Southwind

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EASA
The Electro•Mechanical Authority
SOUTHEASTERN CHAPTER

Electrical Apparatus Service Association
An Association of
Electric Motor Repair Shops
for Co-operative
Self-Improvement

See You in Myrtle Beach October 2!

The 2014 Annual Fall Conference of the Southeastern Chapter will take place October 2 in Myrtle Beach, South Carolina. Some of our most successful meetings have been held in this beautiful city, and we expect this year's conference to join that list. We are focusing on the technical this year, with the following seminars presented by a member of the EASA International engineering staff:

- **Root Cause: Winding & Rotor Failures**
- **Root Cause: Bearing & Shaft Failures**
- **Electrical Testing of 3-Phase Motors**

In addition to these informative classes, our meeting will feature the Vendor's Exhibit Hall, where our Affiliate Members and other vendors will offer their hospitality to you while they display their latest products.

As always, the Annual Business Meeting of the Chapter will be held in conjunction with the Fall Conference, and we strongly encourage our Active Member shops to send an authorized representative to this important meeting.

Taking Data on DC Armatures Part 1

By Leo Letourneau
Presented at the Southeastern Chapter
38th Annual Technical Forum

The LAP winding is used in most small motors, 2 pole (up to about 75 horsepower) and on most large armatures with 4 or more poles. The LAP winding can be recognized by the shape of the coil. See FIGURE LAP-1 and LAP-2. Note that the coil closes on itself making a nearly closed loop with the leads adjacent to each other on the commutator. There are two methods of connecting the coil leads or elements to the commutator in a LAP wound armature. In FIGURE LAP-1, the leads from the same coil are adjacent to each other but do not cross over each other, this commutator connection is a progressive winding, it has a clockwise coil direction if traced from bar to bar. In FIGURE LAP-2 the leads from ...

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NEW MAILING ADDRESS and PHONE NUMBERS for the Southeastern Chapter!

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1395 Hampton Locust Grove Road
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(678) 782-5961
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FIGURE LAP-1

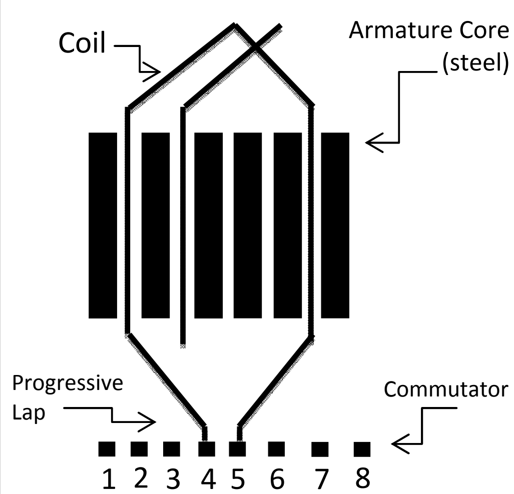


FIGURE LAP-2

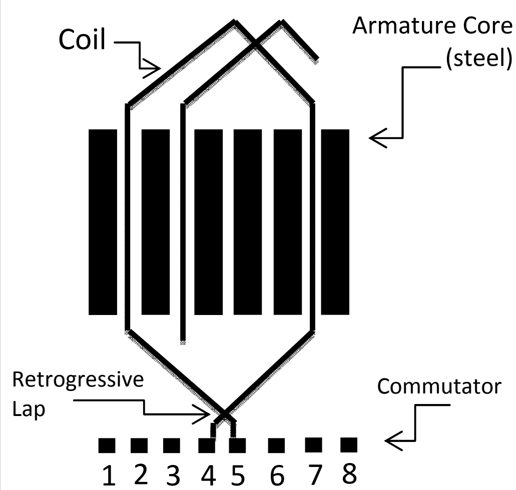
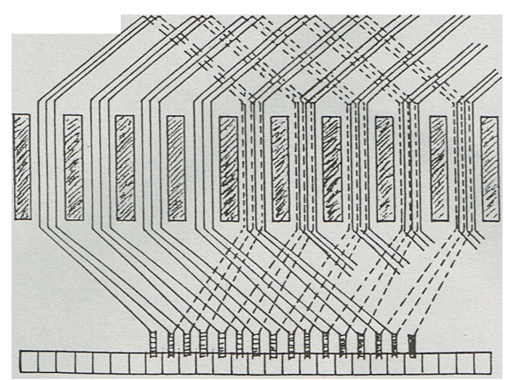


FIGURE LAP-3



…the same coil cross over each other as they enter the commutator bars and are in adjacent bars. This method of connecting the coil results in a retrogressive winding with a counter clockwise direction if traced from bar to bar. (Retrogressive LAP is seldom used in large LAP wound armatures.) Electrically, the windings are identical, whether progressive or retrogressive, but an armature with the connection different from the stripped data, will rotate in an OPPOSITE direction. Therefore, if the leads to the commutator are connected the reverse of what they were, not only will the armature rotate in reverse but the interpole will be connected INCORRECTLY, for the new rotation. This will cause sparking with load application and will result in a short winding life.

A coil may contain from one to six or more sections each insulated from the other. The sections may be a single turn or each section may have two or more turns. See FIGURE LAP-3. A SECTION is a coil of wire that has a beginning and end lead that connects to the commutator. There must be at least one commutator bar per pair of elements, or leads in a simplex LAP winding. Thus, there are twice as many section ends-leads as there are commutator bars (also called commutator segments). A single bar has at least two elements or coil ends. One lead will be an end from one coil and the other lead will be a beginning of the next coil. A single turn coil will have no winding or turn on the commutator end of the coil.

If the bars and slots are equal, then there are two coil sides per armature slot, (one left side, and one right side). If the commutator bars are twice the number of slots, then there are four coil sides per armature slot, (two left sides, two right sides). Up to twelve coil sides per slot may be found in a large armature, (six left sides, six right sides). This means that there are six times as many bars as there are armature slots in a twelve coil sides per slot armature. See FIGURE LAP-3.

In the LAP type of armature winding there are as many CIRCUITS as there are MAIN POLES. There are also as many sets of brushes as there are main poles. Thus, a 2 pole machine is a 2 circuit armature, a 4 pole machine is a 4 circuit, a 6 pole machine is 6 circuit (6 circuits in parallel), etc. UNLIKE AC motors, the NUMBER OF POLES has NOTHING TO DO WITH THE RPM of the motor. The number of turns in the armature and the commutating capacity of the machine determine the rpm.

The fact that so many circuits are in parallel in the lap winding causes problems in machines that have 4 poles or more. The difficulty lies in trying to have the parallel circuits exactly matched so that each one carries its exact portion of the total load. If this is NOT done, improper commutation results with sparking at the brushes and an inability of the motor to carry the load without overheating. A slightly different air gap between one pole and another , a variation of magnetic quality of the steel in the pole pieces, and numerous other factors difficult to control, makes it almost impossible to have the circuits (in a 4 or more pole machine) share the load equally. Some method must be found to have these unbalanced currents bypass the brushes, as the brushes are designed to carry load current and cannot carry any extra circulating currents (voltage).

To eliminate the foregoing problem, equalizers (or cross connections) are used in LAP wound armatures with four (4) or more poles. Equalizers are wires joining equipotential (equal voltage) points around the commutator, usually every third or fourth bar, or every other bar. The equalizers are placed so that at standstill the bars joined by the equalizers are under alternate brushes (brush #1 and #3, for example) which are of the SAME polarity. All the equalizers must have the same pitch (under alternate brushes) no matter how many.

The equalizer wire size of a DC armature should be about ONE THIRD to ONE HALF the size of the wire of the coil lead entering the commutator bar. This means the equalizer could occupy about 1/5 of the total slot in the commutator. In large armatures the equalizers are often tapped to the rear part of the winding. Great care must be taken to INSULATE the equalizers from the rest of the winding from each other, and to be ABSOLUTELY CERTAIN that the equalizers join points of equal potential.

Equalizers MUST close on themselves in one “trip" around the commutator. Equalizers must be EXACTLY on the half on 4 pole machines, EXACTLY on the third on 6 pole machines, EXACTLY on the quarter on 8 pole machines , etc. This value is obtained by dividing 2 by the number of poles (2/P}.

The number of equalizers used to complete a circuit constitutes a "set,” so when an equalizer starts in bar one it will end in the same bar when the last equalizer is put in place. The equalizer set in a 4 pole machine consists of 1 equalizer (on the half). For a 66 bar commutator, since the equalizers must be exactly on the half for a 4 pole armature, 66 divided by 2 = 33, (to physically span 33 bars the wire must be connected at bar 1 and bar 34), which is a pitch of 1 to 34. This one equalizer is a set for the 4 pole armature. This means that if we count EITHER clockwise or counterclockwise from a commutator bar with an end of an equalizer in it, the number of bars is equal to the other equalizer bar around either side of the commutator. See *FIGURE E0-1.*

<u>TO FIND EQUALIZER SPAN:</u>

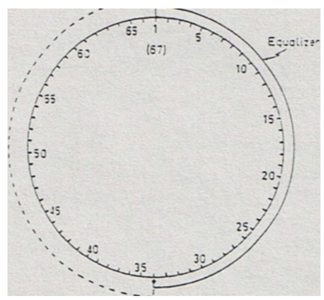
Total Commutator Bars
Poles / 2

$$\text{SPAN} \quad \frac{84}{6/2} \quad 28$$

To verify -1to 29+28 +28 =85. Therefore, bar #85 is the same as bar #1, so the equalizer pitch is correct.

EXAMPLE. An 84 bar commutator on a 6 pole LAP wound armature. Since 6 pole armatures require that the equalizers be placed on the third, 84/3 = 28. Since 28 bars must be spanned the pitch would be (1+28=29). Then 1 to <u>29+28+28</u> =85. This is correct for the 84 bar commutator, because bar #85 and bar #1 are the same. See FIGURE EQ-2.

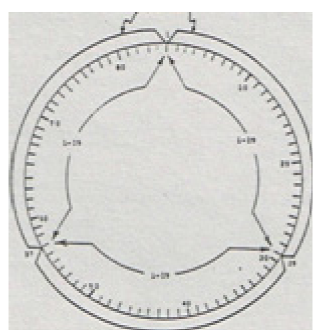
FIGURE E0-1



Equalizers for a 66 bar, 4 pole lap wound armature.

Note that equalizer is same pitch in either direction around commutator.
(Each short line represents a commutator bar.)

FIGURE E0-2



Equalizers for a 6 pole, 84 Bar, lap wound armature. Note inner arrows show 1 to 29 count.

The percentage of equalizers is determined by the fact that a tap from every bar would be 100% equalized. A 50% equalization means that every other bar has an equalizer wire in it. 33% equalization means that one out of every three bars or 1/3 the bars are equalized. 25% equalization means that 1/4 of the bars have an equalizer tap to them. Usually 25% to 33% equalization is sufficient. However, large high current armatures would require a higher percentage of equalization.

Reference materials and drawings from <u>*Direct Current Motors and Generators*</u>, by Samuel Heller, P.E., M.S.E., Permission from Datarule Publishing Company, New Canaan, Conn.

The Electro•Mechanical Authority
SOUTHEASTERN CHAPTER
Raymond K. Paden, Exec Sec/Treas
1395 Hampton Locust Grove Road
Locust Grove, GA 30248
(678) 782-5961   FAX (888) 511-6336

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Southeastern Chapter Board of Directors to Meet Soon

The annual spring meeting of the Southeastern Chapter Board of Directors is scheduled for April. If you have an item of business that you would like the board to consider, please notify the chapter office (see new address and fax number at left) as soon as possible.