

The GE Series' Evolution to the GC50

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The GE4 model was launched for sale in 1994 and marked the beginning of the GE series. Afterwards the GE3 and GE6 models were prepared and put on the market as the GE series. It has now been more than ten years since the initial research and development work was begun. During those years JTEKT's CNC unit has been redesigned and re-introduced as the GC50.

The operational screens of the former unit continue to exist as they were since they were widely accepted for their outstanding features that make it ideal for operations. The newly developed GC50 CNC unit is armed with new technologies (notably improved maintainability and reliability).

The GE series models are equipped with this newly developed CNC unit. Minor changes were implemented in order to improve the operability and reliability of the GE series.

Key Words: GC50, improved performance, integrated function, touch panel, soft switching, selection input, interventional operation

1. Introduction

Since it was first introduced to the market in 1994, more than one thousand units of GE series general purpose cylindrical grinders have been sold. Such popularity is no wonder, considering these reasonably-priced machines are as handy as a hydraulic machine but are also capable of the multi-step grinding that only the CNC machines can achieve. The trend in the metal grinding industry has shifted the simple high-volume grinding processes overseas while keeping the domestic production focused on low-volume, diverse products that require higher precision. That is the reason why the GE series grinders, which can process new work pieces in shorter lead times, and which has the intervening function for high precision grinding, have been well received. Now the GE series has been enhanced even more by integrating the latest GC50B CNC unit, which is based on our GC50 CNC unit. This unit contains the special functions dedicated to our general purpose cylindrical grinders. We are pleased to introduce these GE series grinders and their new features in this report.

2. Objectives of Development

Over the last decade of research and development our GC32 CNC unit has evolved into the next generation GC50 unit. Our development objectives were focused on higher performance and higher reliability. On top of these, GC50B has been developed this time for further

improvement while succeeding the high operability of the GC32S which has been dedicated to general purpose cylindrical grinders.

3. Improvements in Basic Performance

- 1) The GC50 is composed of hardware and software based on the latest PC technology. Therefore, it is capable of performing many calculations at very high speeds. Thanks to this the execution cycles of the axis movement block and the macro block in the NC program have been reduced to 1/10 and 1/50 of the previous speeds, respectively. This enhancement contributes to a reduction in cycle time.
- 2) For data communication between the CNC and the servo drive the IEC61491 (SERCOS*), the only servo interface standard in the world, is being used. Thanks to the rapid synchronous communication technology of the IEC61491 (SERCOS*) we have succeeded in speeding up the position order renewal cycle of the servo drive which directly improves process accuracy.
- 3) The general purpose cylindrical grinders for low-volume-diverse production are required to store data for many different work pieces. The GC50 can now store data for up to 64 different work pieces (3 times that of the original GE series) and 64 × 30 processes (12 times that of the original GE series). This expanded data storage seeks to eliminate the troublesome task of data back-up and replacement (**Fig. 1**).

*SERCOS is a registered trade-mark of Interests Group SERCOS interface eV.

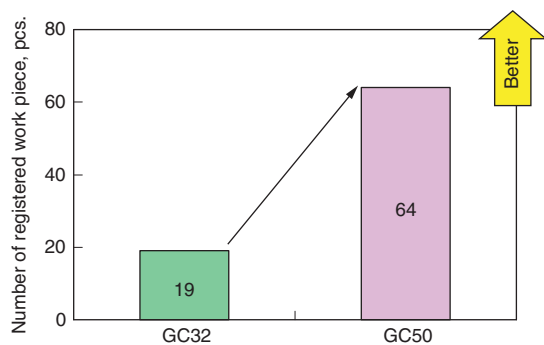


Fig. 1 Expansion of data memory capacity

4) By integrating the PLC tool and other peripheral tools into the CNC, devices otherwise used for PLC editing, downloading, and calculating are no longer needed. Also, the integration of a USB port has enabled data back up (Fig. 2) for all devices (PLC, CNC, servo) further eliminating the need of special dedicated equipment.

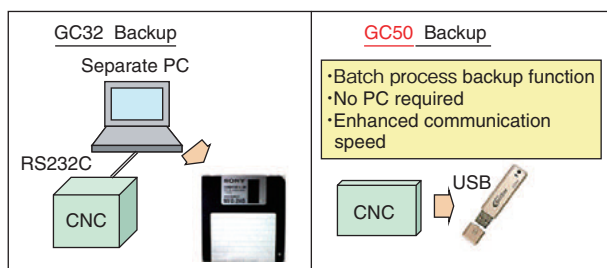


Fig. 2 Data backup

4. Reliability Improvement

The GC50 and its servo system have been developed to improve the MTBF (mean time between failures). It also has a built-in function to reduce the MTTR (mean time to repair) in case of a sudden unpredicted failure.

4.1 Improvement of the MTBF

- 1) The number of components in the new GC50 has been reduced by 75% to improve reliability.
- 2) Nearly 40% of the switches have been changed from hard to soft switches, reducing the number of components as well as improving reliability.
- 3) The servo amplifier has been designed to have twice as long life as before. Also, each unit is equipped with failure and lifetime warnings to facilitate preventive maintenance service thereby avoiding a sudden stop of machine operation.

4.2 Reduction of MTTR

- 1) The CNC incorporates fault guidance functions which display detailed information to aid in the identification of the cause of the trouble. We have built into the CNC

fault flow guidance function, which uses a dialogue style to pinpoint the cause of any trouble. These functions make finding problems and their causes simple for operators. This function has successfully reduced the MTTR (Fig. 3).

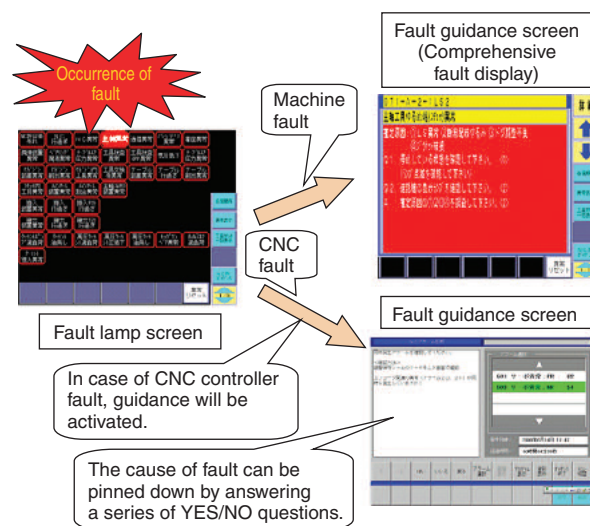


Fig. 3 Guidance in case of fault and guidance in case of fault flow

- 2) When using the operation guidance function the next action button (following the fault) is highlighted which expedites the smooth execution of the actions required to resume operation after an unexpected failure (Fig. 4).

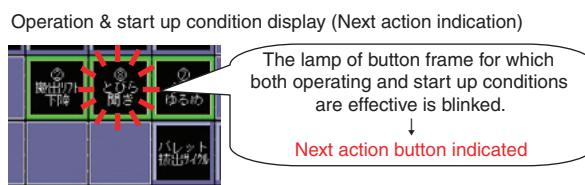


Fig. 4 Operational guidance

- 3) The encoders utilized by the GC50 have intensive self-diagnosis functions to output detailed information about any failures. Also, the servo-amplifier has functions to examine power line breakage or grounding. These measures have reduced the time for dealing with failures. Finally, if an encoder should fail, the problem can be solved by replacing only the broken encoder instead of replacing the entire motor.

5. Improvement of Operability

5.1 Facilitation of Data Input

It is imperative that the CNC general purpose cylindrical grinder maintains a higher productivity than a non-CNC machine in single work processing. Therefore,

the GC50 makes the best use of its general purpose cylindrical grinder functions and its operational screen. In addition, the GC50 system is designed so that the number of operations on screen as well as the amount of required data can be drastically reduced in order to shorten "production preparation time."

- 1) The use of a touch panel allows the operator to directly select the input target on the screen. This greatly improves operability when compared to the old method of moving a cursor around with the arrow button to perform the same task.
- 2) The previous numerical display/numerical input style setting has been changed to a word-based display/word-based input style. This makes it possible for the operator to work without having to memorize the instruction manual or consulting any help screens (Fig. 5).

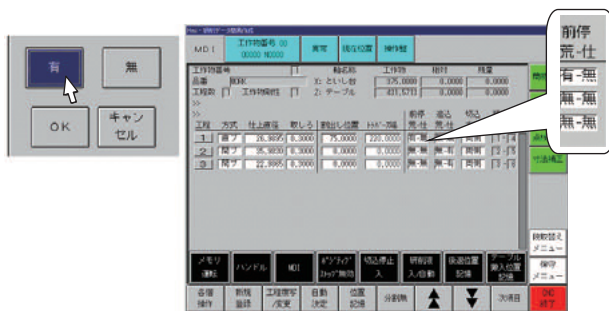


Fig. 5 Screen for programming grinding-data

- 3) By employing a 12.1 inch colored liquid crystal display, the size of display has been expanded. This makes it possible to display more processes at once on the display reducing the need to change screens often.
- 4) Permitting the input of fitness symbols of drawings including tolerances as well as permitting the input of arithmetical operations allows the GC50 to be operated without a calculator or a conversion table (Extended data input function).
- 5) The GC50 also incorporates a simplified automatic grinding condition determination system which allows the setting of grinding conditions with a minimal amount of data. These parameters are also available to the operator so that they may be customized for any unique situation.
- 6) The GC50 has a series of functions including automatic inboard alignment of the grinding wheel and the work piece, taking in the location data at the push of a button and converting that into the data required for automatic operation. This function effectively reduces the amount of required data input and reduces input errors (Fig. 6) (Operation data input function).
- 7) The hard buttons on the conventional CNC have been replaced by soft buttons. Since only those buttons that are needed are displayed, this greatly improves the

- operability and ease of use of the machine. Also, the 30% reduction of hard buttons improves reliability.
- 8) The handle, which used to be integrated on the control board, is now a separate unit to improve operability.

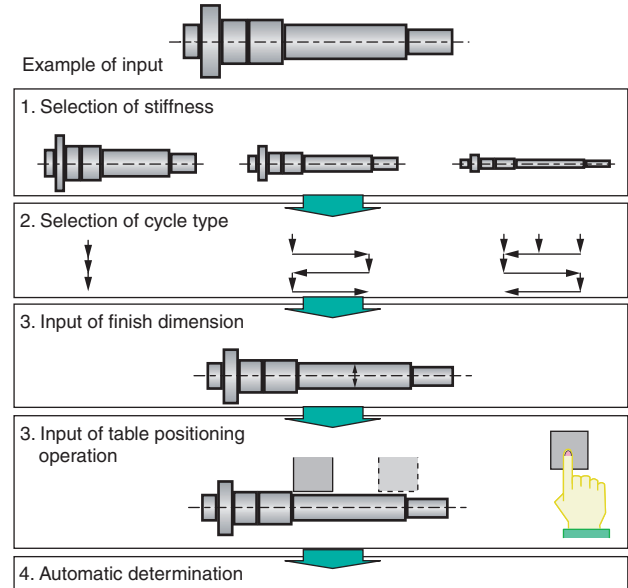


Fig. 6 Programming grinding-data

5. 2 Facilitation of Data Correction

An operator who is accustomed to non-CNC grinders knows when to change grinding conditions based on such sensory information as sparks seen during the grinding process. However, the operation of a CNC machine, which relies on data input through a keyboard, is very different from such a feeling intensive operation. To solve this problem the GC50 is equipped with additional functions that allow data compensation based on the feeling information like in a conventional grinder.

- 1) During the grinding operation, the speed can be adjusted by using the override switch. By reflecting this adjusted speed in the current grinding data, responsive data compensation is possible (Proportional compensation of speed data).
- 2) Data input errors are minimized when making compensations by using incremental offsets. Data compensation can be achieved by adding or subtracting these offsets with the existing data (Arithmetic input function).
- 3) When taper grinding, the compensation of cutting depth in feeding direction can be automatically calculated by inputting the table swivel angle and longitudinal compensation amount. The operator will not need a calculator or conversion table when making adjustments to tapers (Taper grinding longitudinal compensation function).

6. Intervening Operation

A single work processing has to do without a trial grinding run. In this case the most effective method an operator can use is to feed the grinder manually by using the handle and watching on the grinding condition. In order to provide this capability the GC50 incorporates an intervening function that allows mid-cycle handle intervention.

1) When a high precision part is ground, the operators will grind the part oversized. They next measure the part and grind the remaining stock on the part. Adjustment to the appropriate grinding conditions and dimensions should then be made. Air cut time will be long because grinding was half-done to the required stock. On the other hand, the cycle interruption and infeed function allows a quick feeding down to the position where the last grinding was completed, which results in a shortened cycle time. In addition, this function allows re-grinding to repeat as many times as desired by setting it as "finish grinding remains" and selecting the desired oversize dimensions (Figs. 7 and 8).

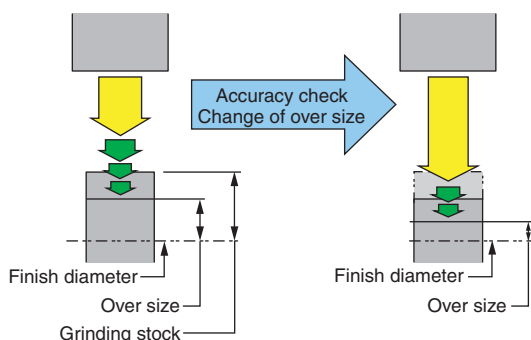


Fig. 7 Cycle interruption and infeed function

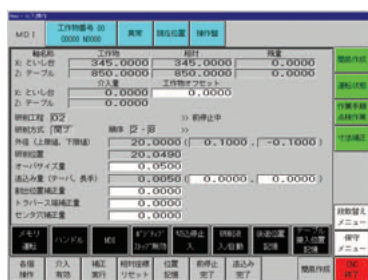


Fig. 8 Screen for interventional operation

2) The software positive stop function is used in manual grinding operation. This prevents the operator from feeding the wheel in handle mode past the programmed position accidentally. This helps to prevent defective works from being made.

3) In automatic traverse grinding, the manual table reverse turning is instrumental. It enables operators to reverse the table stroke at any desired position within

its reverse grinding range. It can be used to remove the medium convex profile. When the grinding stock is uneven, this function can be used to remove the larger stock first. After the stock removal is made even, normal traverse grinding can be started. This greatly shortens the required processing time (Fig. 9).

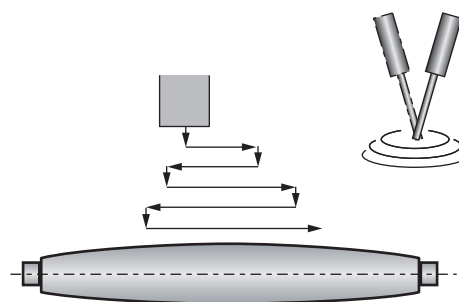


Fig. 9 Manually table reverse turning function

7. GE Series

The GE series is comprised of GE3, GE4 and GE6 grinders, each having straight and angular grinding wheel specifications (Table 1), as well as appropriate centering specifications suitable for each grinder (Only straight grinding wheel specifications for the GE6).

Table 1 Main specifications of GE series

Unit	GE3A	GE3P	GE4A	GE4P	GE6P
Center distance, mm	250	250	500/ 1 000	500/ 1 000/ 1 500	1 600/ 2 500
Wheel diameter, mm	355	355	455	405	610
Max. work dia., mm	200	200	320	320	550
Max. grind dia., mm	60	60	300	300	500



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