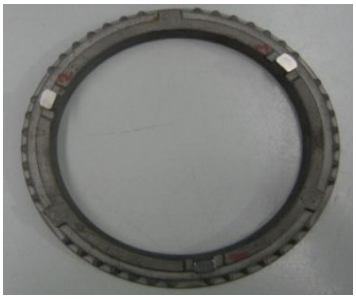
SYNCHRONIZING RINGS - GEAR SYSTEMS:
HOT FORGING



WHY TO PREFER THE HOT FORGING?

1. BETTER MECHANICAL CHARACTERISTICS THAN SINTERED MATERIALS AND CAST MATERIALS :

. more resistance to bending fatigue and contact fatigue;
. more resilience and best behavior to propagation of cracks.

2.DIMENSIONAL TOLERANCES RESTRECTED, comparable with the sintered ones.

3. GOOD ROUGHNESS, comparable with the sintered ones.

4. WIDE RANGE OF MASSES AND DIAMETERS FORGEABLE:

Mass: until to 1,5 Kg; Pitch diameter: until to 200 mm.

5. POSSIBILITY TO PRODUCE ECONOMIC SERIES BELOW 5.000 PCS/YEAR

6. FORGED MATERIALS MORE EASILY WORKABLE,
than sintered alloys having the same composition and structure

7. BETTER RESPONSE TO HEAT TREATMENTS,
than sintered alloys having the same composition and structure

POSSIBILITY TO EXECUTE , AT THE F.COLOMBO SRL,
ALSO SUBSEQUENT MACHININGS
(example: turning pre - heat treatment)

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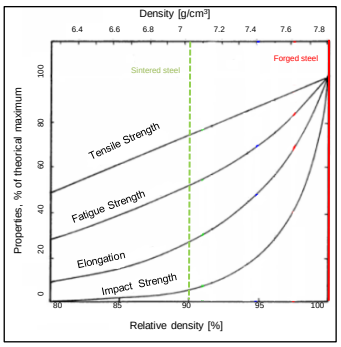
SYNCHRONIZING RINGS - GEAR SYSTEMS:
HOT FORGING

1.MECHANICAL CHARACTERISTICS

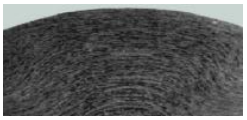
Synchronizing rings hot forged have better mechanical characteristics than the ones made with powder metallurgy (having the same chemical composition). In particular they boast:
. better bending fatigue resistence (tooth root zone);
. better contact fatigue resistence (tooth flank zone);
. more resilience and best behavior to propagation of cracks.

CAUSES OF SINTERED GEARS' FRACTURE

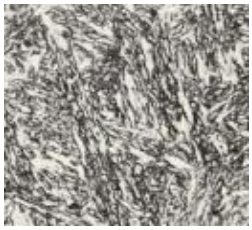
Infact, on the contrary to sintered gears, they DON'T present POROSITIES. Therefore:
1. material density results increased, with superficial resistance increased as consequent;
2. there isn't presence of discontinuities (porosities) that considerably compromise the resistance characteristics and can represent a point of crack's primer/ propagation.



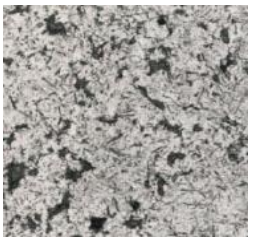
Effect of the density on the steel mechanical properties
Comparison between a sintered steel (density = 7 g/cm³) and a forged steel (density = 7,8 g/cm³)



Macrograph Hot forged steel
Fibrous structure, continue, that allows to maximizer mechanical properties



Hot forged steel
Martensitic structure



Sintered steel
Martensitic structure(presence of porosities, usually from 5 to 15%)

2.DIMENSIONAL TOLERANCES

Dimensional tolerances obtained for synchronizing rings, forged by F.Colombo S.r.l., are much narrow, having comparable values with the same products obtained by syntherization.

SINTERED PRODUCTS	HOT FORGED PRODUCTS (usually)	HOT FORGED PRODUCTS (F.Colombo S.r.l.)
IT10 - IT12	**IT14 - IT16**	**IT12 - IT13**

TOLERANCES ADOPT FOR OUR FORGED PRODUCTS		
Dimensional tolerances		Form tolerances
Diameters	0/ +0,4	Usually max 0.2/ 0.3
Thickness	± 0,2	
Chordal measurement	0/ +0,3	

3.ROUGHNESS

Synchronizing rings forged in F.Colombo S.r.l. present good roughness values, comparable with the sintered ones.

	SINTERED PRODUCTS	HOT FORGED PRODUCTS (usually)	HOT FORGED PRODUCTS (F.Colombo S.r.l.)
Ra [µm]	**0,4 - 3,2**	**12,5 - 25**	**1,8 - 2,8**

4. FORGEABLE MASSES AND DIAMETERS

Wide range of forgeable masses and diameters from F.Colombo S.r.l.
Mass: until to 1,5 kg; Pitch diameter: until to 200 mm. Some examples:

Mass		Mass		Mass		Mass		Mass	
321 g		431 g		835 g		1,35 Kg		1,52 Kg	
Pitch Diameter		Pitch Diameter		Pitch Diameter		Pitch Diameter		Pitch Diameter	
108 mm		125,76 mm		189 mm		189 mm		189 mm	

5. ECONOMIC SERIES

Possibility to produce economic series below 5.000 pcs/year

6. FORGED MATERIALS WORKABILITY

Forged materials are more easily workable than sintered alloys having the same composition and structure.
En opposite of sintered, they don't show porosities and they don't have the following problems:
. Action of cutting edge on superficial porosity, that become occluded (harmful for autolubrification);
. Absorption of cutting fluid in the open porosities;
. Entrapment of abrasive particles , after rectification, with wear problems.

7. RESPONSE TO HEAT TREATMENTS

Forged materials, thanks the absence of porosity, response better and without problems to heat treatments, without any precaution. In the sintered materials porosity influences the response to heat-treatment because reduces the thermal conductivity and consequently the hardenability, increases the contact surface with the treatment's atmosphere, retains fluids and makes hard scouring with possible origin of corrosion phenomenon.

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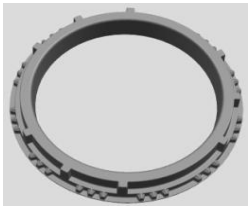
SYNCHRONIZING RINGS
produced by F.Colombo S.r.l.

	Number of teeth	48 (theoretic 57)		Number of teeth	54 (theoretic 63)
	Module	3		Module	3
	Pressure angle	20°		Pressure angle	20°
	Pitch diameter	171		Pitch diameter	189
	Outside diameter	$175,5^{0}_{-0,4}$		Outside diameter	$191,8^{0}_{-0,4}$
	Root diameter	$168^{0}_{-0,4}$		Root diameter	$184^{0}_{-0,4}$
	Span measurement by pressing over 7 teeth	$59,7_{0}^{0,3}$		Span measurement by pressing over 7 teeth	$59,6_{-0,3}^{0}$
	Number of teeth	45 (theoretic 63)		Number of teeth	57 (theoretic 63)
	Module	3		Module	3
	Pressure angle	20°		Pressure angle	20°
	Pitch diameter	189		Pitch diameter	189
	Outside diameter	$191,3_{0}^{0,4}$		Outside diameter	$192,1^{0}_{-0,4}$
	Root diameter	$183,6^{0}_{-0,4}$		Root diameter	$184,5^{0}_{-0,4}$
	Span measurement by pressing over 7 teeth	$59,52_{0}^{+0,3}$		Span measurement by pressing over 7 teeth	$59,6_{-0,3}^{0}$
	Number of teeth	54 (theoretic 63)		Number of teeth	36 (theoretic 60)
	Module	3		Module	2,70
	Pressure angle	20°		Pressure angle	20°
	Pitch diameter	189		Pitch diameter	162
	Outside diameter	$191,8^{0}_{-0,4}$		Outside diameter	$164_{0}^{+0,4}$
	Root diameter	$184^{0}_{-0,4}$		Root diameter	$157_{0}^{+0,4}$
	Span measurement by pressing over 7 teeth	$59,6_{-0,3}^{0}$		Span measurement by pressing over 6 teeth	$45,4_{0}^{+0,3}$
	Number of teeth	36 (theoretic 48)		Number of teeth	36 (theoretic 51)
	Module	2,62		Module	2,66
	Pressure angle	20°		Pressure angle	20°
	Pitch diameter	125,76		Pitch diameter	135,66
	Outside diameter	$127,7_{0}^{+0,4}$		Outside diameter	$137,7_{0}^{+0,4}$
	Root diameter	$120,7_{0}^{+0,4}$		Root diameter	$130,7_{0}^{+0,4}$
	Span measurement by pressing over 6 teeth	$43,6_{0}^{+0,3}$		Span measurement by pressing over 6 teeth	$44,4_{0}^{+0,3}$
	Number of teeth	36 (theoretic 54)		Number of teeth	42 (theoretic 63)
	Module	2,70		Module	3
	Pressure angle	20°		Pressure angle	20°
	Pitch diameter	145,8		Pitch diameter	189
	Outside diameter	$147,5_{0}^{+0,4}$		Outside diameter	$192,5_{0}^{+0,4}$
	Root diameter	$140,5_{0}^{+0,4}$		Root diameter	$184,1_{0}^{+0,4}$
	Span measurement by pressing over 6 teeth	$45,25_{0}^{+0,3}$		Span measurement by pressing over 7 teeth	$59,3_{0}^{+0,3}$
	Number of teeth	42 (theoretic 51)		Number of teeth	24 (theoretic 36)
	Module	3		Module	3
	Pressure angle	20°		Pressure angle	20°
	Pitch diameter	153		Pitch diameter	108
	Outside diameter	$157_{0}^{+0,4}$		Outside diameter	$111,4_{0}^{+0,4}$
	Root diameter	$149,6_{0}^{+0,4}$		Root diameter	$104,4_{0}^{+0,4}$
	Span measurement by pressing over 6 teeth	$50,55_{0}^{+0,3}$		Span measurement by pressing over 5 teeth	$40,57_{0}^{+0,3}$

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