

LAP WINDING

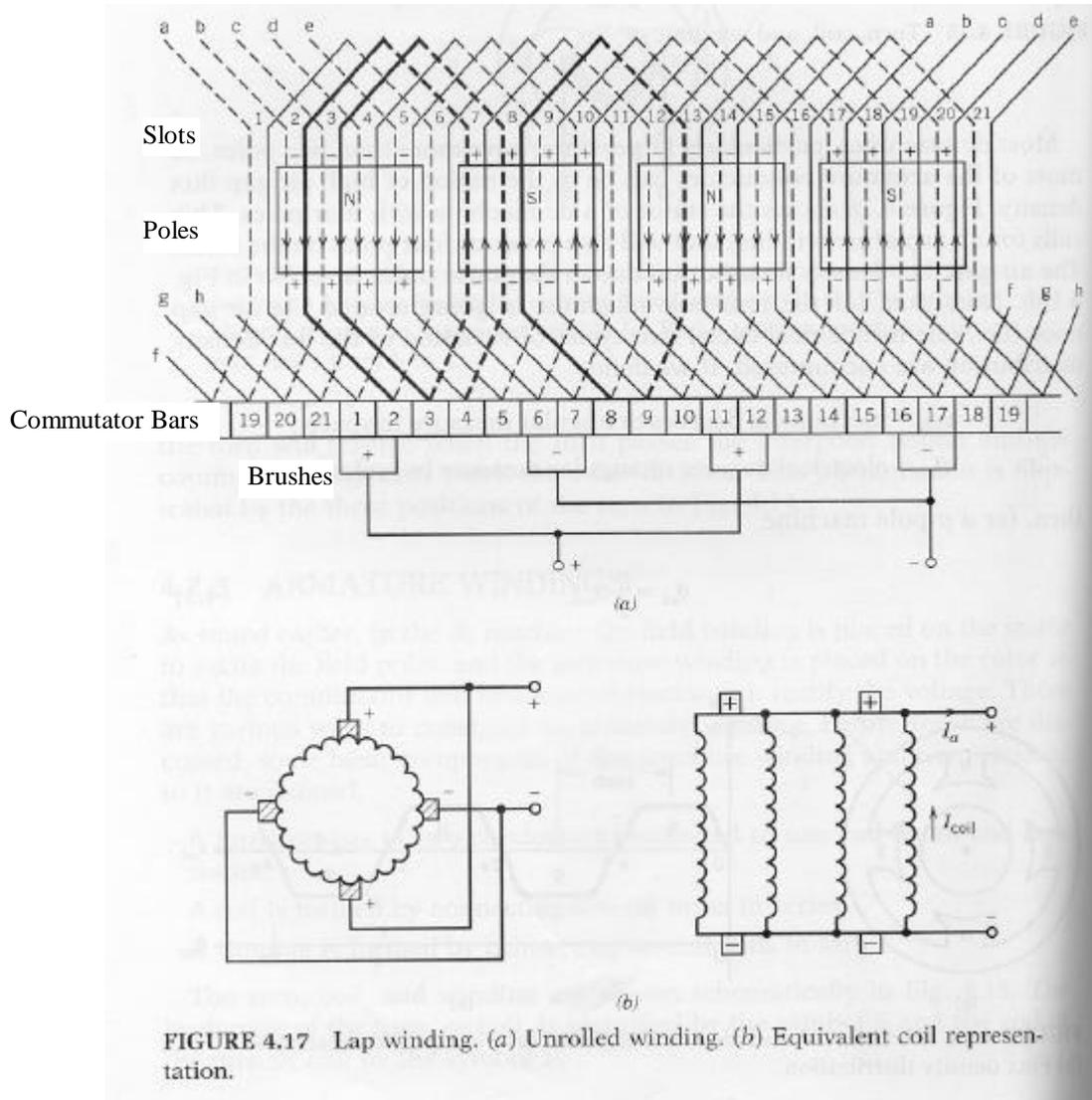


FIGURE 4.17 Lap winding. (a) Unrolled winding. (b) Equivalent coil representation.

Figure from *Principles of Electric Machines and Power Electronics*, 2nd Edition, P.C. Sen, John Wiley and Sons, 1997.

Figure represents an unrolled lap winding of a dc armature, along with the commutator segments (bars) and stationary brushes.

Coils are added in series until the end of the last coil joins the beginning of the first coil.

As the winding progresses, the coil *laps* back on itself.

In a *lap winding*, the number of parallel paths, a , is always equal to the number of poles, p , and also to the number of brushes.

When two adjacent commutator bars make contact with a brush, *one coil is shorted* by the brush in the lap winding.

Lap winding has many parallel paths; thus it is more suited to high-current, low-voltage dc machines.

WAVE WINDING

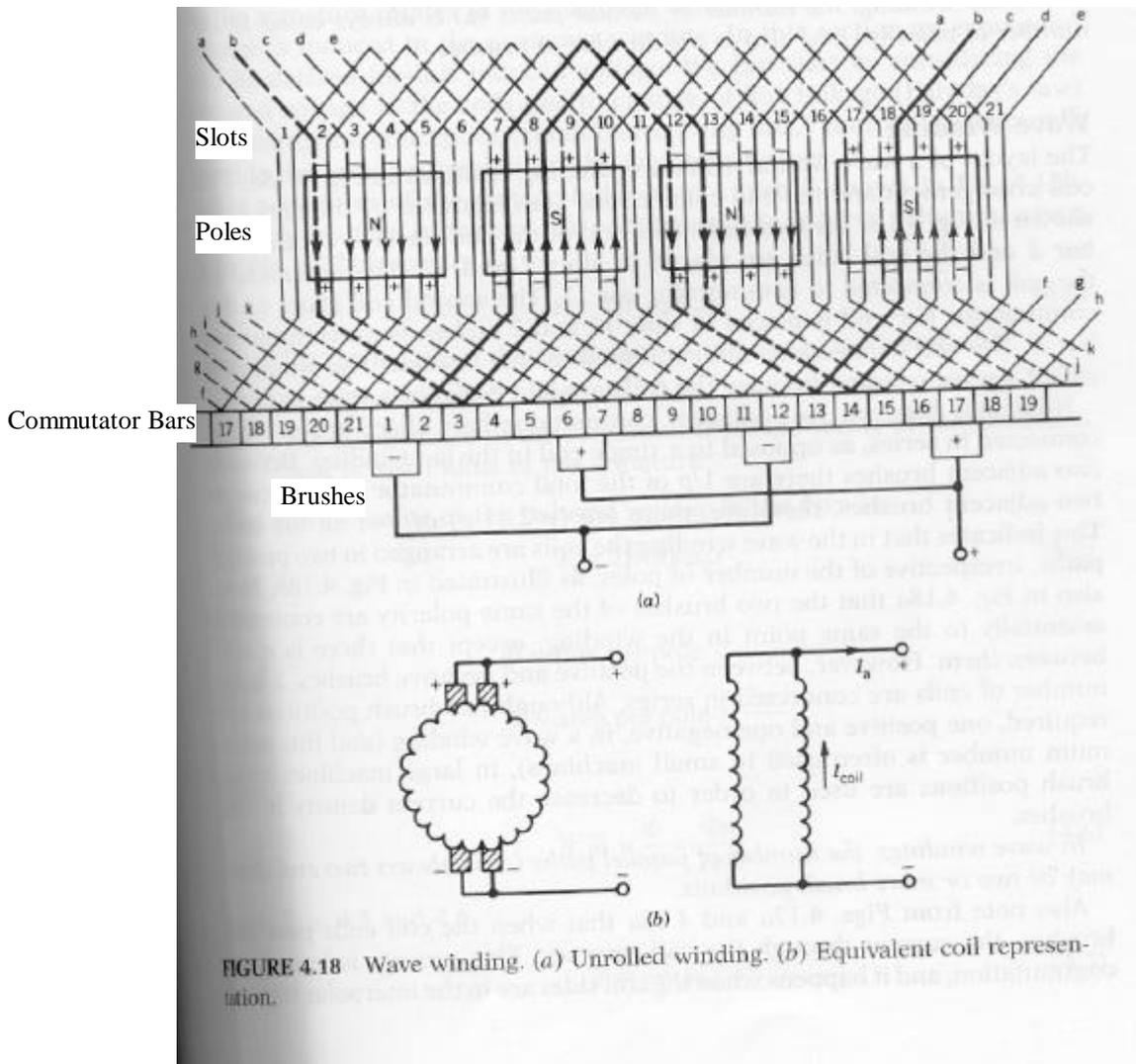


FIGURE 4.18 Wave winding. (a) Unrolled winding. (b) Equivalent coil representation.

Figure from *Principles of Electric Machines and Power Electronics*, 2nd Edition, P.C. Sen, John Wiley and Sons, 1997.

Figure represents an unrolled wave winding of a dc armature, along with the commutator segments (bars) and stationary brushes.

Coils are laid out in a wave pattern and cross all the poles.

In wave windings, the number of parallel paths, a , is always two (2), and there may be two or more brush positions.

When two adjacent commutator bars make contact with a brush, $p/2$ coils are shorted by the brush in the wave winding.

Because *wave windings* have only two parallel paths, this winding is more suited for *high-voltage, low-current* dc machines.

Voltage Rectification by Commutators and Brushes

Brushes B_1 , B_2 are stationary

Poles N, S are stationary and induce a field B in turn ab

Commutator Segments C_a , C_b rotate with armature and are in contact with brushes

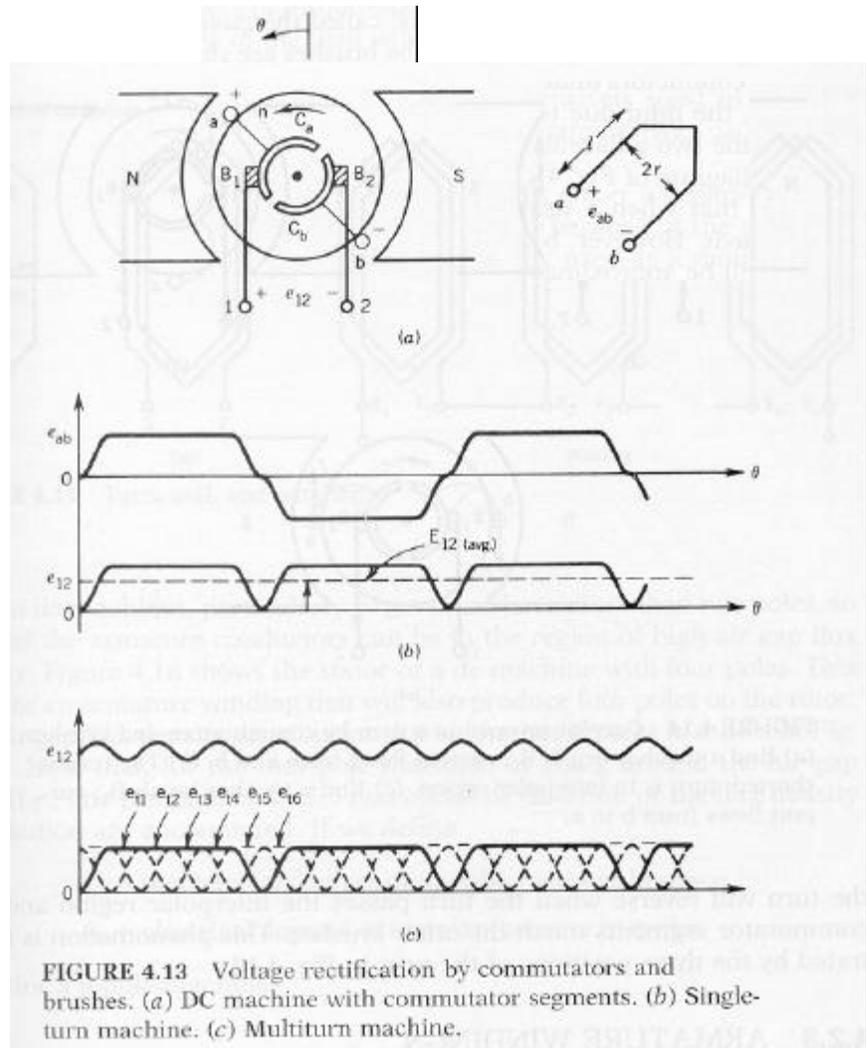
A turn, or wire, (portion of a coil on the armature) is connected to C_a and C_b

e_{ab} is the voltage induced in turn ab and is alternating (positive and negative)

e_{12} is the voltage at the brush terminals (and connection terminals to the machine) and it is unidirectional.

E_{12} is the average of e_{12}

Figure from *Principles of Electric Machines and Power Electronics, 2nd Edition*, P.C. Sen, John Wiley and Sons, 1997.



The terminal under the N pole is positive with respect to the terminal under the S pole.

Voltage e_{ab} is alternating because end a will be positive while it is under pole N and end b is positive while it is under pole S.

Brush B_1 is always connected to the positive end of the turn and Brush B_2 is connected to the negative end of the turn.

The combination of brushes and commutator act like a *rectifier* to voltage e_{ab} in producing the voltage e_{12} .

If several turns are in the armature (rotor) and they are connected in series to the commutator, this will result in a dc voltage that has less ripple.