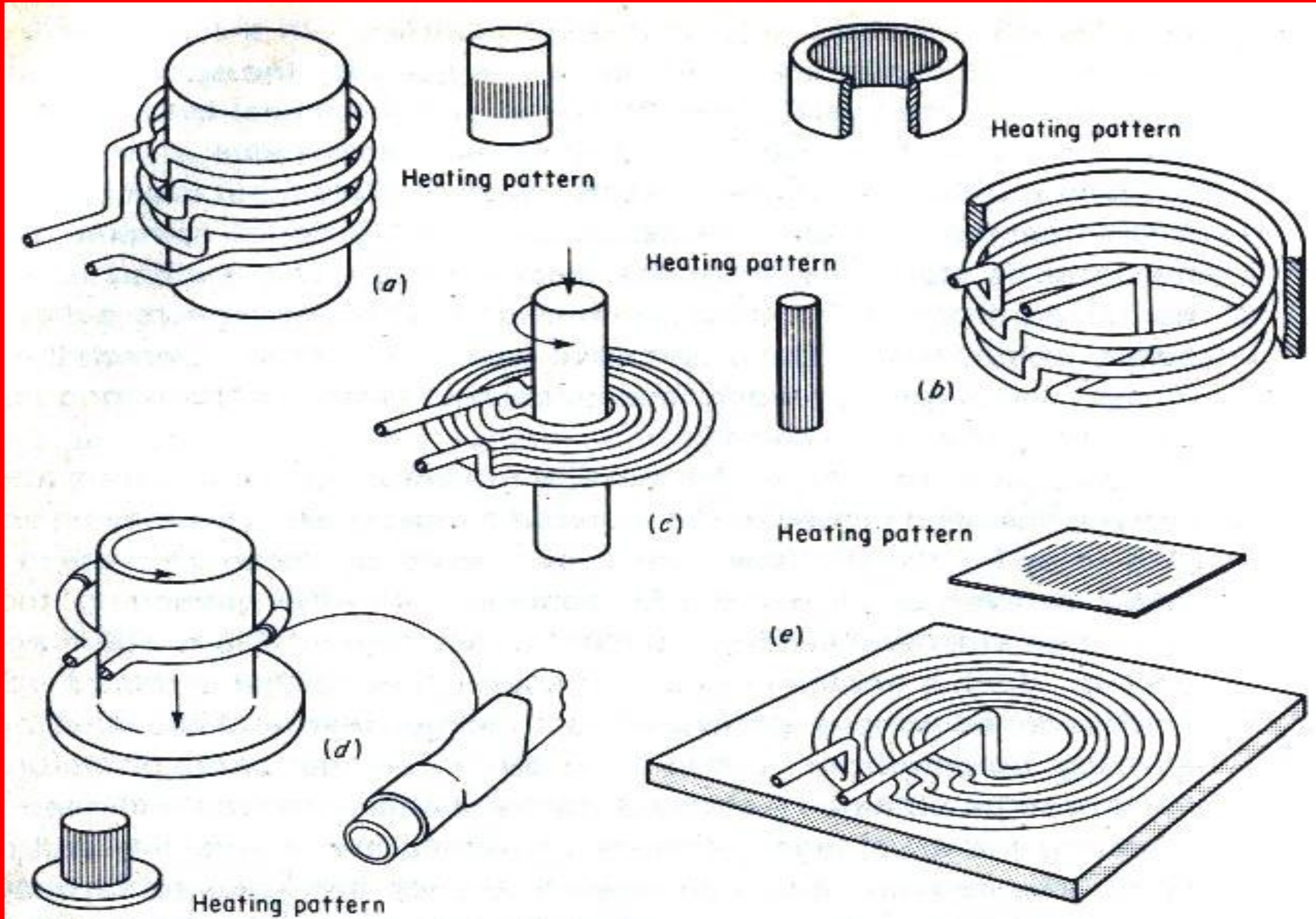


**Fig. ( 23 ): Various method of Induction hardening**