The International Journal of Engineering and Science (IJES)
|| Volume || 7 || Issue || 9 Ver.IV || Pages || PP 67-74 || 2018 ||
ISSN (e): 2319 – 1813 ISSN (p): 23-19 – 1805

New Factor for Improving Designning D.C Lab Winding

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Abstract: *All designning d.c. lap winding machines have standard horse Power (hp.) only (i.e. 0 .25 ,0.33,0 .5 , 1 , 2…) but it is impossiple to design these machines in much wide domain (i.e 0.13, 0.18, 0.27, 1.2...........),because the restricting integer result of equation winding refuse to design the machine in that much wide domain leadind to restrict the values of important parameters like slots, coils & bars.The search suggests to add new factor on equation winding to accept any above parameters and to improve commutation, also its effeciency and to make sparklless as possible. Finally this new factor plays alarge important role to cancel the hardly requiements on machine in addion to that improving its specification and its power.*

Date of Submission: 15-09-2018 Date of acceptance: 01-10-2018

I. Theory

The designning windings of d.c machine are lab , wave and frog leg types. The difference between them in the way of connecting the finishing coils to the commutator bars [1] ,
and the generar coil rules of all these types are the same and depends on demanding design of each one like (coil span ((Y_s) , pole pitch (Y_p) , coil pitch (Y_c) , number of coils (C)......and so on).

$(Y_c) = C/p = 180°$….in full pitch..(1) used in all types.
where C and P are no. of coils and poles respectivlly.
$(Y_s) = (S/p) – K = 180°$ or $\approx 180°$ for full or fractional pitches respectivelly...(2) used in all types

where S is the number of slots , K = 1, 2, 3...... to make Ys integer [2].

$\theta t = 180P$ where θt, P are total angle around the armature and number of poles respectivlly.

$(Y_{avg.}) = (Z/p) \pm m = (Y_B+Y_F)/2 \approx Y_B$..(4)

where Y_{avg} , Z & m are the avarege pitch & n0. of coil sides and multiplicity facter respectivlly.
+ means progrresive [i.e back pitch (Y_B) > 〖front pitch (Y〗_f)] & - is retrogrresive [〖i.e.Y〗_B < 〖Y〗_F]
i.e. Y_(B =) (or≈) θ_(t/P) or,
Y_ave. = (or ≈ 〖)θ〗_(t/P) = Y_B .... (5)
m ………….(6) .where + for progressive (Y_(B)> Y_F)& - for retrogressive (Y_(B)< Y_F) Y_(B)= Yf ±
In lab type winding, the commutator pitch (Y_com) equal to 1 ,2 ,3 ,4 ....i .e. simplex , doublex
triplex, quaderlex and so on depending on the degree of multiplicity factor, so Y_com = ± (1 , 2 , 3 ,4....) where Y_com is the commutater pitch, or
$Y_{com} = \pm m$ where m is the multiplicity factor[3].
If the starting winding starts from bar to bar, so the entire winding must be traced from coil side of one coil to coil side of another befor closure occurs, that is befor the winding reentres [4].

After one complete tracing around the commutator the connection with first bar is after or before it, the after means prorgressive and before means retrogressive.If the number of bar in after case equal one, two,three, four ...this is mean that we have simplex, doublex, triplex and so on (i.e.clockwise direction) respectivlly, the same thing happens in retrrogressive case (i.e anticlock- -wise direction) [4]. The simplex, douplex, triplex & quiderlex...act, have one, two, three and four degrees of reentrances (R) respectivelly [4]. The no. of parallel paths (a) in lab winding is equal to:- a = mp..........(7).

In the case of wave type the commutator pitch (Y_com) approximatly equal to 360° (not exact.), because if Y_com equal exact 360° it is impossible to complete the connecting of total windings.

Some times it is better to take more than one group of coils for obtainning more one of reentraces.
The reentrancy (R) is the group of coils that consistute to form closed circiut winding.[5]. The coil pitch (Yc) of wave type is calculated as follow:-

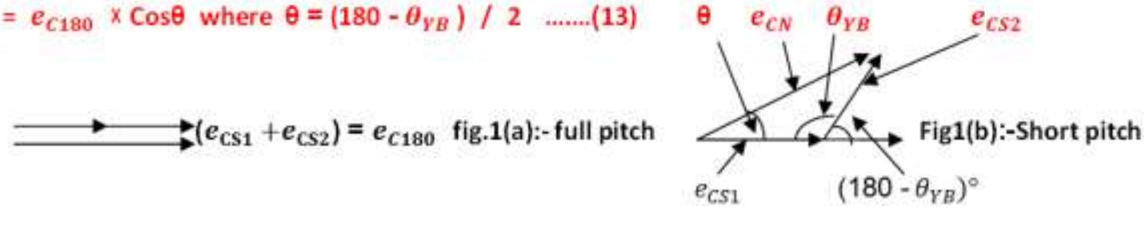
$Y_c = (C \pm m)/(P/2)$ ....(8)

where C , P & m are no. of coils, poles & multiplicity factor respectivelly and m = ± (1, 2 , 3 , 4.....) where (+, -) means progressive & retrogressive respectivelly. Also (1 ,2 , 3, 4...........) are simplex, douplex,triplex & quaderlex respectivelly and so on. Yc must be integer in equation no. 1 above so there is restrection on selection of bars. By the same way of a lab above the starting wave coils starts from bar to bar, so the entire winding must be traced from coil side of one coil to coil side of another befor closure occurs and the winding return back upon it self. Also after one complete tracing around the commutator the connection with first bar is after or before it, the after means prorgressive& before means retrogressive[6]. The no. of bars must be selected with relation to the no. of poles,that the commutator pitch Y_c can be made alittle more or less than two pole pitches[7].
The no. of parallel paths (a) in simplex wave winding is only two regardless of poles. The conductors in each of two paths of wave winding are distributed under all the poles, so wave wound need two sets of brushes only .If the brush sets as poles, so one or more of the satisfactrory operation is still possible,that is not true in wound machine [8]. The sparkless commutation of wave wound is more to occur than lab wound. The reason for this that each of two parallel paths in lap winding contains condoctors distributed compeletly around the entire circumferance under two poles only. If fluxes Produced by all the poles are not exactly the same, the voltages generated in both of the paths of the lab type are not the same but wave type are still exactly equal because the two pathes are affacted similarly. The designers have attempted to use multiplex wave winding, such windings have (2*plex) paths in parallel regardless no.of poles[9].The total electrical angle (θt) around the armature and the slot angle (θs) and bar angle (θc) are equal to:-

$\theta t = (180P)°$...(9) $\theta s = (\theta t/C)°$....(10) $\theta c = \theta t/C_{om}$....(11) $e_p = e_{CN} * C/a = Ip*Zp$........(12)

Where θt ,θs and θc are (total, slot and commutator) angles may C, C_{om} and P are no. of coils, bars and poles also e_p, e_{CN} are induced emfs around path and coil [10]. If the coils having span which is equal to one pole pitch i.e.spanning over 180° (ele.degree) this is mean that we have full pitched winding and the voltage is max. around the coils. But if the coils have spanning less or more one pole pitch, this is mean that we have short pitch winding and the voltage is less and not max. around the coils. The short case is used to save the copper and to improve the waveform to approximate to sin wave also to reduce the distorting harmonicse and to decrease the iron loss i.e. increasing efficiency.
For full pitch the total voltage around the coil is e_{c180} and it is equal to algebraic summation of two induced emfs of two coil sides of the same coil (e_(C!) , 〖e〗_C2 180 between them), but at short pitch the Y_B more or less 180° and the total voltage around this coil is e_{CN} look equation 13 & fig.1(a,b)…[11] .

$e_{CN} = e_{C180} \times \cos\theta$ where $\theta = (180 - \theta_{YB})/2$ ....(13)



$e_c = I_c*Z_c$......(14) $e_p = I_p*Z_p$.......(15) $P_t = I_t*e_p$......(16) $e_{Cs1} = e_{Cs2}$...........[11]
If all the conditions of coils are same (i.e. size, no.of turns…), the Z_c ,Z_p become constants also. [12]
It is clear also that when θ_{YB} = exact 180 (i.e.θ = 0) ,so $e_{CN} = e_{C180}$ look equation 13 above [12],

II. The working

The new proposed additional factor k_1 is proposed to use in above equation (no.5) as follow :-
$Y_B=[(\theta t/P) \pm K_1*\theta s]°$…….(17) for even coils only……….K_1=0,1,2,3.where Y_B is back pitch.
The perpose of using θ_s is to consolidation the units, Y_B is measured by electrical degree .
(+ &-)for Y_B is more and less 180° respectivlly (i.e changing emf or power machine)
$Y_B=[K_1*\theta t/c]°$……………...(18) for odd coils only…..………………… ……...$K_1 \neq 0$ & =1,2,3....
But Y_B = YF ± m ……….equation 6 above ,(+) for progressive &(-) for retrogressive respectivlly, so

Y_(f)= [(θt/P) ± K_1 θ_(S)± 〖m* θ〗 _S]°... for even coils.... (19). where (Y_(f)) is front pitch, m is multiplicity factor ,or
Y_(f)=([K_1*θt/c]°± 〖m* θ〗 _S)°.. for odd coils.......(20) , where θ_t ,θ_(S)are total ,slot angles respectivelly,

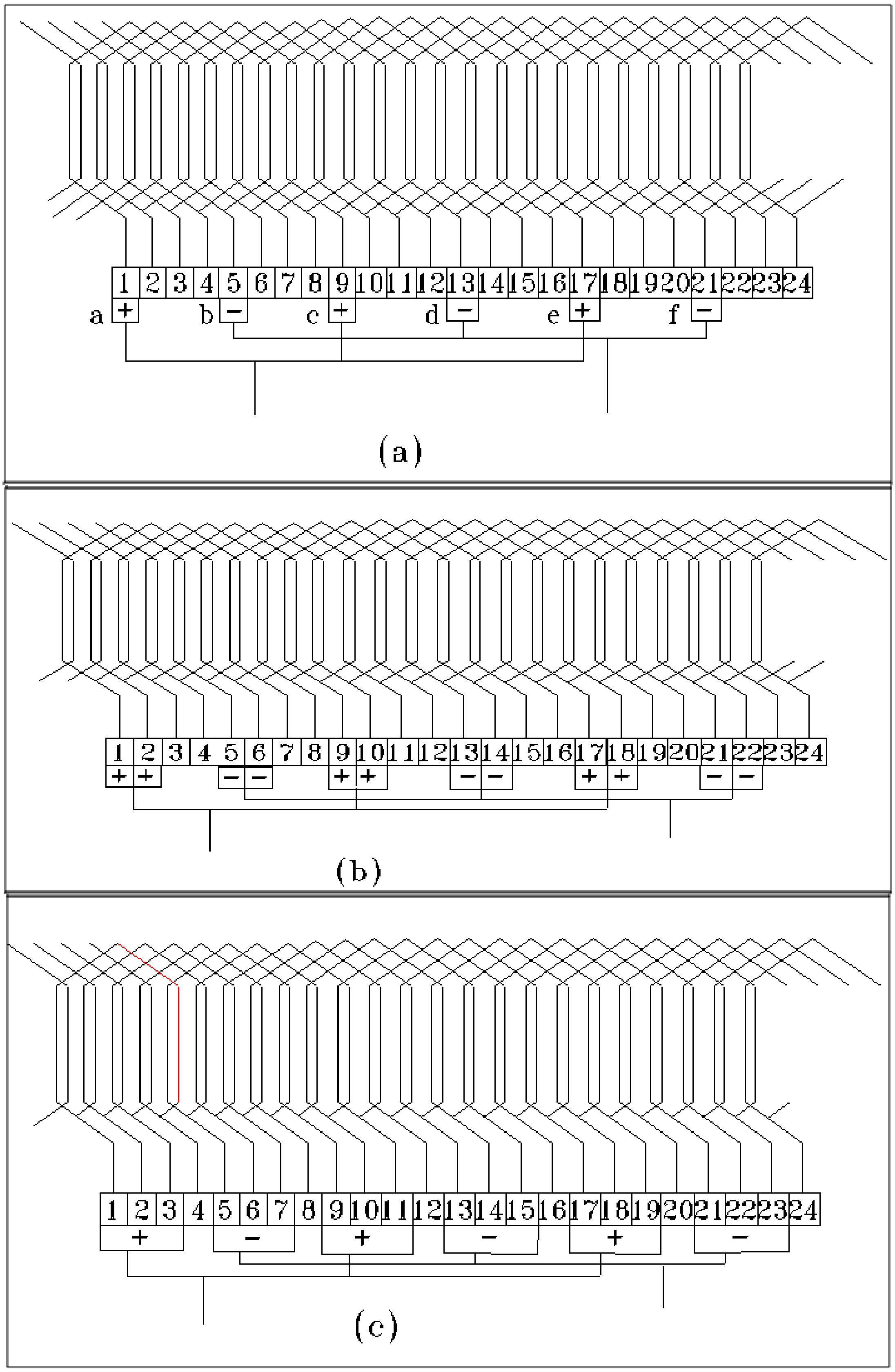
Meannings of symbols used							
word	meanning	word	meanning	word	meanning	word	meanning
C	No.of coils	P	No.of poles	a	No.of parallel paths	R	No.of circles(no.of reentrances)
Zc	Conductors impedance	Zp	Paths impedance	Ycom	Commutator pitch	m	Multiplicity factor
e_{C180}	coils induced emf $e_{C180}=\theta_{YB}$ = exact 180°	e_{CN}	Coils induced emf at (θ_{YB} = or ≠180°)	e_p	Path emf	I_p	Path current
P_p	Paths power	P_t	Total power	θ_{YB}	Back pitch angle	θ_{YF}	Front pitch angle
B	No.of brushes	B_s	Brush Width	P_C	Conductor power	C_{om}	No.of bars
K1	new proposed additional factor	θ	$(180-\theta_{YB})/2$	θt	Total angle around armature	θ_S	Angle between two adjacent slots
YB	Back pitch	YF	Front pitch	Z	No.of coil sides	Y_{avg}	average pitch

At same coil conditions (size, lenth, type & turns) it is possible to suppose that Z_c ,Z_p are unity constants.
At θ_YB = 180 exact (since θ = 0 and e_(CN =) e_C180), so If we suppose that e_C180 = unity then each one of:-
e_CN, I_CN & P_CN equal unity also ....look equation 13 above.

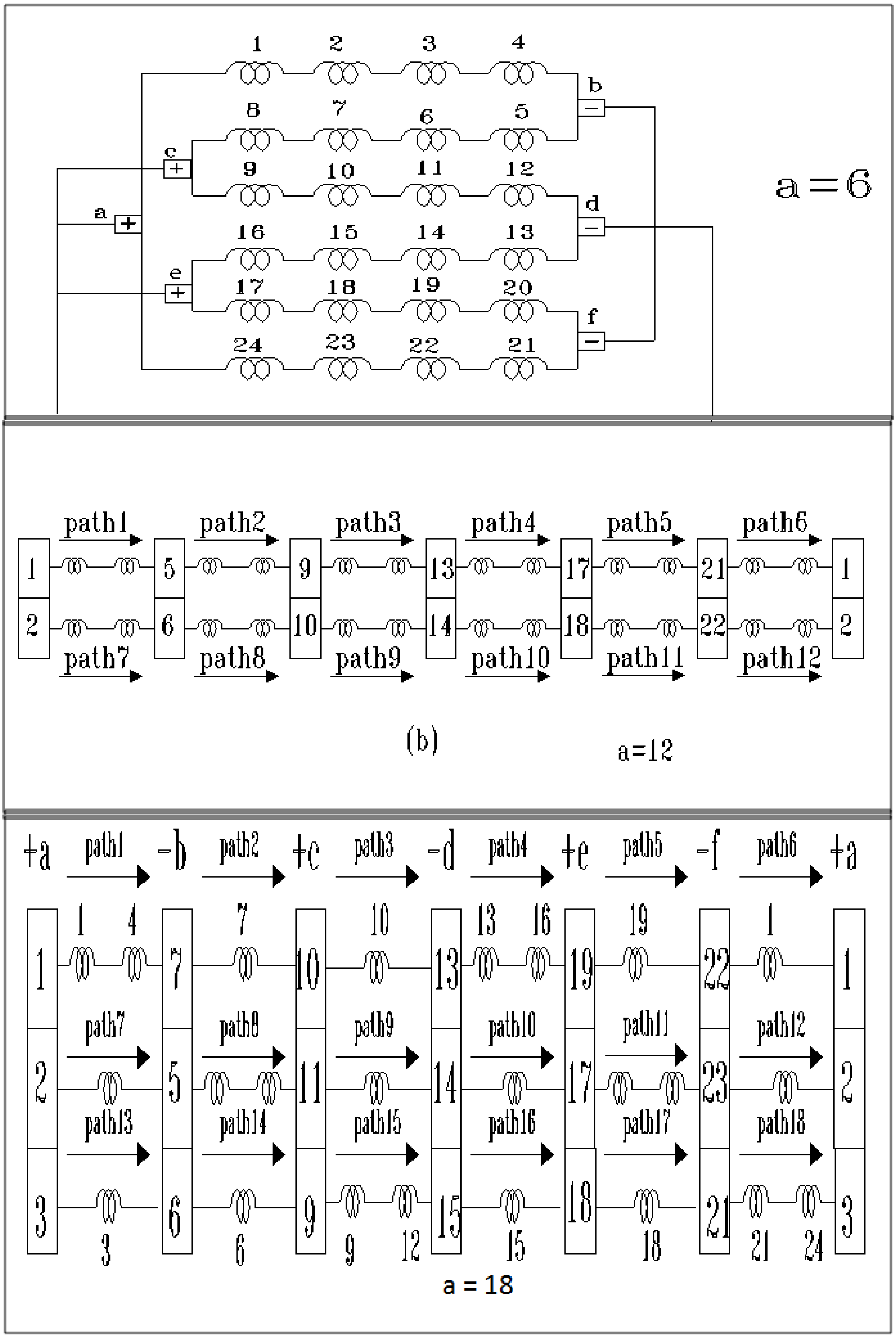
Table (1) shows K_1 against back pitch (Y_(B)) at specified number of coils and pols

C=25(i.e.odd coils) P=4 θt=180P=720° θs=θt/C=28.8° $Y_B = K_1 * \frac{\theta t}{c}$											
K_1	0	1	2	3	4	5	6	7	8	9	10
Y_B		28.8°	57.6°	86.4°	115.2°	144°	172.8°	201.6°	230.4°	259.2	288°
C=24(i.e.even coils) P=4 θt=180P=720° θs=θt/C=30° $Y_B = \left(\frac{\theta t}{P}\right) \pm K_1 * \theta s$											
K_1	0	-5	-4	-3	-2	-1	0	+1	+2	+3	+4
Y_B	180°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°
C=25 P=6 θt=180P=1080° θs=θt/C=43.2°											
K_1	0	1	2	3	4	5	6	7	8	9	10
Y_B		43.2°	86.4°	129.6°	172.8°	216°	259.2°	302.4°	345.6°	28.8°	72°
C=24 P=6 θt=180P=1080° θs=θt/C=45°											
K_1	0	-3	-2	-1	0	+1	+4	+5	+6	+7	+8
Y_B	180	45°	90°	135°	180°	225°	360°	405°=45°	450°=90°	495°=135°	540°=180°
C=25 P=8 θt=180P=1440° θs=θt/C=57.6°											
K_1	0	1	2	3	4	5	6	7	8	9	10
Y_B		57.6°	115.2°	172.8°	230.4°	288°	345.6°	43.2°	100.8°	158.4°	216°
C=24 P=8 θt=180P=1440° θs=θt/C=60°											
K_1	0	-2	-1	0	+1	+2	+3	+4	+5	+6	+7
Y_B	180	60°	120°	180°	240°	300°	360°	420°=60°	480°=120°	540°=180°	600°=240°
C=25 P=12 θt=180P=2160° θs=θt/C=86.4°											
K_1	0	1	2	3	4	5	6	7	8	9	10
Y_B		86.4°	172.8°	259.2°	345.6°	72°	158.4°	244.8°	331.2°	57.6°	144°
C=24 P=12 θt=180P=2160° θs=θt/C=90°											
K_1	0	-1	0	+1	+2	+3	+4	+1 or +5	+2 or +6	-1 or +7	0 or +8
Y_B	180	90°	180°	270°	360°	450°=90°	540°=180°	270°	360°	90°	180°

For each item of table above we take Y_com = ± (1, 2, 3, 4, 5..) for satisfying simplex, doublex, triplex...
where (+) & (-) for progressive & retrogressive respectivlly



Fig(2) -: 6p, 24 Coil , double layer progressive, lap Winding
(a)simplex, (b) doublex, (c) triplex design



Fig(3) :-Schematic diagram of 6 pole, 24 coil, double layer progressive lap winding
(a) simplex (b) doublex (c) triplex

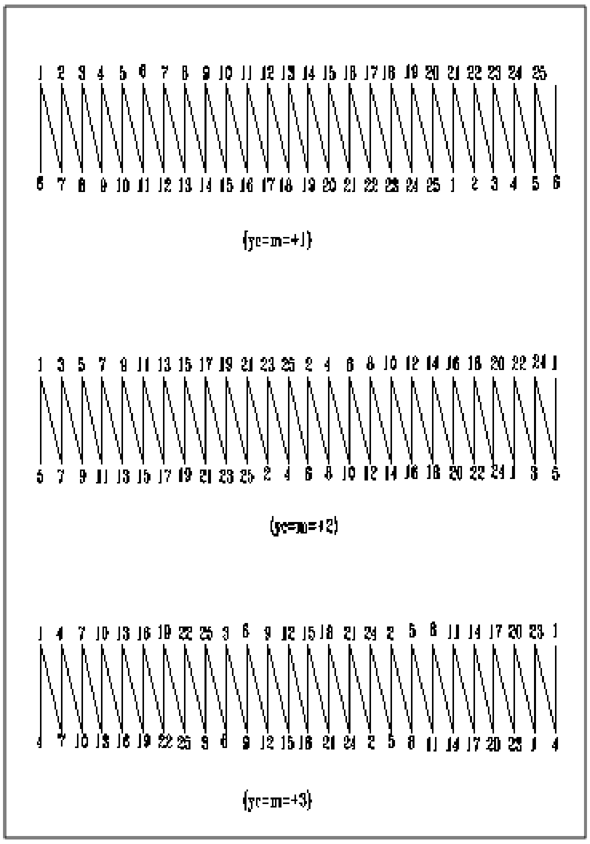
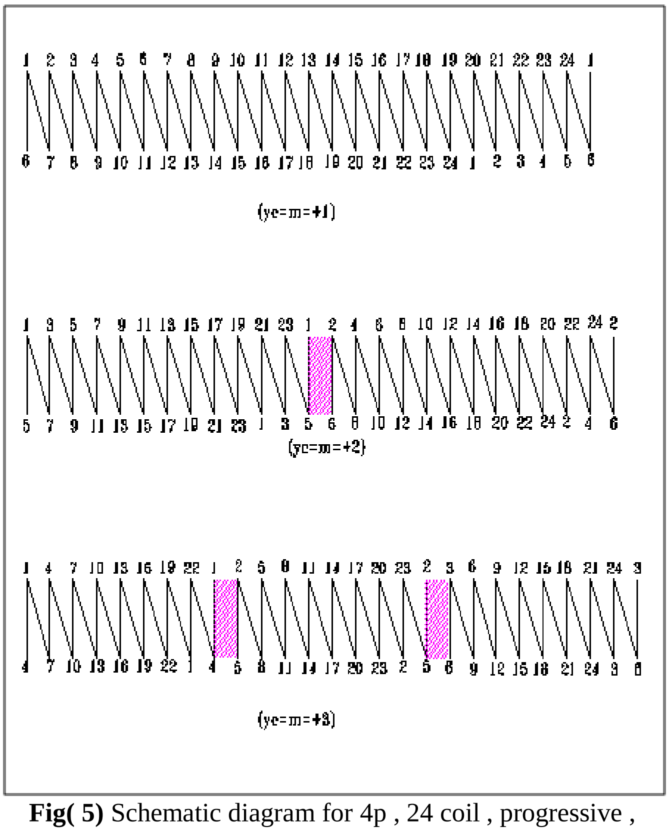


Fig (4) Schematic diagram for 4p, 25 coil, progressive, lap winding
(a) simplex (b) doublex (c) triplex



Fig(5) Schematic diagram for 4p , 24 coil , progressive ,
(a) simplex (b) doublex (c) triplex

Table (2) shows affecting K_1 on active elements of machine.

C=24(even), θt=180P, θs=θt/C, $Y_b = \left(\frac{\theta t}{P}\right) \pm K_1 * \theta s = \theta_{YB}$, $Y_p = Y_F \pm m * \theta s$, $Y_F = \theta_{YF}$, θ=(180 - θ_{YB})/2,
$e_{CN} = e_{C180}$ *Cos θ, $e_p = e_{CN}$ *C/a, $e_{CN} = I_{CN} * Z_{CN}$, $P_{CN} = e_{CN} * I_{CN}$, $I_p = e_p / Z_p$, $P_p = e_p * I_p$, $P_t = P_p$ *a
At same conditions of coils(no. of coils size,...) so Z_p , Z_c are remains constants also [Z_p , Z_c= k (unity for exampl.)]
At θ_{YB} = exact 180°, hence $e_{CN} = e_{C180}$. If we assume e_{C180} = unity then e_{CN}, I_{CN} & P_{CN} equal unity also

P, a	m	θt°	θs°	K1	θ_{YB}	θ_{YF}°	θ°	e_{C180}	B	Bs	e_{CN}	I_{CN}	e_p	I_p	P_{CN}	P_p	P_t
4, 4	+1	720	30	o	180	150	0	1	4	1s	1	1	6	6	1	36	144
4, 4	-1	720	30	0	180	210	0	1	4	1s	1	1	6	6	1	36	144
4, 8	+2	720	30	0	180	120	0	1	4	2s	1	1	3	3	1	9	72
4, 8	-2	720	30	0	180	240	0	1	4	2s	1	1	3	3	1	9	72
4, 12	+3	720	30	0	180	90	0	1	4	3s	1	1	2	2	1	4	48
4, 12	-3	720	30	0	180	270	0	1	4	3s	1	1	2	2	1	4	48
4, 16	+4	720	30	0	180	60	0	1	4	4s	1	1	2	2	1	4	64
4, 16	-4	720	30	0	180	300	0	1	4	4s	1	1	2	2	1	4	64
4, 20	+5	720	30	0	180	30	0	1	4	5s	1	1	1	1	1	1	20
4, 20	-5	720	30	0	180	330	0	1	4	5s	1	1	1	1	1	1	20
4 4	+1	720	30	-1	150	120	15	1	4	1s	0.96	0.96	4.8	4.8	0.93	23.3	93.3
4 , 4	-1	720	30	-1	150	180	15	1	4	1s	0.96	0.96	4.8	4.8	0.93	23.3	93.3
4, 8	+2	720	30	-1	150	90	15	1	4	2s	0.96	0.96	1.93	1.93	0.93	3.7	29.8
4, 8	-2	720	30	-1	150	210	15	1	4	2s	0.96	0.96	2.9	2.9	0.93	8.4	67.1
4, 12	+3	720	30	-1	150	60	15	1	4	3s	0.96	0.96	1.93	1.93	0.93	3.73	44.8
4, 12	-3	720	30	-1	150	240	15	1	4	3s	0.96	0.96	1.93	1.93	0.93	3.73	44.8
4, 16	+4	720	30	-1	150	30	15	1	4	4s	0.96	0.96	0.96	0.96	0.93	0.93	14.9
4, 16	-4	720	30	-1	150	270	15	1	4	4s	0.96	0.96	0.96	0.96	0.93	0.93	14.9
4, 4	+1	720	30	+1	210	180	15	1	4	1s	0.96	0.96	4.8	4.8	0.93	23.3	93.3
4, 4	-1	720	30	+1	210	240	15	1	4	1s	0.96	0.96	4.8	4.8	0.93	23.3	93.3
4, 8	+2	720	30	+1	210	150	15	1	4	2s	0.96	0.96	2.89	2.89	0.93	8.39	67.1
4, 8	-2	720	30	+1	210	270	15	1	4	2s	0.96	0.96	2.89	2.89	0.93	8.39	67.1
4, 12	+3	720	30	+1	210	120	15	1	4	3s	0.96	0.96	1.93	1.93	0.93	3.73	44.8
4, 12	-3	720	30	+1	210	300	15	1	4	3s	0.96	0.96	1.93	1.93	0.93	3.73	44.8
4, 16	+4	720	30	+1	210	90	15	1	4	4s	0.96	0.96	0.96	0.96	0.93	0.93	14.9
4, 16	-4	720	30	+1	210	330	15	1	4	4s	0.96	0.96	0.96	0.96	0.93	0.93	14.9
4, 4	+1	720	30	+2	240	210	30	1	4	1s	0.866	0.866	3.46	3.46	0.75	13.8	55.4
4, 8	+2	720	30	+2	240	180	30	1	4	2s	0.866	0.866	1.73	1.73	0.75	3.46	27.7
4, 12	+3	720	30	+2	240	150	30	1	4	3s	0.866	0.866	0.866	0.866	0.75	0.75	9
4, 4	+1	720	30	-2	120	90	30	1	4	1s	0.866	0.866	3.46	3.46	0.75	13.8	55.4
4, 4	-1	720	30	-2	120	150	30	1	4	1s	0.866	0.866	3.46	3.46	0.75	13.8	55.4
4, 8	-2	720	30	-2	120	180	30	1	4	2s	0.866	0.866	1.73	1.73	0.75	3.46	27.7
4, 12	-3	720	30	-2	120	210	30	1	4	3s	0.866	0.866	0.866	0.866	0.75	0.75	9
6, 6	+1	1080	45	-1	135	90	22.5	1	6	1s	0.9	0.9	2.77	2.77	0.85	7.68	46
8, 8	-1	1440	60	0	180	240	0	1	8	1s	1	1	3	3	1	9	72
6, 12	+2	1080	45	-1	135	45	22.5	1	6	2S	0.9	0.9	0.9	0.9	0.85	0.85	10.4
8, 16	-2	1440	60	0	180	300	0	1	8	2S	1	1	2	2	1	4	64
8, 24	-3	1440	60	0	180	360=0	0	1	8	3S	1	1	1	1	1	1	24
6, 18	-4	1080	45	-1	135	315	22.5	1	6	4S	0.9	0.9	0.9	0.9	0.9	0.9	15.4
6, 6	+1	1080	45	-1	135	90	22.5	1	6	1s	0.9	0.9	2.77	2.77	0.85	7.68	46

P, a	m	θt°	θs°	K1	θ_{YB}	K2	θ_{YF}°	θ°	e_{C180}	B	Bs	e_{CN}	I_{CN}	e_p	I_p	P_{CN}	P_p	P_t
6, 6	-1	1080	45	- 1	135	4	180	0	1	6	1s	1	1	3	3	1	9	54
6, 6	+2	1080	45	-1	135	1	45	22.5	1	6	2s	0.9	0.9	0.9	0.9	0.85	0.85	10.4

Table(3)

C=25(odd), θt=180P°, θs=[θt/C]°, $Y_b = [K_1 * \frac{\theta t}{P}]° = \theta_{YB}$, $Y_p = [Y_F \pm m*\theta s]°$, $Y_F = \theta_{YF}$° θ=[(180 - θ_{YB})/2]°,
$e_{CN} = e_{C180}$ *Cos θ, $e_p = e_{CN}$ *C/a , $e_{CN} = I_{CN} * Z_{CN}$, $I_p = e_p / Z_p$, $P_{CN} = e_{CN} * I_{CN}$, $P_p = e_p * I_p$, $P_t = P_p$ *a
At same conditions of coils(no.of coils,...), so Z_p , Z_c are also remains constants [i.e. Z_p , Z_c= k (unity for example.)]
At θ_{YB} = exact 180° only , hence $e_{CN} = e_{C180}$. If we assume e_{C180} = unity then e_{CN} , I_{CN} & P_{CN} equal unity also
P and a are no. of poles and parallel paths respectivelley

P, a	m	θt°	θs°	K1	θ_{YB}	θ_{YF}°	θ°	e_{C180}	B	Bs	e_{CN}	I_{CN}	e_p	I_p	P_{CN}	P_p	P_t
4, 4	+1	720	28.8	6	172.8	144	3.6	1	4	1s	0.99	0.99	5.9	5.9	0.99	35.8	143.4
4, 4	-1	720	28.8	6	172.8	201.6	3.6	1	4	1s	0.99	0.99	5.9	5.9	0.99	35.8	143.4
4, 8	+2	720	28.8	6	172.8	115.2	3.6	1	4	2s	0.99	0.99	2.99	2.99	0.99	8.96	71.7
4, 8	-2	720	28.8	6	172.8	230.4	3.6	1	4	2s	0.99	0.99	2.99	2.99	0.99	8.96	71.7
4, 12	+3	720	28.8	6	172.2	86.4	3.6	1	4	3s	0.99	0.99	1.99	1.99	0.99	3.98	47.8
4, 12	-3	720	28.8	6	172.2	259.2	3.6	1	4	3s	0.99	0.99	1.99	1.99	0.99	3.98	47.8
4, 16	+4	720	28.8	6	172.2	57.6	3.6	1	4	4s	0.99	0.99	0.99	0.99	0.99	0.99	15.84
4, 16	-4	720	28.8	6	172.2	288	3.6	1	4	4s	0.99	0.99	0.99	0.99	0.99	0.99	15.84
4, 20	+5	720	28.8	6	172.2	28.8	3.6	1	4	5s	0.99	0.99	1.1	1.1	0.99	1	20
4, 20	-5	720	28.8	6	172.2	316.8	3.6	1	4	5s	0.99	0.99	1.1	1.1	0.99	1	20
6, 18	+3	1080	43.2	5	216	86.4	18	1	6	3s	0.95	0.95	0.95	0.95	0.9	0.9	16.2
4, 4	+1	720	28.8	5	144	115.2	18	1	4	1s	0.95	0.95	4.75	4.75	0.9	22.6	90.45
6, 6	-1	1080	43.2	5	216	259.2	18	1	6	1s	0.95	0.95	2.85	2.85	0.9	8.14	48.84
6, 12	+2	1080	43.2	5	216	129.6	18	1	6	2s	0.95	0.95	1.9	1.9	0.9	3.6	43.2
6, 12	-2	1080	43.2	5	216	302.4	18	1	6	2s	0.95	0.95	1.9	1.9	0.9	3.6	43.2
6, 18	+3	1080	43.2	5	216	86.4	18	1	6	3s	0.95	0.95	0.95	0.95	0.95	0.9	16.28
4, 8	+1	720	28.8	7	201.6	144	10.8	1	4	2s	0.98	0.98	2.94	2.94	0.96	8.68	69.47
4, 4	+1	720	28.8	7	201.6	172.8	10.8	1	4	1s	0.98	0.98	5.9	5.9	096	34.74	138.9
4, 4	-1	720	28.8	7	201.6	230.4	10.8	1	4	1s	0.98	0.98	5.89	5.89	0.96	34.74	138.9
4, 12	-2	720	28.8	7	201.6	259.2	10.8	1	4	2s	0.98	0.98	1.96	1.96	0.96	3.8	46.4
4, 12	+3	720	28.8	7	201.6	115.2	10.8	1	4	3s	0.98	0.98	1.96	1.96	0.96	3.8	46.4
4, 12	-3	720	28.8	7	201.6	288	10.8	1	4	3s	0.98	0.98	1.96	1.96	0.9	3.8	46.4
4, 16	+4	720	28.8	7	201.6	86.4	10.8	1	4	4s	0.98	0.98	1.98	1.98	0.9	3.8	60.8
4, 16	-4	720	28.8	7	201.6	316.6	10.8	1	4	4s	0.98	0.98	1.98	1.98	0.9	3.8	60.8
4, 4	+1	720	28.8	8	230.4	201.2	25.2	1	4	1s	0.9	0.9	4.5	4.5	0.8	20.46	81.84
6, 18	-1	1080	43.2	8	345.6	259.2	82.8	1	6	1s	0.12	0.12	0.01	0.5	0.02	0.2	3.6
8, 16	+2	1440	57.6	8	100.8	345.6	39.6	1	8	2s	0.77	0.77	0.77	0.77	0.6	0.6	9.6
8, 16	+3	1440	57.6	8	100.8	288	39.6	1	8	3s	o.77	0.77	0.77	0.77	0.6	0.6	9.6
8, 16	-3	1440	57.6	8	100.8	273.6	39.6	1	8	3s	0.9	0.9	0.9	1.8	1.8	3.27	52.32
4, 16	+4	720	28.8	8	230.4	120	25.2	1	4	4s	0.9	0.9	0.9	0.9	0.8	0.8	12.8
6, 12	+1	1080	43.2	3	129.6	86.4	25.2	1	6	1s	0.9	0.9	2.7	2.7	0.8	7.36	88.3
4, 4	-1	720	28.8	3	86.4	115.2	46.8	1	4	1s	0.68	0.68	2	2	0.46	4	16
12,12	+2	2160	86.4	3	259.2	86.4	39.6	1	12	2s	0.77	0.77	0.77	0.77	0.6	0.6	7.2
8, 16	-2	1440	57.6	3	172.8	288	3.6	1	8	2s	0.99	0.99	1.99	1.99	0.99	3.98	63.68
6, 18	-3	1080	43.2	3	129.6	259.2	25.2	1	6	3s	0.8	0.8	0.8	0.8	0.64	0.64	11.5
8, 16	-4	1440	57.6	3	172.8	43.2	3.6	1	8	4s	0.99	0.99	1.9	1.9	0.99	3.6	57.76
12,12	+1	2160	86.4	2	172.8	86.4	3.6	1	12	1s	0.99	0.99	1.99	1.99	0.99	3.98	47.76
12,12	-1	2160	86.4	2	172.8	259.2	3.6	1	12	1s	0.99	0.99	1.99	1.99	0.99	3.98	47.76
12,12	-2	2160	86.4	2	172.8	345.6	3.6	1	12	1s	0.99	0.99	0.99	0.99	0.96	0.96	11.5
12,12	-3	2160	86.4	2	172.8	72	3.6	1	12	1s	0.99	0.99	1.99	1.99	0.96	3.98	47.76
8, 24	-4	1440	57.6	2	115.2	345.6	32.4	1	8	3s	o.84	0.84	0.84	0.84	0.7	0.7	16.93

Tables(2,3) gave 320 diagrams but it is impossible to Show all them in this search ,so only two are shown in fig.( ) and the others are saved in index.

Table (4) shows effecting of K1 on brushes (1- numbers 2- their widths 3- their distributions)

P_t is total power measuring in p.u. 1,2,3…23 are commutator bars C = 25 (odd number) P=no.of poles

K1	$Y_{B°}$	m	P_t	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	P
6	172.8°	±1	143		■						■						■						■				4
6	=	±2	71.7		■	■					■	■					■	■					■	■			4
6	=	±3	47.8		■	■	■				■	■	■				■	■	■				■	■	■		4
6	=	±4	31.8		■	■	■	■			■	■	■	■			■	■	■	■			■	■	■	■	4
5	144°	±1	90.5			■						■						■						■			4
5	=	±2	32.6		■	■			■	■			■	■			■	■			■	■			■	■	6
5	=	±3	16.3	■	■	■		■	■	■		■	■	■		■	■	■		■	■	■		■	■	■	6
7	201°	±1	139	■						■						■						■					4
7	=	±2	31	■	■					■	■					■	■					■	■				4
7	=	±3	47	■	■	■				■	■	■				■	■	■				■	■	■			4
7	=	±4	35	■	■	■	■			■	■	■	■			■	■	■	■			■	■	■	■		4

III. Discussion

Table (2,3) showed the great effectiveness of using the variable factor to the equation of winding at even and odd coils and showig the following achievements:-

1. K1 is much active for producing different powers to machine, for example item P_(t)shows that there are several values of P_t against different values of K1, at the same time there are several channgings in other active elements like e_(CN), I_CN ,e_P ,I_P P_CN, P_P and this is mean that the machine have different specifications (i.e. different applications), indicating the success of using the veraible factor of K1
2. It shows also that the ability to harvest them is well sequenced, not large distances, but very close, and this is a very good Indicator which supports the use of the variable factor K1.
3. The laying of brushes on the front side of the commutator to any scheme was very smooth indicating to sparkless (at even or odd coils) leading to success of using the variable factor K1 (look table.4)
4. The variable values of the multiplicity factor m (for the same Y_B) giving variable values for the P_t, & specifications which is a good indicator of the use of the K1.
5. It shows also that at same no. of poles and multiplicity factor with different (Y_B) giving different powers and Specifications (tables above).
6. It shows also that at same poles & θ_(YB°) with different plex we can also obtain different powers & specifications.
7. it shows also that at same plex , poles & 〖θ〗_(YB°) ,we can obtaine same power.
8. it shows that at different poles we can obtaine different powers.
9. at same plex with different poles & 〖θ〗_(YB°) we ca obtaine different powers & specifications.
10. Finally at using veraible factor above we have wide domaine for controlling power and specification of machine.

IV. Conclusions

The new K factor plays alarge important role to produce different types of d.c. Lab windings which is Produce new perfect cases that are shown as follow:-

1. It cancels the hardly requirements on the equation of winding so it is possible to use any number of segments and coils in it because befor adding (k) the equation not accept all values (i.e. the domain of design and application are improved.
2. It makes the machine as sparkless as possible to improve its commutation and charactiristics.
3. It gives different specifications to machine which leading to different applications.

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