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Engineering and Pricing Data on Carburized and Nitrided Gears

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Morgan Construction Company,
Worcester, Massachusetts.

Attention: Mr. Norman Wilson

Reference: Your request for engineering and pricing data, on
carburized and nitrided gears, for comparison
purposes.

Gentlemen:

Please find listed below prices for both carburized and ground,
and nitrided gears per your request. Also please note suggestions
for processing the carburized gears, in the enclosed attachments:

(5) sets strands 2 and 4 (Carburized and ground) $20,015.00/set
(5) sets Strands 1 and 3 (Carburized and ground) $20,015.00/set
  Total (10) sets.
(5) sets Strands 2 and 4 (Nitrided) $19,423.00/set
(5) sets Strands 1 and 3 (Nitrided) $19,423.00/set
  Total (10) sets.

The above prices are predicated upon Indiana Gear Works furnishing
all labor and material to manufacture the above parts complete to
your blueprints.

This quotation will remain valid for a period of (90) days.

Very truly yours,

INDIANA GEAR WORKS
a division of
THE BUEHLER CORPORATION

George T. Foggas
Eastern Sales Manager

cc: T. E. Whittington, Morgan Construction Co.
    M. Knott
    M. Paugh, Indiana Gear Works (2)
MORGAN PARTS LIST

Strands 2 and 4 - to consist of one each:

167680 A and B
167681 A and B
167682 A and B
167683 A and B
167684 A and B
167685 A and B
167686 A and B
167687 A and B

Strands 1 and 3 - to consist of one each:

167672 A and B
167673 A and B
167674 A and B
167675 A and B
167676 A and B
167677 A and B
167678 A and B
167679 A and B
The following heat treat procedure will be used to insure that parts meet the Morgan drawings and inspection sheet #B-171744.

1. Carburizing will be performed at 1700°F in precision gas carburizing furnaces, equipped with automatic carbon control devices to assure optimum case carbon content of .70-.90%.

2. Following an oil quench, parts will be sub-zero treated at -120°F for maximum freedom from retained austenite.

3. Parts will be tempered in circulating air furnaces for four (4) hours minimum to assure adequate stress relief and proper case hardness values.

4. The above heat treatment is designed to produce the most desirable case microstructure, consisting of tempered martensite with a moderate number of randomly distributed undissolved carbides with a particle size not to exceed .0004".

The following will be on file at Indiana Gear Works and certified on our metallurgical report form. This form will be sent with each lot parts as shipped.

1. Material certifications and chemical and physical properties test reports.

2. Tensile test certifications for each heat of material.

3. Heat treat certification for each carburized harden lot containing the following information:
   a. Core hardness.
   b. Case hardness.
   c. Case depth.

4. Carburized harden lot number to be etched on each part before it is released by Heat Treat Inspection.

5. All certifications to reflect part number and serial number of part.

6. Magnaflux certifications.
7. Check sheets will be available at Indiana Gear Works Final Inspection.

8. Certification of balancing and inspection stamp.

9. Each pair of gears will be identified by a set number and serial number to each individual gear.

10. Maximum mounting distance and backlash will be marked on gear set.

11. All gear sets as they are mated into sets will have a record of the tooth contact pattern made and transferred on a card (see sample). Three copies of these cards will be made. One for Morgan and two to be on file at Indiana Gear Works. This card will show contact pattern at the basic and maximum mounting distance as called out on Morgan drawings.

12. This quote is based on using grinding dummies on Gleason Cutters and Grinders while developing the pattern for proper location. This will insure proper tooth thickness and pattern, location on production gears.

We recommend the following treatments be incorporated on these parts to give the optimum case microstructure and to help the break-in lubrication of these gear meshes.

1. Phosphate coating for pinions only - This type of coating has been found most desirable, since it substantially increases the corrosion resistance and lubricity of gears. The coating itself is composed of very fine grained iron and manganese phosphate crystals, which are formed by immersion in a hot processing solution. The coating builds up to a thickness of 0.0002/0.0004", although it is friable and on gear teeth will wear into the original dimensions. The spaces between these small crystals act as reservoirs, which maintain a continuous film of oil between mating steel surfaces, even under the extreme pressures encountered in gear teeth meshes. The coating will wear off in time.

2. Stress relief - We stress relieve carburized and hardened gears to relieve any surface stresses imparted by the grinding operation which might result in latent grinding checks. Even with the most carefully controlled grinding conditions, residual tensile stresses may be formed by the abrasive action and pressures of the grinding wheel. These stresses, combined with the predominantly tensile stresses in service, can result in a variety of surface defects, and even cracking of the hardened case. Stress relieving at a temperature
of 275°F will reduce the value of the residual tensile stresses, and greatly minimize the problems mentioned.

3. Parts be sub-zero treated at -120°F for maximum freedom from retained austenite.

4. Although the core hardness is not called out, we would recommend a R/C 28-40 range. This is a normal range for 9310 Aircraft Quality Steel.

Indiana Gear Works has the following machinery which will be used in the manufacture of these parts.

(4) #26 Generators for cutting of gears.

(2) #27 Gleason Grinders altered to take the large grinding wheel.

(2) #137 Grinders which will also use the large grinding wheel.
1. **Forging**

   The material change is indicated on the enclosed print of 167688.

2. **Hard Surfaces**

   The only surfaces that must be hard are the profile, fillet radius, and bottom land of the teeth. We recommend, in addition, that the holes of the ring gears and the journals X and Y of the integral shafts be hard to minimize damage of these surfaces during the tooth grinding operation. The surfaces not covered in (3) below may be hard or soft.

3. **Soft Surfaces**

   The surfaces that must be soft have been indicated by green lines on the enclosed prints of 167672 and 167676. In all cases this is for machining after hardening.

4. **Manufacturing Procedure**

   A procedure which removes the carburized material at the locations which must be soft has been given. We would remove 1/8" of material from the surfaces marked by red lines. If (3) is taken care of by plating a slightly different procedure will be used. We would like to see your final selection.

   We would make a sketch like X of the enclosed print 167668 which would be used to turn the forging before gear cutting and carburizing.