

NEW-GENERATION HYBRID RECORDERS

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1. FOREWORD

The world's industrial recorder market is approximately 500,000 units. Approximately 70% of these are the so-called hybrid type (for the year 1990). Recorders are rapidly becoming digital and intelligent. Hybrid recorders can be made to indicate and record digitally, in addition to conventional analog recording, by installing a microprocessor. Recently, they have become more advanced and flexible providing with various calculation processing and data communication functions, and have increased their market in the field.

Since 1985, Fuji Electric has developed and supplied to the market the 250 mm recording width type PGH and 100 mm recording width type PGC. hybrid recorders. But users needs have changed greatly with the recent rapid growth of electron-ification of industry as a whole so that multiple colors and higher speed, higher reliability, and simplification of operation, etc. are strongly desired.

The Microjet introduced here are revolutionary hybrid recorders using an ink jet system. They were developed to meet such user needs and as new-generation recorders with ample market competitive power in the world.

2. OUTLINE

The two models of the Microjet recorders developed this time are shown in *Fig. 1*.

The PHA (*Fig. 1* right) can record up to 12 input points at 180 mm chart width and the PHC (*Fig. 1* left) can record up to 6 input points at a 100 mm chart width. The recording method is the ink jet for both models.

An unique ink jet head was completed with the original silicon micromachining technology fostered with the FCX transmitter, etc. and high quality, bright, sharp, and reliability recording was realized. The smallest and lightest in the industrial recorder field and easy to use recorder was made by fusing microelectronics with this excellent element technology.

3. INK JET TECHNOLOGY

The ink jet method is becoming a key technology in

Fig. 1 Microjet recorders

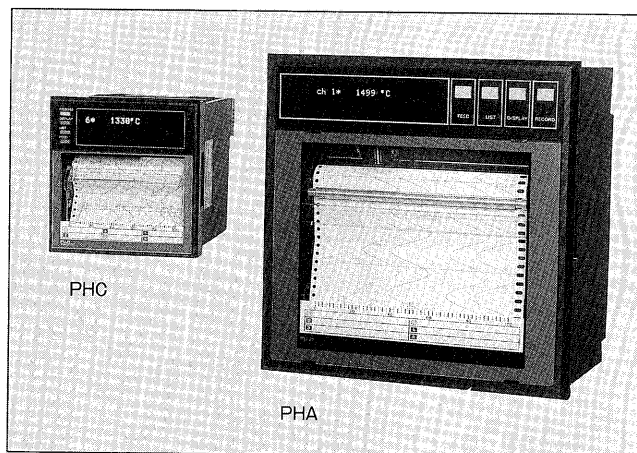
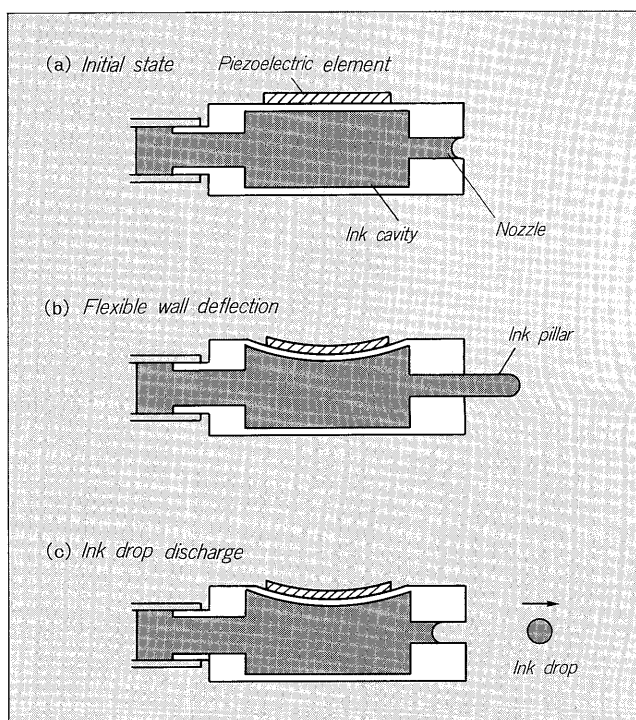


Fig. 2 Principles of operation of ink jet



the printer and other information processing fields. Recently, its application to plotter, etc. has also be considered.

Backed by micromachining technology, the Microjet uses an ink jet head with a piezoelectric element. Its principles of operation are shown in *Fig. 2*.

The properties of the piezoelectric element are such that it is deformed when a voltage is applied. When the ink cavity is filled with ink and a voltage is applied to the piezoelectric element as shown in *Fig. 2*, the ink in the ink cavity is compressed by the deformation of the piezoelectric element and a drop of ink is discharged from the nozzle. This drop of ink makes a minute dot on the chart. Sharp and bright printing quality can be obtained by forming lines and characters by connecting these minute dots.

The ink jet head is housed in an ink cartridge as shown in *Fig. 3*. Bags containing different inks are connected to four ink passages on the head in the cartridge. Six colors recording (7 colors on test pattern) can be realized by superimposing the drops of four colors of ink on the chart.

4. FEATURES

To make full use of the advantages of the ink jet method, the development concept was designed as follows:

- (1) Simple design Trouble-free construction
- (2) High quality recording Recording equal that of a pen recorder
- (3) Simple operation

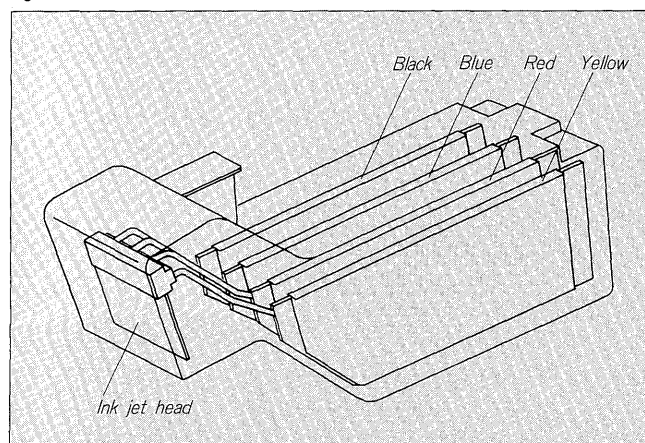
4.1 Simple design

- (1) Smallest size and lightest weight
 - Depth:PHA, PHC both 199 mm
 - Weight:PHA Approx. 6 kg, PHC Approx. 2.8 kg

The smallest in this class.

By using an ink jet head, the complex servo mechanism indispensable with the conventional pen recorder is unnecessary and the many mechanical parts of the drive unit can be replaced with electronic parts. The mechanical parts were reduced to approximately 1/3 those of conventional recorders and even the electronic parts were intensified by multiple use of the microprocessor and the total number of parts was reduced to approximately 2/3.

Fig. 3 Ink cartridge



(2) Trouble-free construction

The ink cartridge drive mechanism is shown in *Fig. 4*. The ink jet head discharges ink while moving at high speed perpendicularly to the chart in accordance with rotation of the carriage motor. Since the head and chart do not touch at this time, there is no wear parts and the chart is not damaged. Therefore, long-term stable recording can be performed.

Moreover, the Microjet has an independent A-D converter for each input for high-speed sampling of the input signal. Therefore, the input scanning relays that was indispensable with conventional multi-point recorders is unnecessary and, theoretically, the construction is such that there is no trouble generated due to relay life.

(3) Multi-input, free power supply

To simplify model selection by the user and shorten the delivery time, products capable of flexibly coping with the market are demanded.

Twelve thermocouples (B, R, S, K E, J, T, N, W, L, U, PN) and resistance bulbs (Pt100 Ω , JPt100 Ω), DC voltage input (± 50 mV, ± 500 mV, ± 5 V, ± 50 V) and their combinations can be arbitrarily selected and modified as the Microjet input signals.

The power supply is AC85–300 V free power supply for the PHA and AC85–150 V/AC150–300 V switching system for the PHC so that they can be widely used even overseas.

4.2 High quality recording

(1) Six color continuous recording

The ink jet head performs recording while raster scanning on the chart. One scan takes a minimum of 3 seconds for the PHA and 2 seconds for the PHC.

Since the recording would skip like a dot recorder if performed only once every 2 or 3 seconds, a special algo-

Fig. 4 Ink jet head drive mechanism

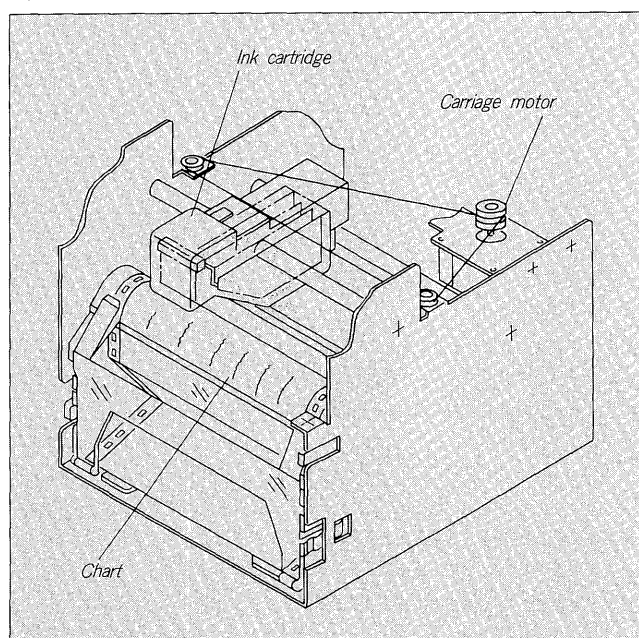


Fig. 5 Hybrid recording example (actual recording is in color)

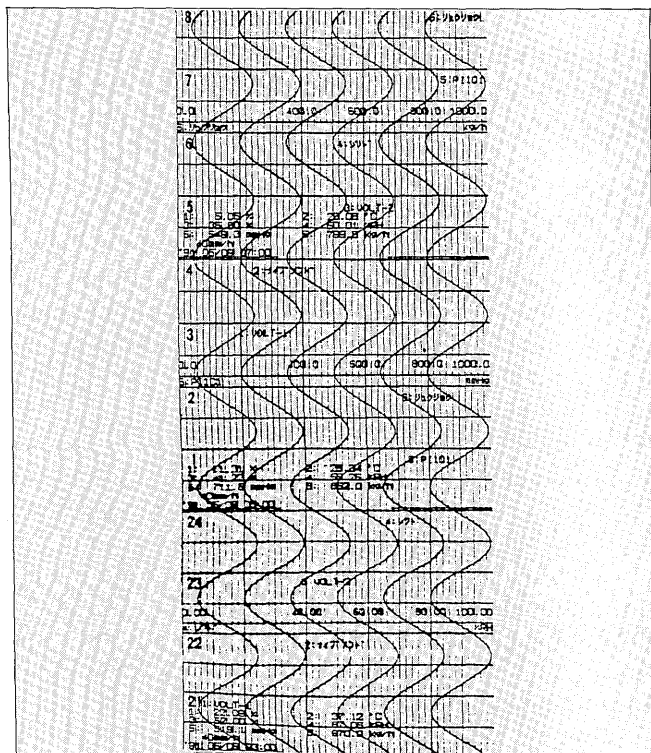


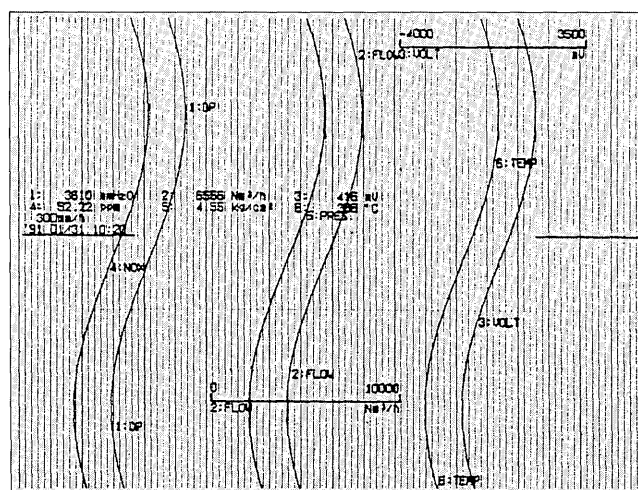
Fig. 6 Daily report list example (actual list is in color)

DAILY REPORT						
UNIT	ch 1	ch 2	ch 3	ch 4	ch 5	ch 6
atmos.	flux	density	current	rev.	Power	
mmHg	1/h	ppm/ox	mA	rpm	W	
06/07 14:00	759.9	1499.7	0.501	92.22	1599.6	379.9
06/07 15:00	759.9	1499.7	0.501	21.76	1599.6	379.9
06/07 16:00	759.9	1500.0	0.501	32.12	1600.0	379.9
06/07 17:00	759.9	1500.0	0.501	18.84	1599.6	379.9
06/07 18:00	759.9	1500.0	0.501	-2.88	1599.6	379.9
06/07 19:00	759.9	1500.0	0.501	-21.78	1600.0	379.9
06/07 20:00	759.9	1499.7	0.501	-35.28	1600.0	379.9
06/07 21:00	759.9	1500.0	0.501	-40.02	1599.6	379.9
06/07 22:00	759.9	1500.0	0.501	-34.66	1599.6	379.9
06/07 23:00	759.9	1500.0	0.501	-21.08	1600.0	379.9
06/08 00:00	759.9	1500.0	0.501	-2.12	1599.6	379.9
06/08 01:00	759.9	1500.0	0.501	17.06	1599.6	379.9
06/08 02:00	759.9	1500.0	0.501	32.66	1599.6	379.9
06/08 03:00	759.9	1500.0	0.501	39.72	1599.6	379.9
06/08 04:00	759.9	1500.0	0.501	37.04	1599.6	379.9
06/08 05:00	759.9	1500.0	0.501	25.18	1600.0	379.9
06/08 06:00	759.9	1500.0	0.501	7.02	1599.6	379.9
06/08 07:00	759.9	1500.0	0.501	-12.76	1599.6	379.9
06/08 08:00	759.9	1500.0	0.501	-29.44	1600.0	379.9
06/08 09:00	759.9	1500.0	0.501	-38.66	1599.6	379.9
06/08 10:00	759.9	1500.0	0.501	-38.66	1600.0	379.9
06/08 11:00	759.9	1500.0	0.501	-28.86	1599.6	379.9
06/08 12:00	759.9	1499.7	0.501	-11.68	1600.0	379.9
06/08 13:00	759.9	1499.7	0.501	7.86	1599.6	379.9
MAX	14:00	14:00	14:00	14:00	14:00	14:00
MIN	14:00	14:00	14:00	14:00	14:00	14:00
AVERAGE	759.9	1499.7	0.501	-40.04	1599.6	379.9
	759.9	1499.9	0.501	0.45	1599.7	379.9

rithm which performs recording period data compensation and ink amount adjustment was developed for the PH Series and the same recording quality as a pen recorder was obtained.

Generally, input signal sampling is a very high speed compared to the recording period, and several ten samplings are possible during one recording period. A seemingly continuous recording can be obtained by calculating dot of the number balanced to the signal change amount during one recording period at the next recording period so that

Fig. 7 Zone recording example (actual recording is in color)



there are not dot intervals (as if the dots were connected) and discharging the ink.

Since the input signal sampling time of the Microjet is a fast 160 ms up to 3 points and 320 ms for 4 to 12 points, it can catch even rapid signal changes.

(2) Six colors digital printing

The ink jet is an original printer technology. Its advantage is that characters and numerics can be printed in multiple colors.

The Microjet printing font consists of 8×10 dots and alphanumeric and some special symbols printing are possible. In analog and digital mixed hybrid recording, recording, recording reading ease and reliability are given by printing tag No., instantaneous value (periodic printing), and memory line in colors corresponding to each channel. (Fig. 5)

The following tabulation functions are also available and the recorded result can be made more valuable.

- Instantaneous value list: Prints a list of instantaneous values of each input.
- Daily report list: Prints the instantaneous values and maximum, minimum, and average values for each hours of each input in table format. (Fig. 6)
- Prints the integrated value for each hour and the daily total of each input in table format.

(3) Operation function

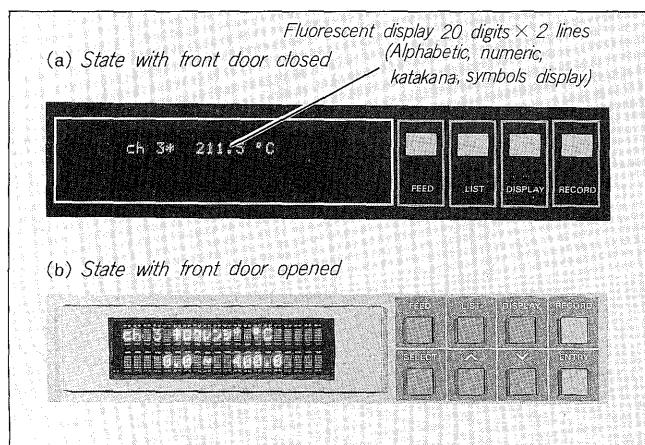
A big feature of a hybrid recorder is that the input signal can be recorded and printed as an industry value by microprocessor control.

The Microjet performs data conversion on the input signal by filter, square root extraction, subtract calculation, scaling, etc. and leaves a record as data which can be read directly.

Recording matched to plant operation and the user usage conditions is also possible by selecting the following recording formats:

- Autorange recording: When the signal exceeds the recording range, it is recorded by shifting the range automatically.
- Zoom recording: Recording is performed by ex-

Fig. 8 Simple key operation



panding one part and contracting other parts in the recording range.

- (c) **Zone recording:** Recording is performed by dividing the recording range into 2 to 4 zones and distributing the input signal. (Fig. 7)

4.3 Simple Operation

(1) Use of large fluorescent display

Conventionally, for this kind of instrument, as the functions were advanced and performance was improved, the number of setting parameters increased and operation became difficult.

For the Microjet key operating was simplified by providing a large fluorescent display on the front of the instrument.

In the state in which the front door is closed as shown in Fig. 8. recording starting and stopping, feed, and other operations are performed by means of four keys. When the door is opened, four more keys appear so that parameter setting, etc. can be performed.

The fluorescent displays are 20 digits \times 2 lines for the PHA and 16 digits \times 2 lines for the PHC. Both displays alphanumerics. When setting parameters, the individual name of parameters and helpfull comments by the language and manualless setting can be performed. The language can be selected from English, German, or French.

(2) Easy maintenance

The ink cartridge is a detachable type and can be easily changed from the front of the instrument.

Chart end and out of ink detection functions are provided so that maintenance is performed easily and smoothly.

5. CONCLUSION

The features of the Microjet recorders were introduced above. The Microjet recorders are new-generation hybrid recorders with revolutionary features and are new products which bear the nucleus of industrial instruments.

This product is an international product which amply meets the needs of the overseas market, and we are confident that it will contribute to the world wide industrial field.

In the rapid development of advanced informationalization and total automation, the need for recorders is expected to also change and expand in the future. Fuji Electric will continue its efforts in the development and research of superior element technology and products and meet the needs of users.