SWCC

WATER-COOLED CABLE

Contribution to Optimum Operation of Electric Furnace

SWCC GROUP
Creating for the Future

More and more, water-cooled cables are now being used for various furnaces, in particular for the melting arc furnace and the melting induction furnace. SWCC, as a leading manufacturer in this field, is supplying reliable and high quality water-cooled cables, utilizing to the full its vast experience and research, and is achieving highly satisfactory results.
SWCC Water-Cooled Cables are in great demand not only in Japan, but also from overseas, and are contributing to the optimum operation of electric furnaces all over the world.

SWCC SHOWA CABLE SYSTEMS CO., LTD.
www.swcc.co.jp/

SWCC Water-Cooled Cables may be classified in two types according to their construction, the hose type cable using a rubber hose and the wire type cable which is similar to the general rubber insulated cable.
The hose type is applicable for the working voltage of up to l,000V and is suitable where the mechanical load on the cable is large.
The wire type on the other hand, is applicable for the working voltage of up to 3,000V and is suitable where the mechanical load is small.
The application fields for each type of cable are;

Hose type cable: Primarily, melting arc furnace, vacuum degassing unit, vacuum arc furnace, electroslag remelting furnace, etc.

Wire type cable: Primarily, melting induction furnace, induction heating unit, resistance heating furnace, electrolytic machining unit, etc.

Hose Type Water-Cooled Cable for Arc Furnace

The hose type water-cooled cable for melting arc furnace is SWCC's highly esteemed product developed on the basis of vast experience and consequent success.

Appearance of the water-cooled cable for the melting arc furnace

ADVANTAGES

1. High Flexibility

Use of the surface corrugated hose and either non-separate type or separate type conductor allows smaller bending radius even in a large size cable, and prevents kinking of a hose with a conductor even when the cable is strongly twisted, thus greatly improving flexibility compared with conventional SWCC products. The improved flexibility enables the reduction of the cable required length as well as the furnace installation area.

2. Low impedance, Low Energy Loss

Low impedance and low energy loss are achieved by reducing the cable required length and by improving the conductor construction so that larger geometric mean radius (G.M.R.) and smaller skin effect are assured.

3. Excellent Durability

SWCC Water-Cooled Cable is constructed using the surface corrugated hose and either separate type or non-separate type conductor so that loads by bending, twisting, and impact can be satisfactorily relieved. The conductor is so constructed as to minimize the mechanical wear, thus improving the durability.

4. Easy maintenance

The Cable can be easily disassembled without being damaged, by simply removing the stainless steel bands and pins for the check and cleaning of the conductor. Reassembling is also easy.

Water-cooled cable used in the melting furnace

CONSTRUCTION

1. Conductor

a. Non-separate type

High-conductive annealed copper wires are stranded over the star-shaped hexagonal rubber core made of highly-elastic water-proof and wear-resisting rubber (see fig.1).

b. Separate type

Surfaces at both ends of the hose core are finished flat, while remaining surface is finished corrugated. The individual conductor is covered with a perforated rubber tube and reinforced against wear (see fig.2).

2. Terminal

High-conductive tough-pitch copper is used after being machined and plated. Thus the contact resistance is reduced and the current density on the contacting surface is increased.

The cooling water is separately circulated within the terminal in order to cool the inside and outside surface of the conductor.

3. Hose

Hose if made of wear-resisting and water-proof rubber. Surfaces at both ends of the hose are finished flat, while remaining surface is finished corrugated.

The flat-finished surfaces relieve the repeated bending stress applied to the conductor ends.

On the surface of the hose, splash-proof material is adhered during he vulcanization process.

4. Protection hose

The protection rubber hoses, on which outer surface the material is applied by vulcanization, are fixed on the both ends of the hose by means of stainless steel bands, in order to relieve the repeated bending stress on the conductor ends.

5. Stainless steel band

As corrosion-resisting, non-magnetic stainless steel is used, water leakage and corrosion breaking of the band are completely eliminated.

Note) For articles from 2 to 5, refer also to Table 2.

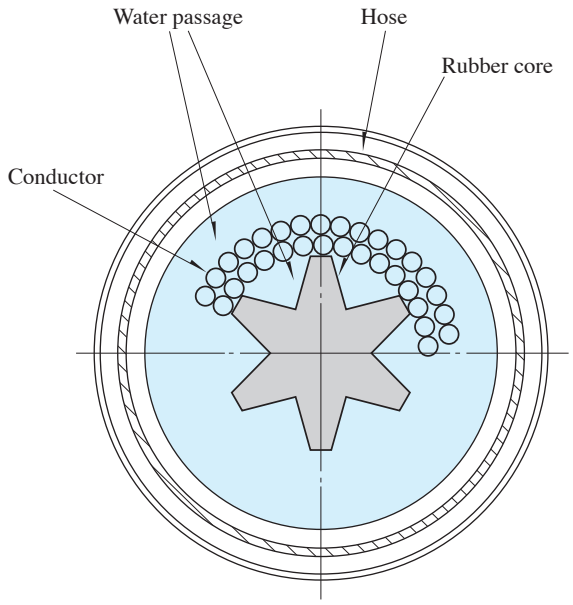


Fig.1 Section of the non-separate type

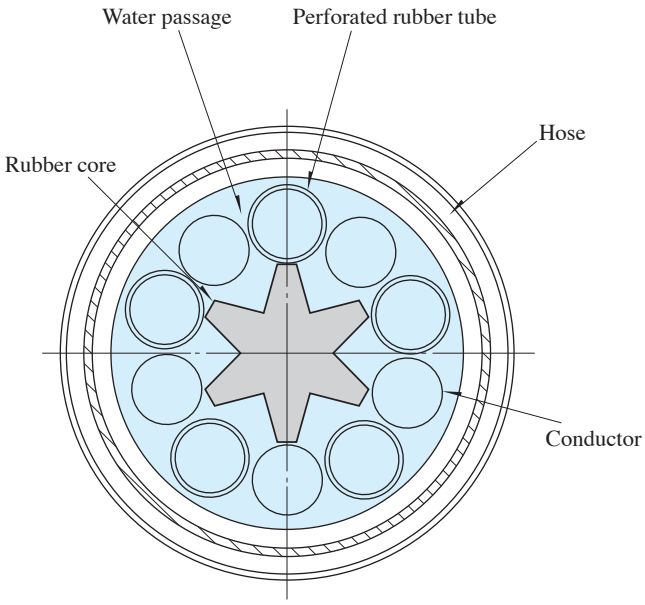


Fig.2 Section of the separate type

SPECIFICATIONS

Table 1 shows the specifications of the standard size water-cooled cable

Conductor cross-sectional area mm²	Rated current*1 A	Conductor type	D.C.resistance (20˚C) 10⁻⁶Ω/m	Skin effect coefficient 50Hz	Skin effect coefficient 60Hz	G.M.R mm	Cooling water flow rate*2 ℓ/min	Approx. weight*3 kg	Min. bending radius mm
800	4800	Non-separate	25.5	0.03	0.04	23.2	10	180+17 (L–10)	500
1000	6000	Non-separate	20.4	0.04	0.06	25.8	13	250+23 (L–10)	
1500	9000	Non-separate	12.8	0.08	0.11	33.6	19	330+31 (L–10)	600
2000	12000	Non-separate	9.86	0.12	0.17	39.3	27	380+35 (L–10)	
2500	15000	Non-separate	7.70	0.13	0.18	49.5	33	495+46 (L–10)	700
3000	18000	Non-separate	6.49	0.13	0.18	57.9	40	660+57 (L–10)	900
3500	21000	Separate	5.47	0.16	0.21	51.0	47	675+61 (L–10)	800
4000	24000	Separate	5.00	0.18	0.25	51.5	57	710+65 (L–10)	850
4500	27000	Separate	4.04	0.31	0.40	51.8	66	745+68 (L–10)	
5000	30000	Separate	3.72	0.24	0.42	58.3	72	970+90 (L–10)	950

Note) *1: At commercial frequency
*2: Rated current, cooling length = 10m
*3: Including cooling water, L (m) means overall length of the cable

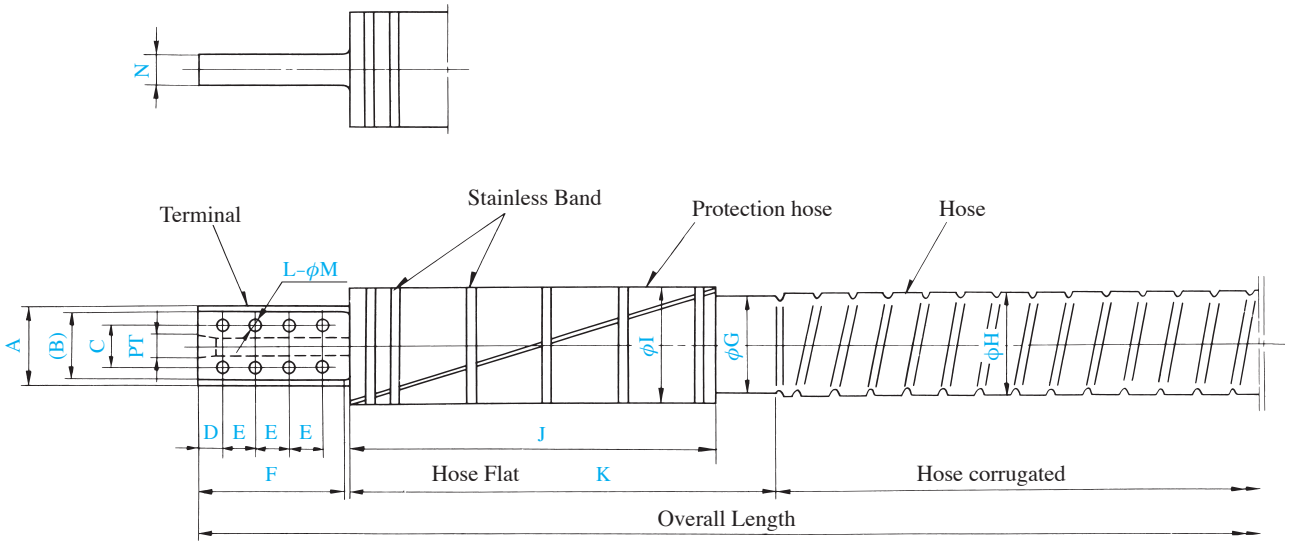
DIMENSIONS

Table 2 shows the overall dimensions of the standard size water-cooled cable

Unit: mm (PT = inch)

Conductor cross-sectional area mm²	A	B	C	D	E	F	G	H	I	J	K	L	M	N	PT
800	69	60	38	30	40	135	95	100	119	500	600	6	13	35	3/4
1000	75	64	47	30	45	145	115	121	136	500	600	6	13	40	3/4
1500	95	84	55	35	50	165	132	134	154	600	700	6	17	45	1
2000	100	86	60	35	55	175	138	140	160	600	700	6	17	50	1
2500	120	106	70	40	55	235	157	159	179	600	700	8	17	55	1 1/4
3000	144	130	80	40	60	250	184	190	210	700	800	8	17	60	1 1/4
3500	134	120	80	40	65	265	174	180	200	700	800	8	17	60	1 1/4
4000	139	125	80	40	65	275	179	185	205	700	800	8	22	60	1 1/4
4500	139	125	80	40	65	275	179	185	205	700	800	8	22	60	1 1/4
5000	159	146	80	40	70	295	199	205	230	700	800	8	22	60	1 1/4

Note) *1: Non-separate type up to 3000mm², 3500mm² and above is separate type
*2: Terminal size is based on Copper type



COVERING

The rubber-made covering is attached to lower the cable impedance during the furnace operation.
This ring also protects the hose.

Other Hose Types for the water-cooled cable

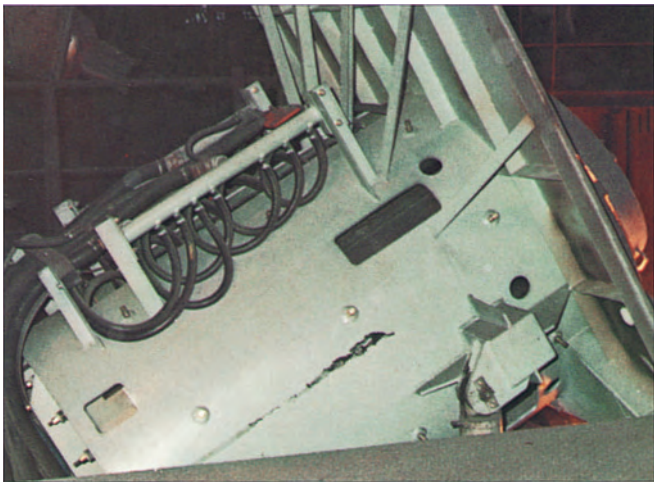
Hose type water-cooled cables, other than that used for the melting arc furnace, are designed according to the application field.
They are used, for example, for the vacuum degassing unit, vacuum arc furnace, electroslag remelting furnace, slag melting furnace and high frequency generator.

Covering in the installed condition

Wire Type Water-Cooled Cable

The wire type water-cooled cable is widely used for the melting induction furnace, induction heating unit, resistance heating furnace, electrolytic machining unit, while the type of electric current which can be used ranges from direct current to high frequency alternating current (10kHz).
The standard size is 125, 200 and 400mm^2.

Appearance of the wire type water-cooled cable



Used condition in the melting induction furnace

CONSTRUCTION

1. Cable

Annealed copper wires are wrapped over the rectangular hard drawn copper spiral, binder tape, insulating ethylene propylene rubber, strengthening braid (to ensure the water pressure resistivity), and the sheath of chloroprene rubber is applied in this order over the wrapped wires (wee Fig.3).

2. Terminal

The terminal is made up of machined and plated copper castings. Two types are available, battledore type and flange type.

In case of the battledore type, the connecting tubes are provided for feeding and discharging the cooling water (see table 4)

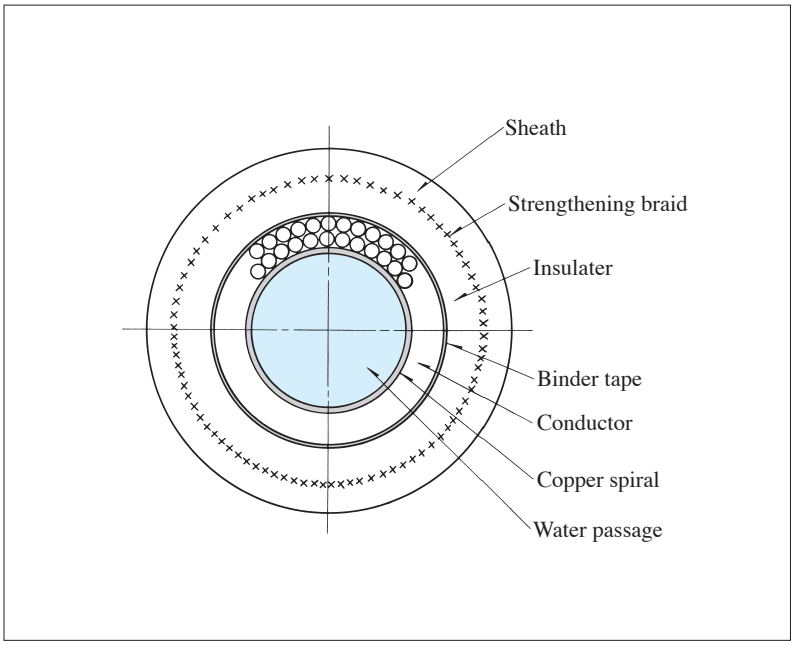


Fig.3 Cross sectional drawing of cable

SPECIFICATIONS

Table 3 shows the specifications of the standard size wire type water-cooled cable.

The rated current shown in Table 3 is at the commercial frequency (50, 60Hz). Where higher frequencies are used, the rated current decreased accordingly. Fig.4 shows the ratio of rated current at the commercial frequency to that at other frequencies.

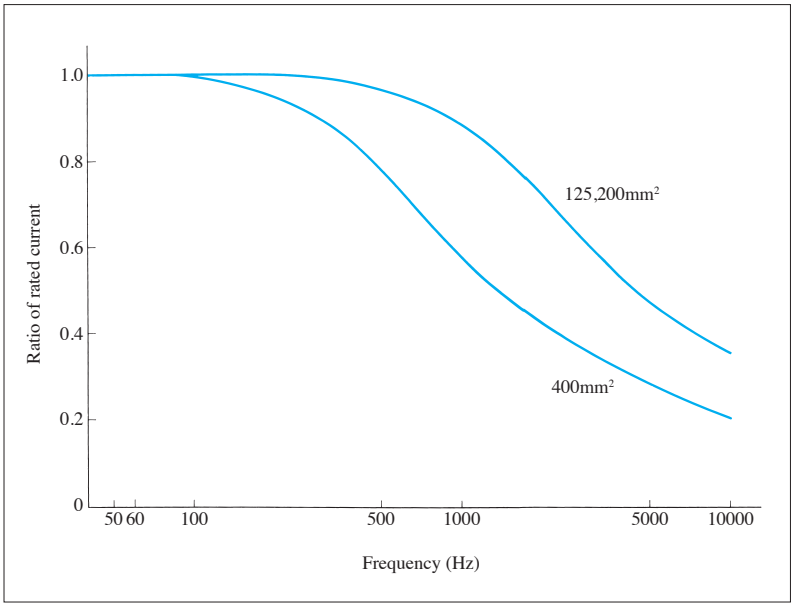


Fig.4 Frequency - Ratio of rated current

Table 3 Specifications of the standard size water-cooled cable

Conductor cross-sectional area	Rated current*1	D.C. Resistance (20˚C)	Cooling water flowrate*2	Overall diameter (Approx.)	Min. bending radius	Approx. weight*1
mm^2	A	$10^{-6}\Omega/m$	ℓ /min	mm	mm	kg/m
125	1875	148	4	37.5	200	2.27
200	3000	94.7	7	51.0	350	3.9
400	6000	47.6	14	58.3	400	6.1

Note) *1: At commercial frequency
*2: At rated current and cooling length of 10m
*3: Including cooling water

DIMENSIONS

Table 4-1 shows the dimensions of the battledore type terminal

(Unit: mm)

Conductor cross-sectional area mm²	W_P	L_P	P_1	P_2	P_3	P_4	N	A	B	T_P	L_A	L_B	L_C	L_H	L_T	L_{SP}	D_1	D_2	D_3
125	50	110	—	25	25	40	2	14	28	(7)	65	16	80	43	60	215	47	37.5	14.5
200	65	110	—	32.5	25	40	2	14	32	(12)	95	25	90	41	75	250	60	51	21
400	100	140	50	25	30	50	4	14	28	(12)	125	30	98	46	90	300	70	58.3	27.5

Battledore type terminal

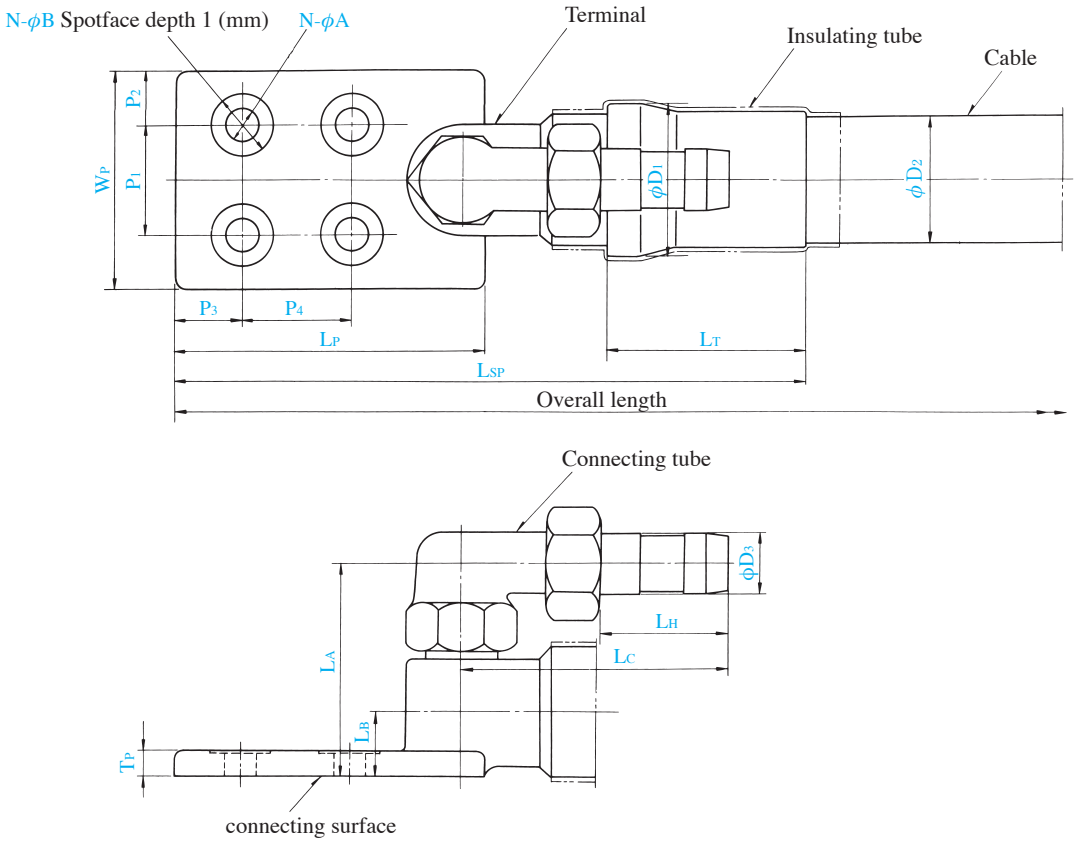
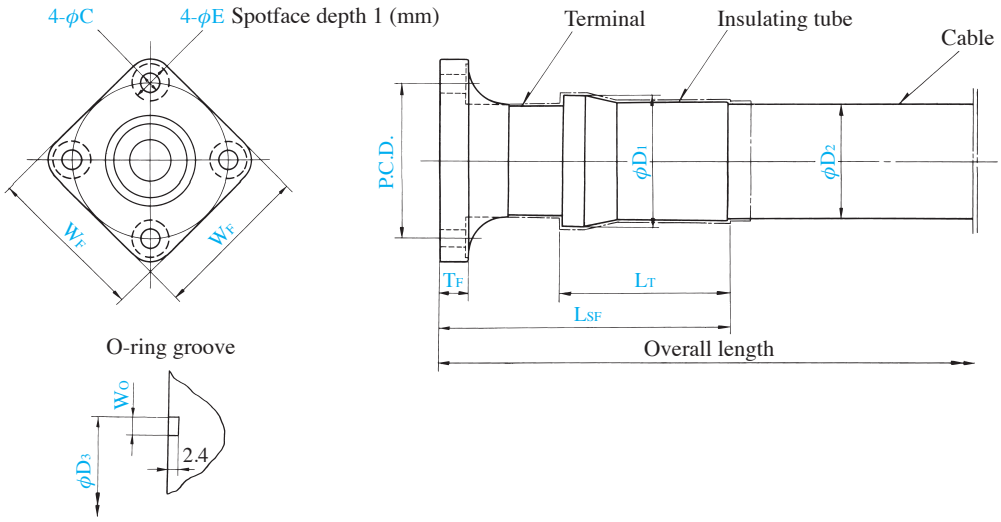


Table 4-2 shows the dimensions of the Flange type terminal

(Unit: mm)

Conductor cross-sectional area mm²	W_F	W_O	C	E	P.C.D.	D_1	D_2	D_3	T_F	L_T	L_{SF}	O-ring
125	50	4.1	7	13	50	47	37.5	30	10	60	105	G25
200	70	4.1	9	18	70	60	51	40	13	75	140	G35
400	95	4.3	14	28	90	70	58.3	45	16	90	150	G40

Flange type terminal



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CAT. NO. 90-134-0 14.08㊍