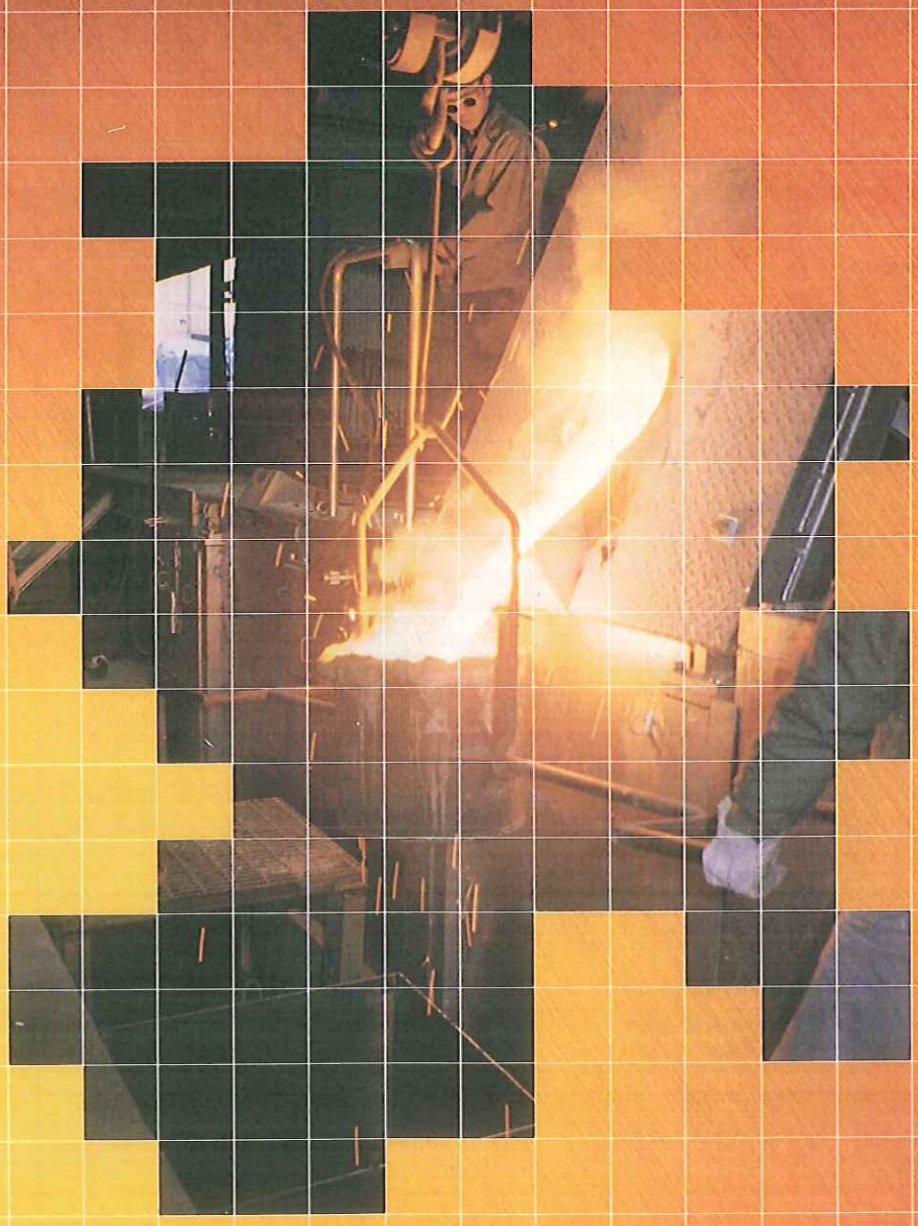
TAICHIKU

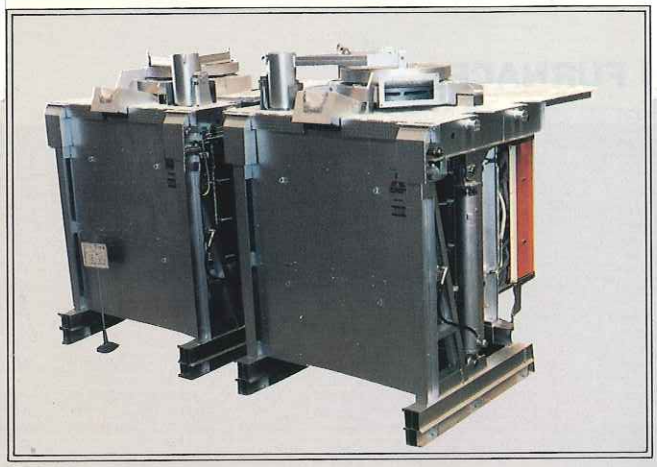
MEDIUM-FREQUENCY INDUCTION FURNACES



The spectacular development of induction-furnace facilities has modernized foundries,achieving stable product quality,high operational efficiency,greater operational safety,and environmental improvements.Medium-frequency furnaces are being extensively used for melting special steel and other high-grade casting metals as well as for ordinary cast iron.Thanks to these capabilities, these furnaces have become indispensable to the casting industry.

In response to customers'requests,Taichiku has carried out development in this field based on our abundant experience and accumulated technical knowledge.

As a full-range manufacture,Taichiku offers planning well-suited to individual corporate needs,in addition to design,manufacturing,and installation services based on top-notch technological performance.The full range of our services is geared to satisfying every need of clients in this field.



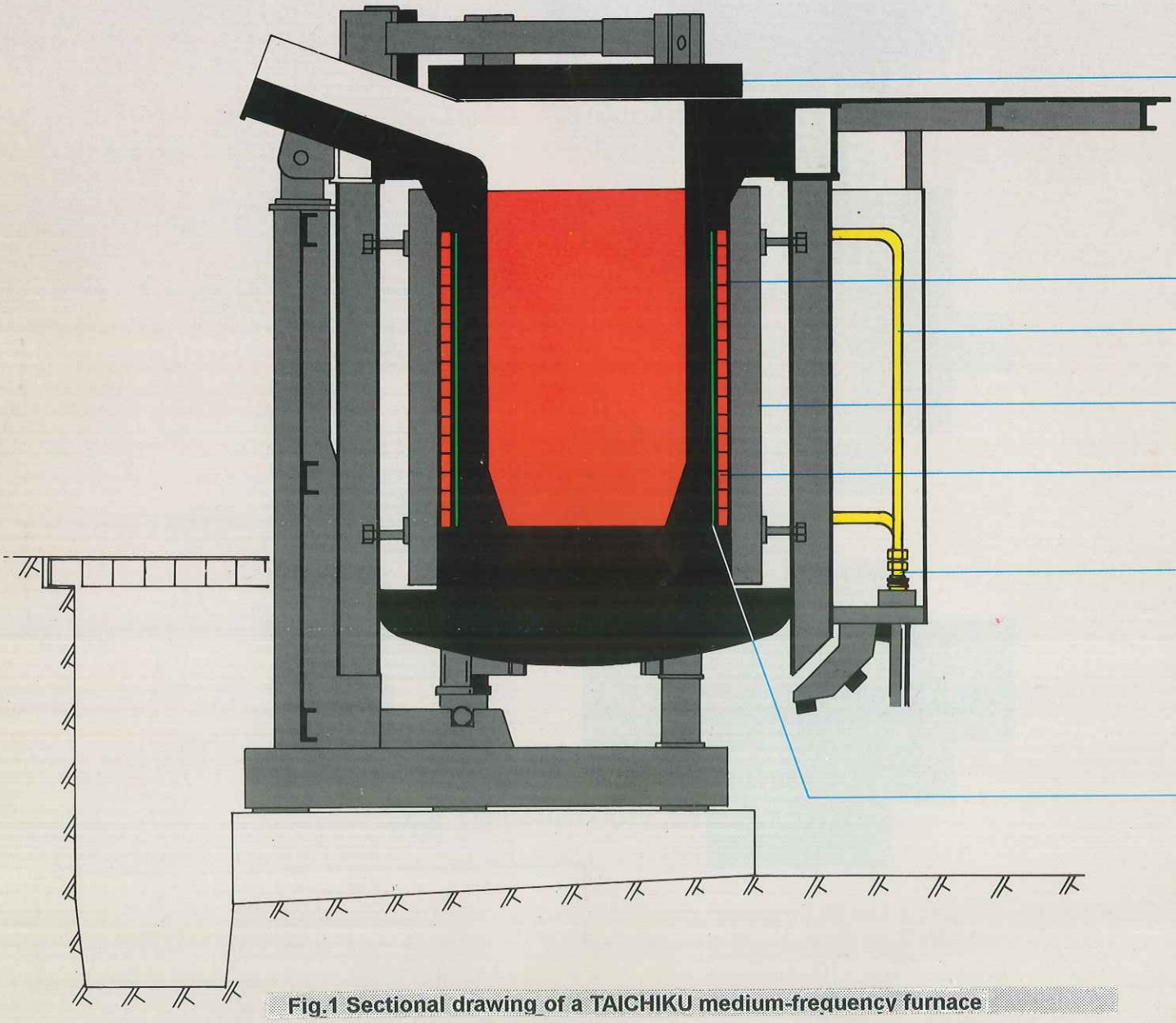


Fig.1 Sectional drawing of a TAICHIKU medium-frequency furnace

FEATURES OF THE FURNACE BODY

Furnace Cover

Opening and closing are carried out smoothly using a hydraulic cylinder. Since the cover is sealed tightly against the furnace body, heat loss is mimimized, thus saving energy. In small-size furnaces, a manual rotating cover is adopted.

Water-Cooled Coil

Since the copper tubing for the coil is drawn from oxygen-free copper, there is no coil deformation and no water leakage at joints. This design realizes a highly efficient furnace with a long-life coil and good coupling with molten metal.

Furnace Body

A cage-type welded structure using H-shaped steel is adopted. By virtue of this structure and the plate used at the furnace bottom, a sturdy structure is achieved. Observation is possible from positions near the coil, iron yokes, coil lead tubes, etc., so that maintenance can be easily performed.

Iron Yokes

These yokes are arranged around the entire outer circumference of the coil to prevent magnetic flux. Coil deformation is also prevented during expansion of the lining.

Coil Cement

The inner surface of the coil is provided with coil cement with high refractory properties,a unique Taichiku formulation developed to protect the coil from hot-water corrosion.

Water-Cooled Cable

Connection with the coil is made with an engaged joint-type union, which allows the connection to be used simultaneously for both electric current and water. Assembly and disassembly are simple, the installation space is small, and maintenance is easy. The rubber hose and conductor wire are easy to separate, so that overhauls may be easily performed.

Molten-Metal Detector with Probes

This Taichiku-developed device is protected by patents and and has won a reputation as the top performer in its field.

FEATURES OF THE POWER-SOURCE UNIT

Maximum-Power-Supply Control Sysfem

This control system, which is built into the power-source unit, allows constant impression of the maximum electric power by compensating in a forced manner the reduction of electric power at the initial melting period, a function not possible with the fixed-capacitor system. The result is shortened melting time and decreased power consumption per unit.

Highly Efficient Thyristor Converter

The selection of thyristors was made to ensure that only optimum types were applied, including those of the world's largest class. Thanks to circuit construction that preserves the characteristics of the parallel-type inverter, the following high efficiency and energy saving are obtained:

Actually measured value: 95.5% of the conversion efficiency (incl. the input transformer).

Thyristors of the Highest Power

Among the thyristors adopted for reverse conversion are a large-capacity type that has a reverse and off-state voltage of 1,350V (nonrepetitive peak), RMS on-state current of 2,360A, surge on-state current of 30,000A, and turn-off times of 20 and 30μs. And of course, the thyristors used have been selected for optimum correspondence with the required capacities. In this way, the number of parts in the power-source unit has been reduced and high reliability established.

The operation record shows the outstanding reliability of 20,000hr MTBF.

Compact Installation Space

This special-use power-source unit is designed and manufactured on the basis of our experience as a full-range manufacturer. By combination with the most suitable water-cooling system, a compact power-source unit for functional plant layouts is achieved.

Complete Protection System

Equipment protection and safe operation are fully realized. In the event of a malfunction, the type of malfunction is indicated at the panel to facilitate prompt repair.

Table 1 Capacities

Furnace capacity (kg)	Rated power (kW)	Freq. (Hz)	Cast iron (1500°C)		Cast steel (1600°C)	
			Melting time (min)	Power requirement (kWh/t)	Melting time (min)	Power requirement (kWh/t)
150	200	1000	29	635	31	685
200	200		40	644	42	700
250	300		31	607	33	648
300	300		39	615	41	655
500	300		64	625	68	669
	600	500	29	564	31	598
1000	600		59	573	62	610
	900		39	555	41	587
	1200		28	544	30	574
1500	900		58	557	61	590
	1200		43	544	45	575
	1500		34	537	36	567
2000	1200		57	545	60	577
	1500		45	537	47	567
	1800		37	532	39	561
3000	1500		67	538	70	569
	1800		55	532	58	561
	2400		41	524	43	552
5000	2400		68	526	71	555
	3000		54	521	57	549
	3600		45	517	47	544
8000	3000		86	524	90	552
	3600		71	519	75	547
12000	3600		107	524	113	552
	4800		80	517	84	544

Notes: 1. The values given in the table refer to the melting of cold charge with a hot furnace, and such operations as slag removal, maintenance, and pouring are not included. In an actual operation, the values will of course differ according to the type of charge material, charging method, molten-metal handling, and other operating conditions.

2. Furnaces of various specifications are available in addition to the standard type used in the table. Please consult your Mitsubishi Electric representative.

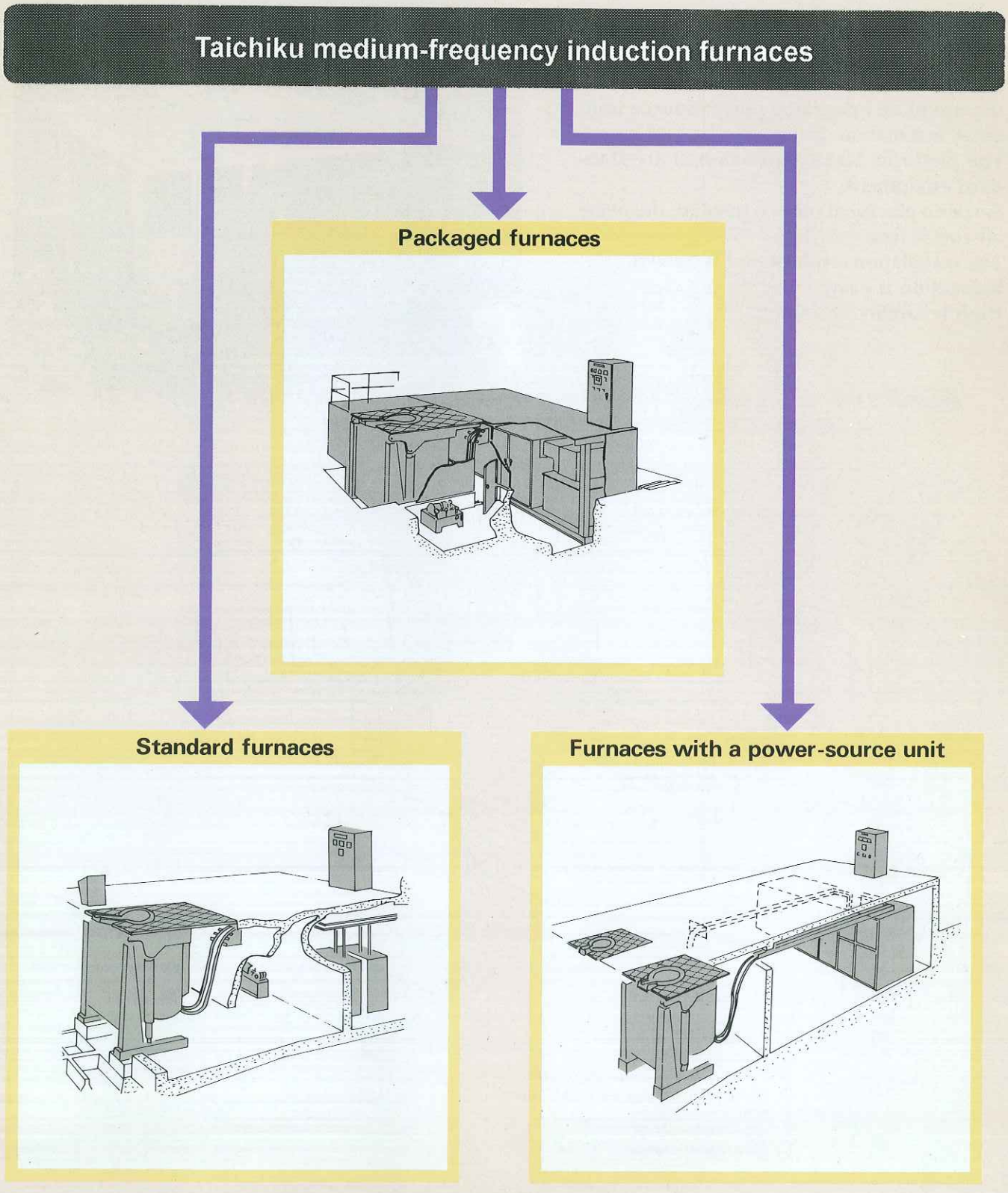


Fig. 2 Available furnace types

PACKAGED FURNACES

FEATURES

- Energy Saving—Wiring loss is reduced by the use of an integrated power-source unit.
- Small installation space.
- The platform, stairs, and handrail are standard equipment.
- Since no electrical room is needed, the overall cost is low.
- The installation work period is halved.
- Relocation is easy.
- High reliability and safety.

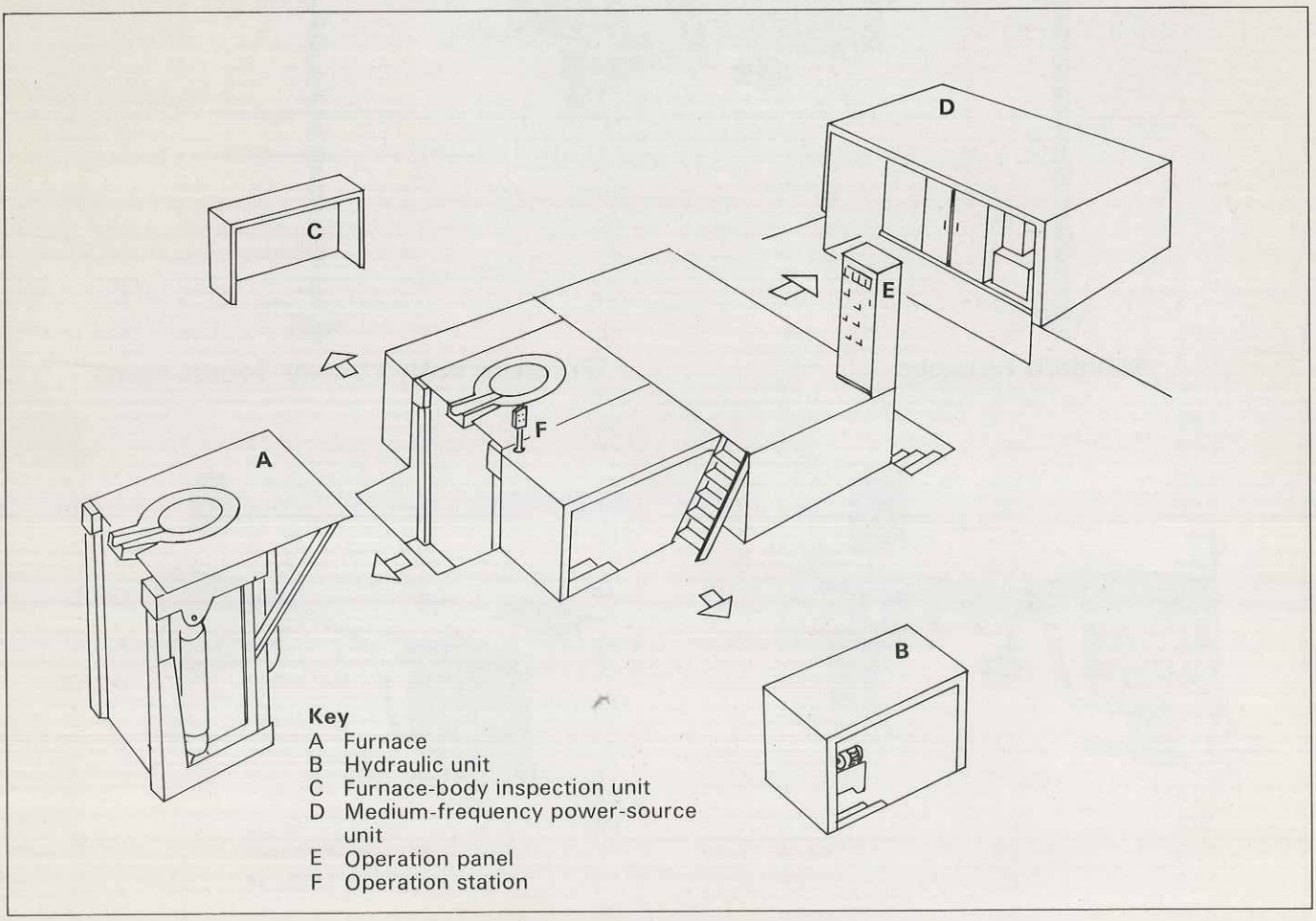


Fig. 3 Packaged-furnace layout

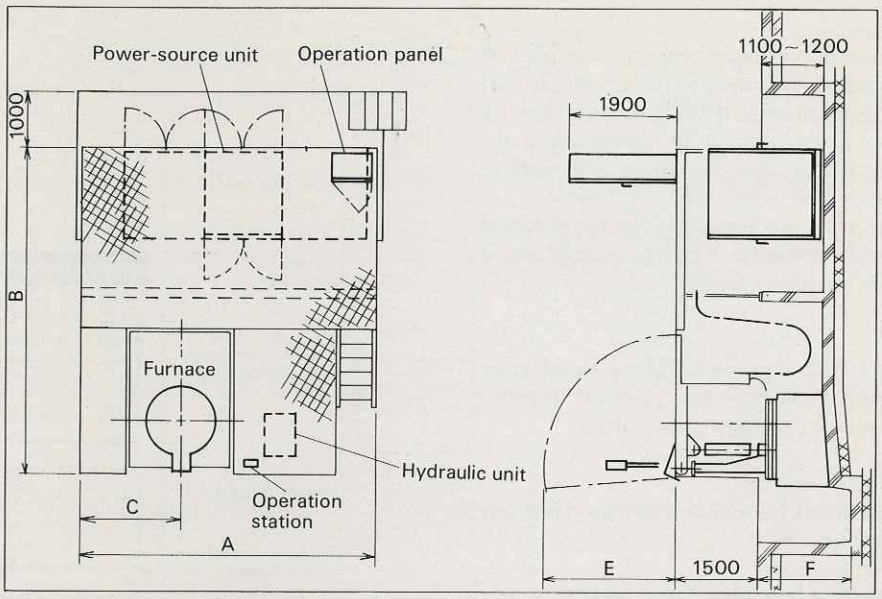


Fig. 4 Outlines and dimensions of a packaged furnace with 1 power supply and 1 furnace

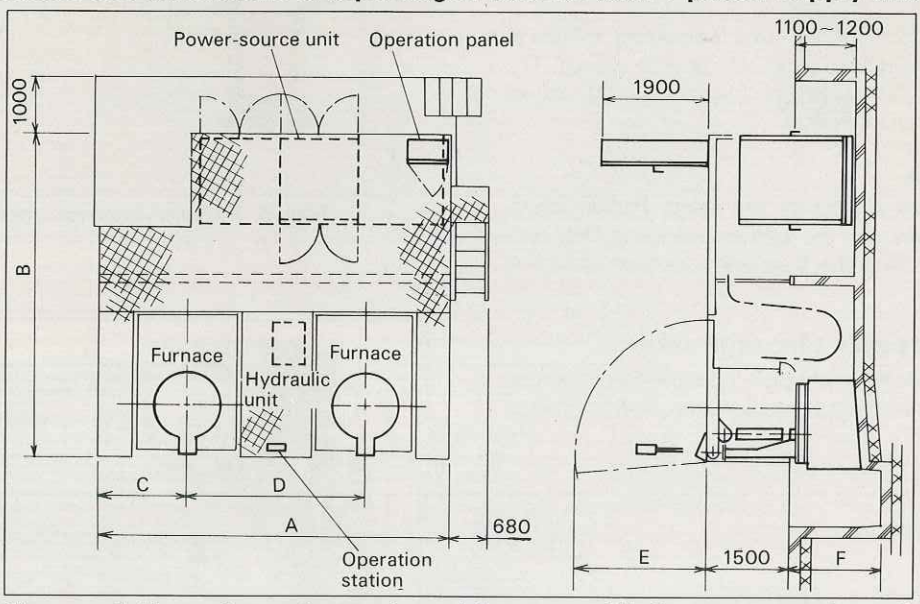


Fig. 5 Outlines and dimensions of a packaged furnace with 1 power supply and 2 furnaces

Key to Fig. 4

Furnace capacity (kg)	Electric power (kW)	Dimensions (mm)					
		A	B	C	D	E	F
300	300	4400	5060	1525	—	1865	600
500	300	4400	5060	1525	—	1865	600
	600	4400	5060	1575	—	1880	750
1000	600	4400	5700	1525	—	2285	1650
	900	5600	5500	1925	—	2285	1650
	1200	5600	5500	1925	—	2285	1650
1500	900	6000	6125	2225	—	2505	1800
	1200	6000	6125	2225	—	2505	1800
	1500	6000	6125	2225	—	2505	1800
2000	1200	6000	6300	2125	—	2670	1800
	1500	6000	6300	2125	—	2670	1800

Key to Fig. 5

Furnace capacity (kg)	Electric power (kW)	Dimensions (mm)					
		A	B	C	D	E	F
300	300	5000	5060	1250	2200	1865	600
500	300	5000	5060	1250	2200	1865	600
	600	5200	5060	1300	2300	1880	750
1000	600	6200	5800	1525	3150	2285	1650
	900	7300	6300	1525	3150	2285	1650
	1200	7300	6300	1525	3150	2285	1650
1500	1900	7900	6500	1825	3350	2505	1800
	1200	7900	6500	1825	3350	2505	1800
	1500	7900	6500	1825	3350	2505	1800
2000	1200	7900	6800	1725	3550	2670	1800
	1500	7900	6800	1725	3550	2670	1800

POWER-SOURCE UNIT

The "package" of Taichiku packaged furnaces includes all the power-supply equipment, but not the furnace body and hydraulic device. Packaging assures that the wiring loss of this equipment is kept at the mimimum, achieving a remarkable energy-saving effect. Irrespective of the furnace capacity, the power source can supply 300～1,800kW.

A furnace-body changeover unit can also be included to meet the needs of systems with 1 power supply and 2 furnaces, thus assuring increased versatility.

● Incoming Panel

The contactors supplied with this panel allow load connection and disconnection and serve for overload protection, and a power fuse protects against short circuit.

● Power Transformer

An oil-immersed, water-cooled transformer of the minimum size is installed for indoor use.

● Medium-Frequency Thyristor-Converter Panel

This panel employs the well-known Mitsubishi constant-voltage-constant-frequency (CVCF) AC power source. The parallel inverter features stable performance, and almost all the parts are maintenance-free.

● Capacitor Bank

Low-loss water-cooled capacitors are used. Partial adjustment of the capacitors can be performed using the contactors, and by controlling the frequency, power reduction can be compensated.

● Furnace-Changeover Circuit Breaker

A compact, water-cooled, two-pole, double-throw circuit breaker especially developed for medium-frequency furnaces is employed.

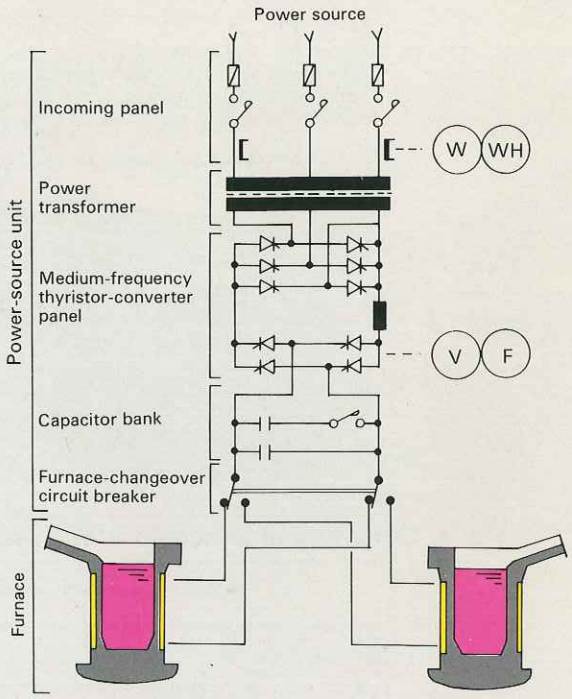
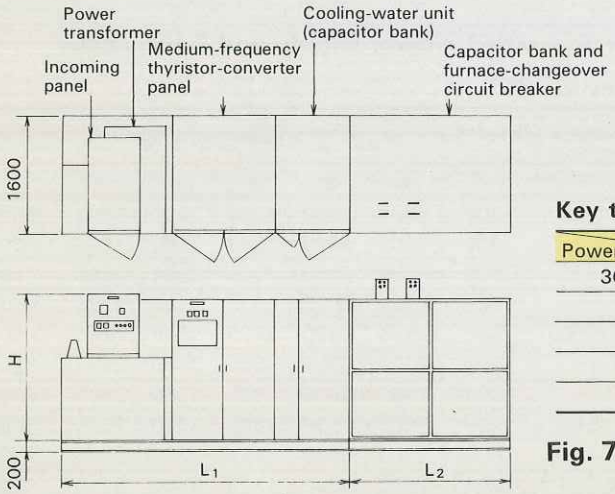


Fig. 6 Power-source connections



Key to Fig. 7

Power \ Dimension	L1	L2	H
300～ 600kW	4000	—	2050
～ 900kW	4700	1800	2050
～1200kW	4700	2400	2050
～1500kW	5200	3000	2300
～1800kW	5500	3600	2300

Fig. 7 Outlines and dimensions (mm) of the power-source unit

COOLING-WATER UNIT

Cooling water plays a very important role in induction furnaces. As shown in Fig. 8, a spare pump is supplied in addition to the working pump, and an emergency engine pump is provided. The piping is arranged so that change-over can be performed immediately if an emergency occurs.

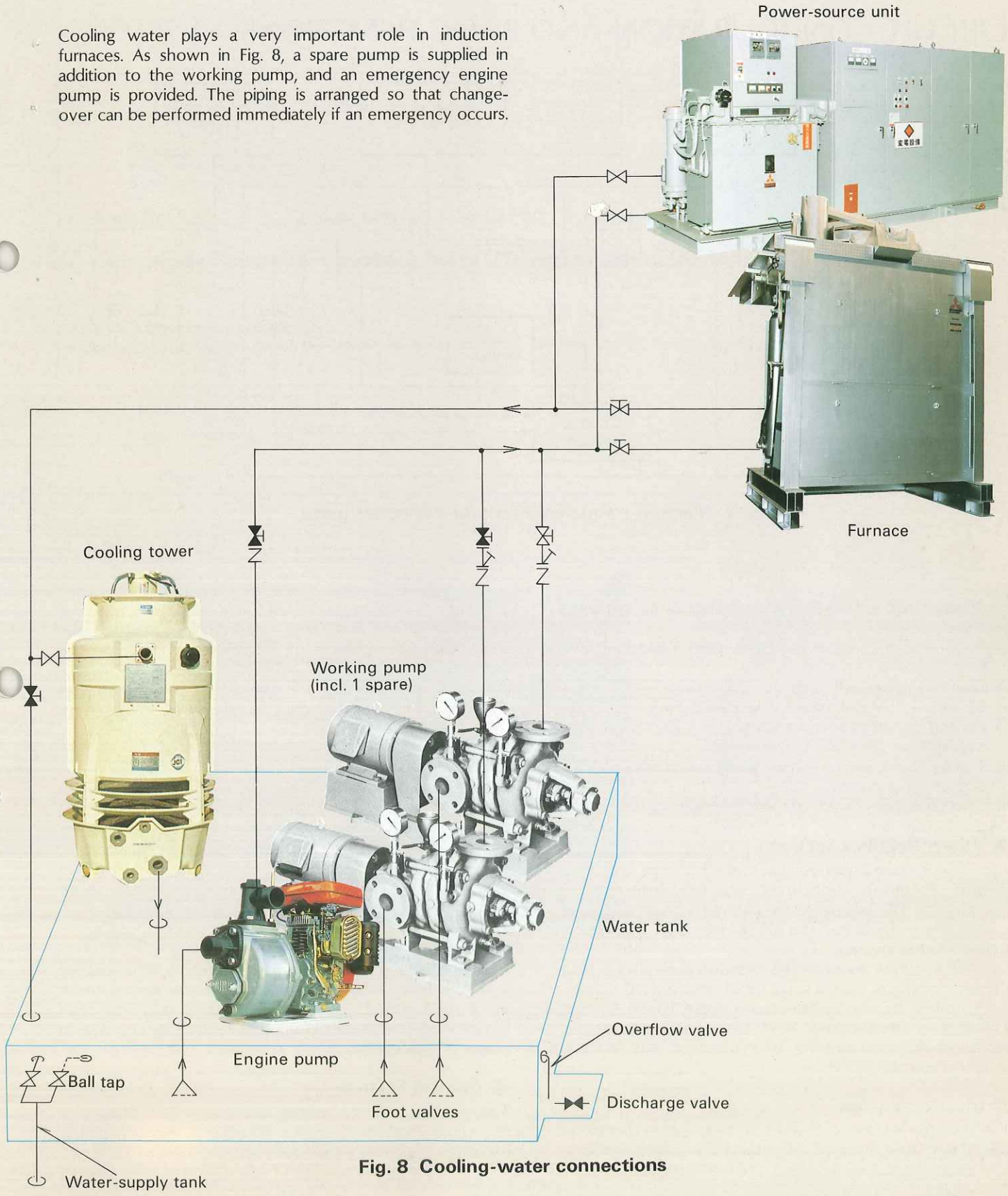


Fig. 8 Cooling-water connections

THYRISTOR CONVERTER

CIRCUIT CONFIGURATION AND BASIC FUNCTIONS

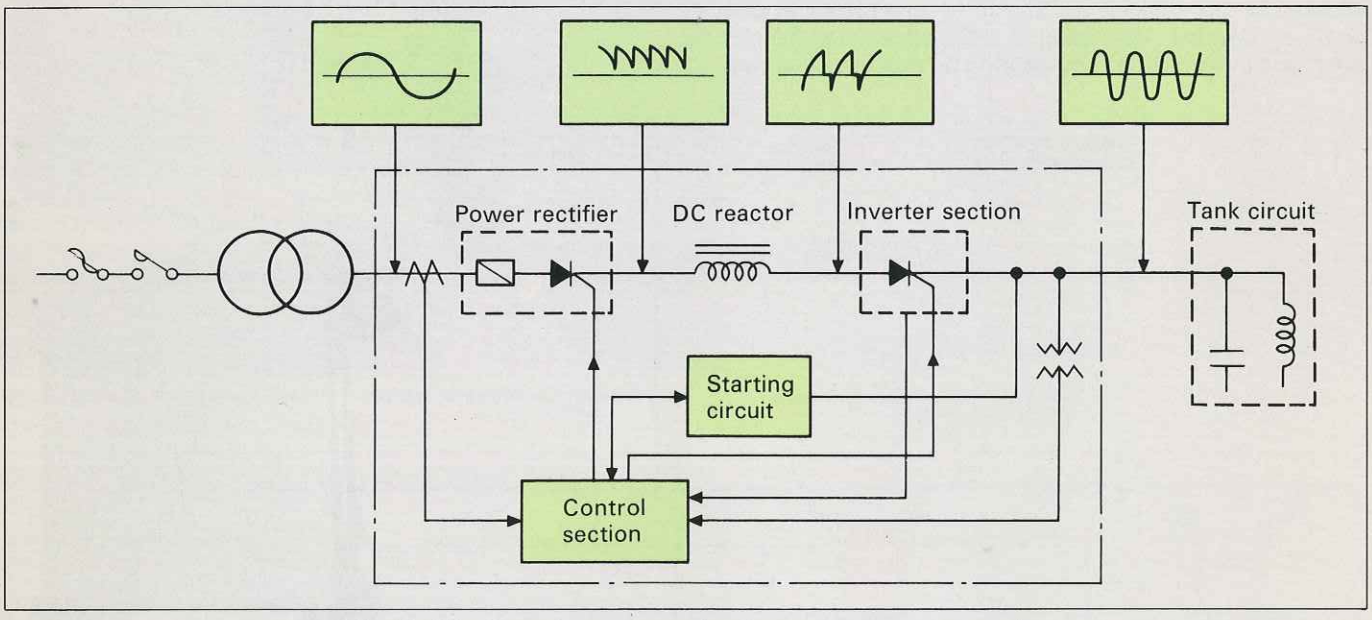


Fig. 9 Medium-frequency thyristor-converter panel

As shown in Fig. 9, the basic circuits consist of the following sections:

- Power Rectifier Section—which converts 3-phase AC into DC.
- Inverter Section—which changes DC into AC.
- DC Reactor Section—which is located between the rectifier and the inverter and functions as a filter preventing overlap.
- Starting Circuit Section—which generates vibrations in the tank circuit at starting.
- Control Section—which controls the main circuits.

Power Rectifier Section

This is a 3-phase bridge circuit formed by the use of a thyristor. It converts 3-phase AC into DC, simultaneously adjusting the DC current to the desired voltage by phase control using thyristors. The DC power thus obtained is supplied to the inverter.

If the output exceeds the designated level due to a sudden increase of load, a short circuit, etc., the DC voltage is controlled by the phase-control system, and is thus limited to a fixed current level. If the current is further increased, the gate breaker is actuated to shut off the abnormal current.

Inverter Section

The inverter section comprises a single-phase bridge in which the latest flat-type thyristor (high-speed switching thyristor) is used. Since thyristor current commutation is performed by the tank-circuit capacitor, the inverter output must always be applied with a leading power factor. The frequency is automatically adjusted to secure the inverse voltage time necessary for turn-off of the thyristor. In this way, a leading power factor is obtained. (Control system under patent application.)

DC Reactor

This reactor absorbs the ripple current difference between the DC output voltage of the power rectifier section and the DC voltage of the inverter section, and by smoothing the DC, safe parallel-type inverter operation is achieved.

The reactor also prevents sudden increases of DC due to a sudden change of load, short circuit, conversion failure of the inverter, etc.

Starting Circuit

Since the parallel inverter cannot initiate system start by itself, the energy must be supplied from the starting circuit for a short period. The starting circuit functions by generating electric vibrations in the tank circuit. (Starting system patent is registered.)

Control Section

This section performs control, protection, and display for the entire medium-frequency inverter. It also carries out exchange of control signals with outside sources.

PROTECTION SYSTEM

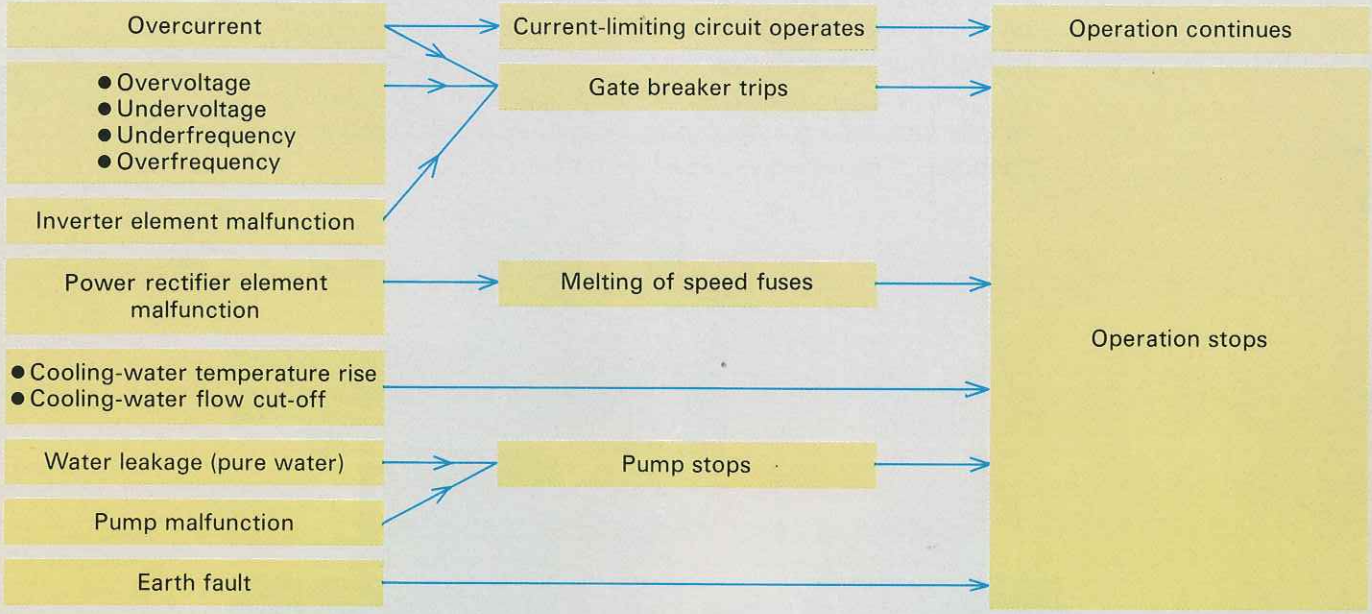
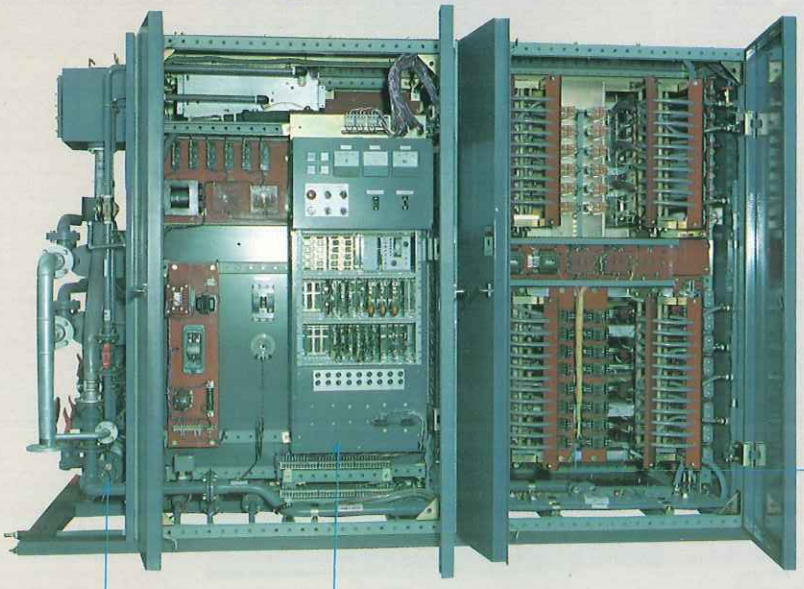


Fig. 10

CONSTRUCTION



Thyristor Stack

This water-cooled stack uses flat-type, large-capacity thyristors for both the power rectifier and inverter.

Control Section

This section consists of IC, transistor, diode, resistor, capacitor, and other printed-card units that can be easily exchanged using connectors.

Note:
Clearance for maintenance should be provided at the front and rear only.

Cooling Device

The heat generated in the panels is mainly cooled with pure circulating water, which is then recooled in the heat exchanger by means of an outside water source.

To maintain high specific resistance, a part of the internal circulating water is always sent to ion-exchange resin cylinders via a bypass route. This process eliminates the problem of electrolytic corrosion. The ion-exchange resin cylinders, which must be replaced periodically, are easy to exchange.

Fig. 11

OPERATION GUIDANCE

The methods of operation, lining, and repair are important factors for increasing the performance of medium-frequency induction furnaces to the maximum. Taichiku Offers its customers a full measure of guidance and cooperation, backed by abundant experience and support data, for maximizing your furnace's efficiency.

An easy-to-understand, detailed operation and handling manual designed for optimizing operation standardization in foundries is provided with each purchase.