CLASSIFICATION CONFIDENTIAL

CENTRAL INTELLIGENCE AGENCY

INFORMATION FROM FOREIGN DOCUMENTS OR RADIO BROADCASTS

CONFIDENTIAL

REPORT CD NO.

50X1-HUM

COUNTRY	USSR	DATE OF INFORMATION	1943
SUBJECT	Automotive industry	DATE DIST.	13 December 1948
HOW PUBLISHED	Monthly periodical		
WHERE PUBLISHED	Moscow	NO. OF PAGES	6
DATE PUBLISHED	January 1948	SUPPLEMENT TO	
LANGUAGE	Russian		

THIS IS UNEVALUATED INFORMATION FOR THE RESEARCH USE OF TRAINED INTELLIGENCE ANALYSTS

SOURCE IDENTIFICATION: Avtomobil'naya Promyshlennost', No 1, 1948. (Translation specifically requested.)

LABOR-SAVING METHODS IN THE MANUFACTURE OF MOTOR-VEHICLE GEARS

M.D. Genkin and A.O. Etin
Candidates in Technical Sciences

Use of Gears in Modern Automobile Construction

The tendency in modern automobile construction is toward the increasing use of gears of a diminished module having oblique teeth and an increased number of teeth. In small-displacement engines, 2 - 2.5-module gears are used. In medium and large displacement engines, 3- 3.75-module gears; in engines for trucks up to 2.5 tons, 2.5 - 3-module gears; in 3- to 4-ton trucks, 3 - 4.5-module gears; and in trucks of 5 - 7 tons, 4.5 - 6-module gears are used. Three oblique-tooth gears and two spur gears are used in the majority of automobile gear boxes. Cylindrical gears of the rear axle in many cars are made with spur teeth. About 60 percent of gears in an automobile are oblique-tooth gears and 40 percent, spur gears.

The angle of engagement for the most part is 20 degrees. Correction of profile is seldom used except on certain high-grade engines. The number of teeth ranges from 18 to 40.

The precision of manufacture of passenger-car engine gears corresponds to about first- or second-class precision; for truck engines, to about third- or fourth-class precision as rated by GOST 1643.

For classification, gears are divided into the following categories: by external contour (a) with spur teeth, and (b) with oblique teeth; by dimensions (a) of the first range, 1.5 - 2.25-module, and (b) of the second range, 2.5 - 4.25-module and (c) third range, 4.5 - 6-module; and by class of precision (a) first class, and (b) second class.

General Technology of Gear-Cutting

In the process of machining gears from circular blanks, it is necessary to cut out a large quantity of metal. Thus, for example, the gear

CLASSIFICATION CONFIDENTIAL

STATE	X	NAVY	X	NSRB		DISTRIBUTION						
ARMY	X	AIR	X									

CONFIDENTIAL

50X1-HUM

for the third speed of the ZIS-5 automobile weighs 2.2 kg, whereas the blank before forging weighs 4.2 kg and the forging, 3.4 kg. In other words, about 50 percent of the weight of the blank, or 30 percent of the forging goes to waste. The machined surface of a gear exceeds by about three times the surface of the cylinder of corresponding diameter. The precision of manufacture of the gear rim is determined by more than a score of interrelated factors, while the complexity of the configuration of the surface has almost no equal among auto parts.

Since the surface of the teeth is not polished after heat treatment, the precision of the gear naturally is determined to a great extent by the quality imparted up to the heat treatment. Under such conditions, the production capacity of basic gear-cutting operations cannot be high, and lags far behind the rate of pouring (vypusk).

The rate of pouring of gears ranges from 0.3 - 3 minutes, while the productivity of gear-cutting operations in both preliminary and semifinished stages does not exceed 20 gears per hour, and in some cases is as low as six gears per hour per machine. In other words, the production capacity of the machines in milling some gears is one-twentieth of the rate of pouring. This necessitates vast parks of gear-cutting machinery in automobile plants both here and abroad.

The cost of gear-cutting is relatively high. Seventy percent of the cost is for tools, of which the cost of material (high-speed steel) is 50 percent, while the proportion of wages is comparatively low. With the cost of a first-class cutter for semifinished cutting at 200 rubles, and the usual tool life 1,000 parts, the cost of the tool constitutes 20 kopeks per unit produced, while the labor cost per unit rarely exceeds 5 kopeks.

Technical Operations in Machining Gears

The following table summarizes the stages in the manufacture of heat-treated and non-heat-treated gears:

Operation	Heat-Treated Gear	Non-Heat-Treated Gear
1	Machining contour	Machining contour
2	Machining technological datum lines	Machining technological and operating datum lines
3	Preliminary machining	Preliminary machining
4	Semifinished machining	Semifinished machining
5	Supplementary machining	--
6	Finished machining	Finished machining
7	Heat treatment	--
8	Machining the operation base	--
9	Final processing	Final processing
10	Selection of pairs by acoustic characteristics and contact	Selection of pairs by acoustic characteristics and contact

CONFIDENTIAL

Tooth-maching operations 3, 4, 5, 6, and 9 are the topic for analysis in the present work.

The rough-machining operations include rolling-out of the teeth, casting the wheel with its teeth, and rough milling and rough slotting of the teeth. [The term "rolling-out" (vykatka) is used by the authors to emphasize the physical nature of the operation -- a strong upward squeezing of the layer of metal, in contrast to the usual rolling which gives a negligible plastic deformation to the metal.] Included in the semifinished cutting operations are broaching of the teeth, profile shaping of the teeth (sheer-speed), and semifinished cutting, and semifinished shaping of the teeth.

The following table summarizes the above operations:

Operations (Group)	Significance of Operation	Lateral Allowance for Subsequent Machining	Precision Under GOST 164-43
Preliminary	Removing bulk of metal from recess of tooth	0.1 module	4th class
Semifinished	Cutting of teeth under clean operation	0.2 module	3d class*
Finished	Final shaping of meshing	--	1st-2d class*
Lapping	Final lapping of teeth for grade of surface and precision	--	1st-2d class

*The class of precision of the operation is determined by the class of precision of the cut gear.

Rolling-Out of Teeth on the Blanks of Cylindrical Gears

The need to reduce the consumption of steel led to the idea of rolling-out teeth in the hot state. The prerequisites for the development and use of rolling-out teeth emerged with the growth of inductive heating and the possibility of conducting work in an inert atmosphere.

Several proposals in this field were worked out by Professor Tselikov of TsNIITMASh (Central Scientific Research Institute of Machine Technology); Zakirzanskiy, engineer, Orgavtoprom (Organization of the Automobile Industry); Sokolov, engineer, NAMI (Moscow Automobile and Automotive Institute?); Vorob'-yev, engineer, Academy imeni Zhukovski; and others.

The basic concepts evolved from these proposals include: (a) automatic movement of the blank along the tool; (b) use of a heavy mandrel having internal cooling for holding the blank; (c) maintenance of fixed temperature of the blank with the aid of inductive heating; (d) use of a shaping instrument with a large area; (e) production in an inert atmosphere; (f) use of cooling for scale removal, general cooling of the setup, etc.

Heating the blank to the necessary temperature takes 5 - 8 seconds. The blank is worked in six courses, the time of one course being 3 seconds, and the time for placing on and removing the part, 13 - 20 seconds. The total time depending on the dimensions of the gear is 1 - 1.5 minutes. The weight of the blank comes down 15 - 20 percent. The life of the tool i.e., the rack, should be significantly increased.

50X1-HUM

CONFIDENTIAL

The gears receive increased hardness since in this method the fibers are not machined across the grain, and supplementary grinding and shrinkage of the structure is done.

The accuracy of rolling-out of the blank in gears from 3.5 - 4.5 module ranges from 0.15 mm to 0.12 mm in the meshing elements (profile, pitch, and alignment). The recess in the gear at the time of rolling-out is not distorted.

The above-mentioned process seems to determine the following technological procedure when rolling-out of teeth is introduced: stamping of round blocks, turning the rim, machining the technological datum lines, rolling-out the teeth, semifinished cutting of the teeth, shaving, etc.

While final adoption of the rolling-out process still requires a great industrial effort, the above-mentioned considerations indicate the process to be one of great profitability.

Casting of Gears

Experimentation in the centrifugal casting of gears is being conducted in the USSR (at the Moscow Automobile Plant imeni Stalin, by Engineer V. N. Sokolov), as well as in the United States. According to available data, a centrifugally-cast steel gear blank, with subsequent normalization, will produce a gear with the following mechanical properties: ultimate tensile strength, 120 kg/sq mm; Brinell hardness, 350; compression (szhatiye), 108 percent; elongation, 8 - 7 percent.

Clark, an engineer, experimented in 1941 with the casting of gears using wax and "isocerite" matrices. These developments, according to bibliographic data, prevent the formation of a skin and guarantee a blank with a meshing-element precision of 0.1 mm.

Engineer V. N. Sokolov's experimental work cut the casting time of one blank to 1 - 2 minutes. The consumption of metal may be expected to be 10 - 15 percent lower than in rolling-out. Cast blanks, as well as rolled-out blanks, require semifinished operations before shaving.

Casting, like rolling-out, assures high productivity and should have further development. The question of the machinability of cast blanks in subsequent operations must be cleared up.

Rough Milling

At the present time, rough milling of the gear blank for gears of second- and third-pitch dimensions is done by hobbing cutters on special machines designed for preliminary milling.

The cutter is specially shaped to cut on both strokes, and has grinder radii attachments. The cutting speed is 20 - 25 meters/minute with a feed of 1.8 - 2.5 mm/revolution. The mean economical tool life in cutting gears of the second-pitch dimension is 100 units. The production capacity is about 15 units/hour.

Until recently, the machines most widely in use for rough milling were the Type 5V-32 vertical machine of the "Komsomolets" Plant and the 12-N and 24-N Guld Ebergard. Also in use is the Type 534 horizontal machine of the "Komsomolets" Plant and the Series No 12 Barber Kol'man.

Machines of increased rigidity have been found to increase the productivity of milling operations and the life of the tools. Hydraulic machines for milling

CONFIDENTIAL

CONFIDENTIAL

Sanitized Copy Approved for Release 2011/06/29 : CIA-RDP80-00809A000600200460-0

steel gears up to 8.5 module have appeared; these have fixed tool holders and increased control and reinforcement of the other basic units. There has been some use of vertical-milling machines of increased rigidity (uni- and octi-spindle) having fixed supports and a feed by moving the job in a carriage along vertical guides.

In order to increase the life of the tool and assure its uniformly effective use along all lines, a machine has been created with horizontal movement of the supports and tangential feed, by advancing the cutter in a horizontal plane. According to data of the Automobile Plant imeni Stalin, the life of the tool used for machining gears of 4.5 module was increased from 150 to 250 units by this method, where velocity was 30 meters/minute, vertical feed 0.7 mm/revolution and horizontal feed 0.7 mm/revolution. Tangential supports are being installed in recent models of cutting machines.

The installation of flywheels on the cutting spindles and a slight braking has shown good results on the score of more rigid operation of the machine. According to preliminary data obtained on the basis of 3-month operation of Type 5V-32 vertical milling machining, the installation of flywheels and tightening of the system has permitted an increase of feed speed from 1.8 to 2.2 mm/revolution in cutting gears with a pitch of 6.

Such methods, however, must be considered as only partially effective. Basic solution of the productivity and economic problems depend on the following: (1) use of sectional design in hobbing cutters; (2) use of hard-alloy blades on sectional hobbing cutters; (3) the design of special high-productivity machines for roughing-cut.

There has been partial installation of sectional hobbing cutters with interchangeable cutter-teeth racks at the Moscow Automobile Plant imeni Stalin, and complete installation at the Ural Automobile Plant imeni Stalin. The Orgavtoprom has worked out the following departmental standards for these cutters:

No Units Given	Maximum Dimensions of Tooth (mm)		Length (mm)		
	Module	Height	Cutter	Guide	Maximum Diameter of Tap
70	2	5	80	56	27
90	3	6	95	66	32
110	4.5	11	110	76	40
130	6	14	125	91	50

The use of sectional hobbing cutters with high-speed steel racks considerably lowers tool expenditure. Fitting them with hard-alloy disks enables cutting speed to be increased to 100 meters/minute.

Experimental work has shown that hard-alloy blades cut through hard, as well as slightly tempered, steel better than soft, ductile steel.

The most complex task is the creation of an especially rigid machine on which to apply these new, faster cutting methods.

CONFIDENTIAL

Sanitized Copy Approved for Release 2011/06/29 : CIA-RDP80-00809A000600200460-0

Rough Slotting of Cylindrical Gears

Rough slotting is used where milling is not possible because of the special design of the gear. The productivity of these operations is extremely low -- about half that of milling.

Such separate rationalization procedures as use of special gear-wheel cutters and improvement in the number of passes per minute give only partial results. The new Model OZ-7 gear-slotting machine put out by Vol'man, the Czechoslovakian firm, has increased productivity to a certain degree.

The machine is equipped for cutting, at one setting, multirim (not more than four) gear blocks of the same module. This not only cuts down the time of subsequent resetting, but increases the precision of the block, assuring great concentricity to the initial periphery of the ger-rim block. The cardinal solution, however, depends on the use of sectional profile shaping.

Broaching of Teeth

Broaching of the toothed periphery is an extremely productive method of machining teeth and for this reason long ago attracted the attention of technologists. However, the manufacture of broaching machines and the actual broaching operation on external-meshing gears is an extremely complex job.

In 1936, Korsun', a Soviet engineer, suggested a broaching machine composed of separate wheels, which machine would simultaneously broach all external teeth. Many difficulties have been encountered in working out the design for the broacher and its manufacture, and practical answers have not yet been found.

Data has been published on the simultaneous broaching of 30-tooth external-rim transmission gear on an ordinary vertical broaching machine modified for this purpose. The broacher was securely reinforced, and the unit drawn downward through it. The broacher was made in the form of angular segments rigidly attached to the wheel. In the event of damage to the teeth of the broach, only one segment is affected.

In the special semiautomatic machine for simultaneous broaching of all teeth on a cylindrical gear, the broaching is accomplished in one pass of the machine, during which each recess is machined by a separate broacher, permitting their individual dressing and adjustment. The attachment and control of the broachers is accomplished by special heads.

In other semiautomatic broachers, only one recess is cut at a time, after which the circular table on which the gear is fixed accomplishes an indexing revolution.

The broaching of teeth on gears having external meshing has not, however, achieved wide use either in the USSR or in America. This can be explained by the complexity of manufacturing, sharpening and installing such machines, and by the fact that the precision of the finished unit is not of sufficient quality to permit normal speed in the shaving process. Its high productivity, however, merits serious study and further working out for industrial use.

- E N D -