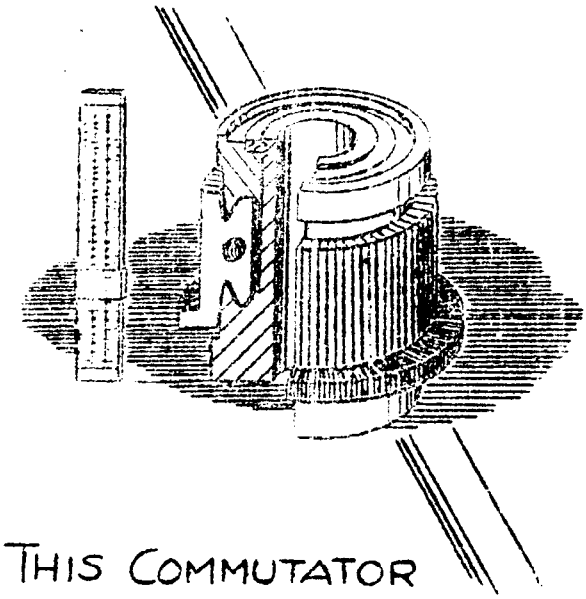
PURCHASING VALUE ANALYSIS STUDY OF GY-27 AUXILIARY GENERATOR COMMUTATOR

Commutator
6733939-G1
700/year



IS YESTERDAY'S PUDDING TODAY'S POISON?

THIS COMMUTATOR

...DESIGNED WITH YESTERDAY'S COST RELATIONSHIPS

HAS 41 LB COPPER		
	COST THEN	$8.00
	COST NOW	$24.00
HAS 2½ LB MICA		
	COST THEN	$5.00
	COST NOW	$15.00

USING TODAY'S COST RELATIONSHIPS AND NEW FUNCTIONAL MATERIALS, WE BELIEVE TODAY'S COST CAN BE HALVED.

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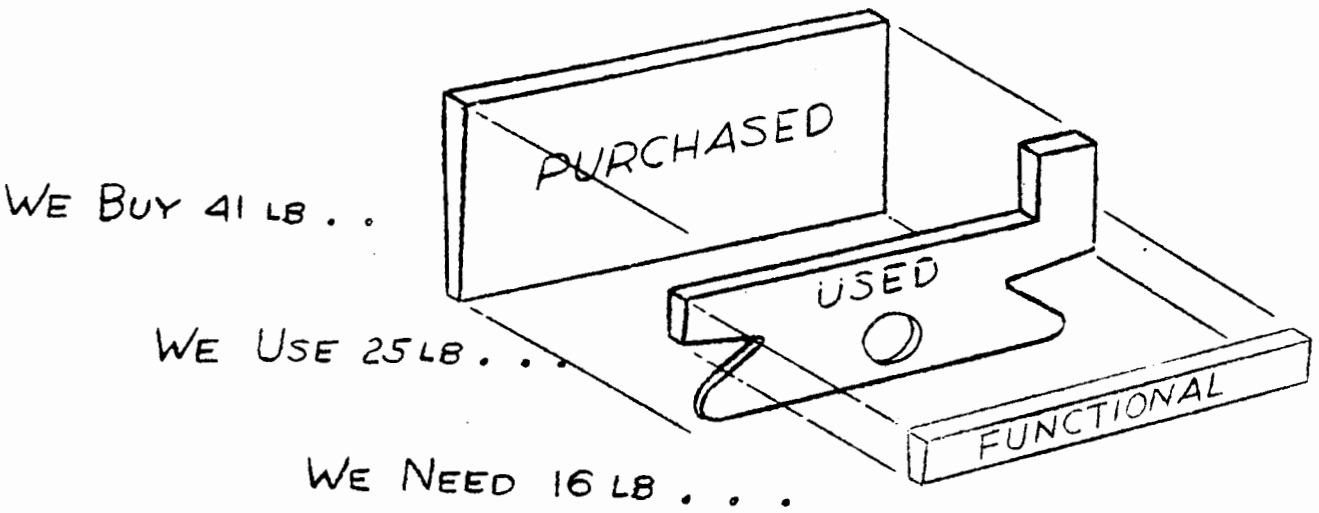


Several alternate designs would halve the copper--halve today's cost--ease shortages.

Let's Set This Bogy:

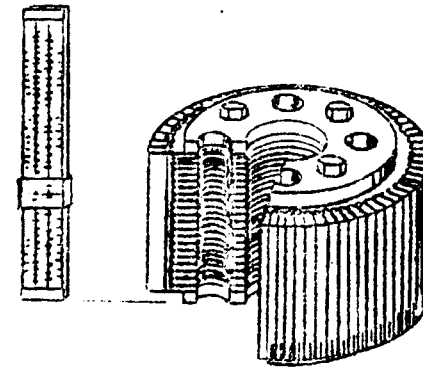
	Cost	Copper	Weight	Length
Today's Unit	$71	41 lb.	62 lb	9¼ in.
Bogy	$30	20 lb.	30 lb	4½ in.

Following are suggested approaches to the bogy:

	Shop Cost	Copper
Proposal #1	$ 44.42	20.2 lb.
Proposal #2	34.49	27.5 lb.
Proposal #3	32.86	20.9 lb.
Proposal #4	29.32	20.2 lb.

PROPOSAL #1

Glass reinforced plastic laminations form the core. Assembly is similar to a rotor. Extruded copper segments are pressed into slots.



	Cost/Each		
	Material	Adjusted Labor	Shop Cost
Present			
Assembly		3.00	9.90
Copper Segments (111)	24.72	.69	27.00
Mica Segments (111)	6.73		6.73
Shell	11.31	.59	13.25
Cap	1.50	.54	3.28
Mica Cones (2)	8.68		8.68
Nut	.33	.35	1.49
Miscellaneous	.08	.21	.82
	$53.35	$5.38	$71.15
Proposed			
Assembly (Stack laminations, press segments into core, cement segment insulation, machining operations, flux slots, balance, test, undercut mica)		2.30	7.60
Copper Segments (111)	16.80	.76	19.30
Laminations (34)	11.83	.30	12.85
Mica Segments (111)	1.92		1.92
End Caps (2)	1.10		1.10
Bolts, Nuts, Washers	.60		.60
Cement	.50		.50
Cure Cement		.17	.55
	32.75	3.53	44.42

Proposal #1 (Cont.)

Tool Charge for Extrusion Die	$100
Tool Cost for Carboloy Drawing Die	800
Die Cost for Punching Laminations	3500
Tools for Sawing Slots in Segments	2500
Die Cost for Segment Mica	350

Estimated Annual Reduction at Shop Cost	$18,700
Annual Copper Reduction	14,600 lbs.

COMMENTS:

A core is built up of glass mat reinforced plastic laminations in much the same manner that a rotor would be assembled. Plastic laminates having filamentary reinforcement can be used if their extra strength is required. The laminations punched from these sheets have slots especially shaped to grip the copper bars. The plastic core is held between end plates by through bolts.

Preliminary investigation indicates that some of the new glass-reinforced plastic laminates have temperature ratings high enough for most commutator applications. In the cost figures, a polyester bonded material is represented. At higher cost, a melamine resin could be used in place of polyester and would have much better temperature resistance.

The copper segments, which are extruded and drawn to a grooved cross-section, are pressed axially into the grooves in the core. The plastic laminations thus provide the body of the structure as well as insulation.

The riser has been removed to eliminate the waste from blanking and to enable the complete commutator bar to be supplied as an extruded and drawn part. This eliminates all waste copper except that which is sawn from the terminal slot. This slot is cut prior to assembly of the segments and is covered by the .76 adjusted labor assigned to the copper segments.

It is believed that a program to evaluate ways of attaching rotor windings without the use of risers would be worthwhile. Substantial copper savings could be effected even on the present design.

For segment insulation, one-half inch strips of mica sheet are suggested. These are cemented into the slots between copper segments with a thermosetting adhesive which does not deteriorate when in contact with copper. It promises to withstand 400°F.

Proposal #1 (Cont.)

The quantity of copper is reduced from 41 lbs. to 20.2 lbs.; the weight of the commutator is reduced from 62 lbs. to 37 lbs.; the overall diameter of the unit is reduced from 9¼" to 8"; the length shortened from 9¼" to 6¼".

PROPOSAL #1--ALTERNATE

Cement the core laminations together, eliminating the end plates, bolts and nuts.

Saving on plates, bolts, and nuts	$1.70
Estimated cost of cementing and curing core	1.20
Net Savings	$ .50

This would also remove 3 lbs. from the weight and shorten the length from 6¼" to 4¼".

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MATERIALS & PURCHASING DEPT.
VALUE ANALYSIS UNIT
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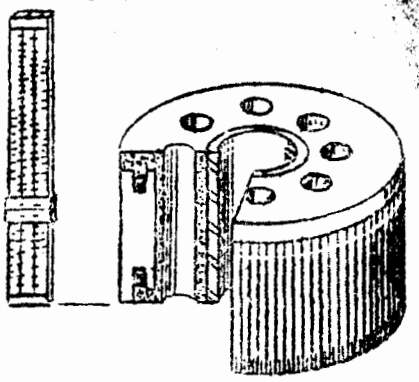
PROPOSAL #2

Narrow copper and mica segments are assembled as at present. Glass reinforced polyester rings bind the assembly together. A molded glass-resin compound forms the body.



	Cost/Each		
	Material	Adjusted Labor	Shop Cost
Present	53.35	5.38	71.15
Proposed			
Assembly (Segments, Press Rings, Molding, Machining, Flux Slots, Balance, Test, Undercut Mica)		2.19	7.20
Copper Segments (111)	15.20	.76	17.70
Mica Segments (111)	4.37		4.37
Binding Ring (2)	1.00	.17	1.55
Glass Reinforced Plastic	3.00		3.00
Steel Liner	.67		.67
	24.24	3.12	34.49

Mold Cost $1000
Die Cost for Segment Mica 1000

Estimated Annual Reduction at Shop Cost $25,600
Annual Copper Reduction 9,450 lbs.

COMMENTS:

Copper and mica segments are assembled exactly as in the present design. The assembly is compressed by two polyester bonded glass fiber rings which are pressed into tapered grooves at each end of the segments. This corresponds to the clamping of the shell, cap, and nut on the present commutator.

Proposal #2 (Cont.)

Inside the assembly is molded a glass reinforced plastic core which serves as the commutator body. It also encloses the glass fiber rings, locking them in place. It is believed the fiber rings will hold their position during molding if a self-locking taper is used. If this is not true, they could be held by pins in the mold itself.

A metal liner in the molded core provides a surface for machining an accurate bore and cutting a key way.

The copper segments are narrowed to about one-half their present width by changing the groove contour and eliminating the riser. These segments must be slotted before assembly and this is indicated by .76 adjusted labor in the copper segment cost.

Polyester resins when reinforced by parallel glass fibers, have tensile strengths greater than most steels. For this reason, the binding rings are an excellent application. The material is being used to its best advantage, and provides support against centrifugal force on the segments, relieving the molded body.

A polyester resin containing very short glass fibers promises to fulfill the requirements of the molded core. By proper coring, these can be molded at a rate of four per hour.

The required copper is reduced from 41 to 27.5 pounds; the total weight is cut from 62 to 39 pounds; the diameter is reduced from 9¼" to 8"; the length is shortened from 9¼" to 5-3/4".

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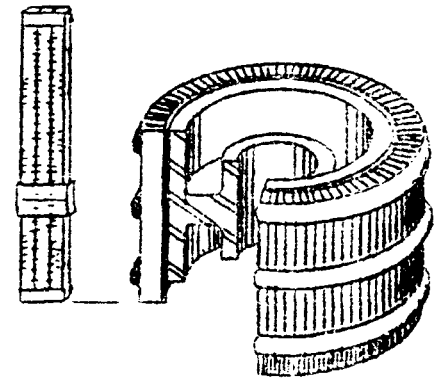
PROPOSAL #3

A standard flat belt pulley insulated with glass cloth supports the copper. Resin-bonded glass yarn, tension wound, binds the assembly together, resists centrifugal force.



	Cost/Each		
	Material	Adjusted Labor	Shop Cost
Present	53.35	5.38	71.15
Proposed			
Assembly (Wrap insulation on hub, assemble segments, wind glass yarn, machining operations, flux slots, test, balance)		2.30	7.60
Hub (Standard Pulley)	7.50		7.50
Copper Segments (111)	13.60		13.60
Mica Segments (111)	2.70		2.70
Polyester Bonded Glass Yarn	.30		.30
	24.10	2.30	31.70

Die Cost for Punching Mica--$350

Estimated Annual Reduction at Shop Cost--$27,600
Annual Copper Reduction 14,100 lbs.

COMMENTS:

The commutator body is provided by a standard flat belt pulley. The pulley is wrapped with several turns of glass tape such as that used presently as insulation on coils.

Proposal #3 (Cont.)

Narrow Copper and Mica segments are assembled on this insulated pulley. The assembly is tightly clamped and a resin-bonded glass yarn is tension-wound around each end. This construction utilizes the resin-bonded glass to its best advantage since it is placed in tension by the centrifugal force on the segments. Its electrical properties make it unnecessary to use insulation between binding and copper.

An ideal construction would place a third binding around the center of the assembly. This would necessitate a split brush holder, but would greatly strengthen the copper section and would thus reduce to a minimum the quantity required for beam strength.

The required copper is reduced from 41 to 20.9 pounds; total weight is cut from 61 pounds to 47 pounds; the diameter is reduced from 9¼" to 8"; the length is shortened from 9¼" to 5-3/8".

PROPOSAL #3--ALTERNATE

Replace the metal pulley and its glass cloth insulation with a molded plastic core.

Cost of Pulley and Insulation		$9.55
Cost of Plastic Core		
Plastic	$3.00	
Molding Cost	1.50	
Metal Liner	.67	
		5.17
Cost Reduction		$4.38

The total cost for Proposal #3 alternate is $27.32. The total weight is 32.5 lbs. which is a reduction of 14.5 lbs. from Proposal #3.

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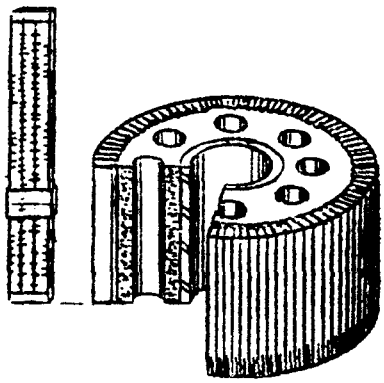
PROPOSAL #4

Extruded copper segments are molded as inserts in a glass-filled plastic matrix. The plastic may or may not serve as segment insulation



	Cost/Each		
	Material	Adjusted Labor	Shop Cost
Present	53.35	5.38	71.15
Proposed			
Assembly (Position Bars in mold, Mold unit, Machining Operations, Flux Slots, Test, Undercut Mica, Balance)		1.87	6.35
Copper Segments (111)	16.80	.76	19.30
Glass Reinforced Plastic	3.00		3.00
Steel Liner (2)	.67		.67
	20.47	2.63	29.32

Mold Cost $2500
Tools for Sawing Slots $2500

Estimated Annual Reduction at Shop Cost $29,300
Annual Copper Reduction 14,600 lbs.

COMMENTS:

Extruded and drawn copper segments having a grooved cross-section are positioned in a cavity and a glass-reinforced plastic molding is made with the segments as metallic inserts.

The terminal slots are cut before assembly. .76 adjusted labor is assigned to the copper segment cost to cover this. A steel liner is provided to permit an accurate bore and key way.

It is suggested that the molding compound be allowed to fill in between the copper bars and thus act as segment insulation in addition to providing the body of the commutator.

Proposal #4 (Cont.)

Tests at the L&CE Laboratory show that glass-filled polyesters have arc resistance roughly comparable to mica. Present difficulty is in maintaining dimensional stability at elevated temperatures. It is believed that if the right resins and fillers can be found, this problem can be solved.

A glass-reinforced plastic with the proper resin should make possible a short molding cycle, with relatively low temperature and pressure.

The quantity of copper is reduced from 41 to 20.2 lbs.; the total weight is cut from 67 to 31 lbs.; the diameter is reduced from 9½" to 8"; the length is shortened from 9¼" to 4¼".

PROPOSAL #4--ALTERNATE

Cement mica or other insulation between segments. This would add to the cost but would possibly prove a workable solution if the molding compound were not satisfactory segment insulation. The copper-mica assembly could be built, then compressed as it is positioned in the mold.

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