

A.C. ELECTROMAGNETIC CONDUCTION PUMPS



Creative Engineers, Inc.
P O Box 206 Phoenix, MD 21131

Phone 443-807-1202

Fax 410-683-9707



CUSTOMER DRIVEN SOLUTIONS
www.CreativeEngineers.com

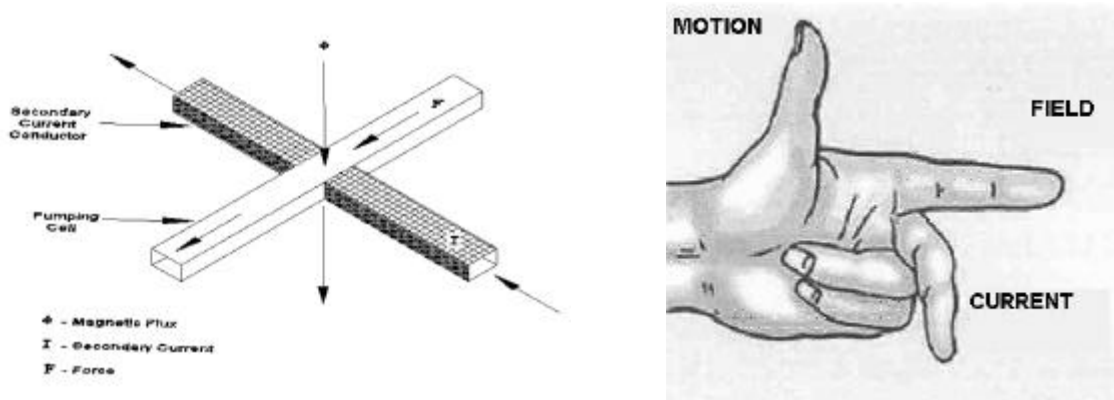
A. C. ELECTROMAGNETIC CONDUCTION PUMPS

FEATURES

1. Continuous operation at liquid metal temperatures to 1600 °F (871 °C)
2. No moving parts -- no seals -- no packing glands -- no leaks.
3. Flow control from 10 to 100 % of capacity with no throttling valves.
4. Full reversible flow in only minutes.
5. Low maintenance – reliable to 20 years or more
6. Operable in radiation fields.
7. Proven performance since 1950.

PRINCIPLE OF OPERATIONS

Creative Engineers, Inc.'s AC Electromagnetic Conduction Pump operates on the principle of the "Fleming's Left Hand Motor Rule." This describes the direction of a force produced on a conductor by a current and a magnetic flux. The principle is illustrated in the diagram below.

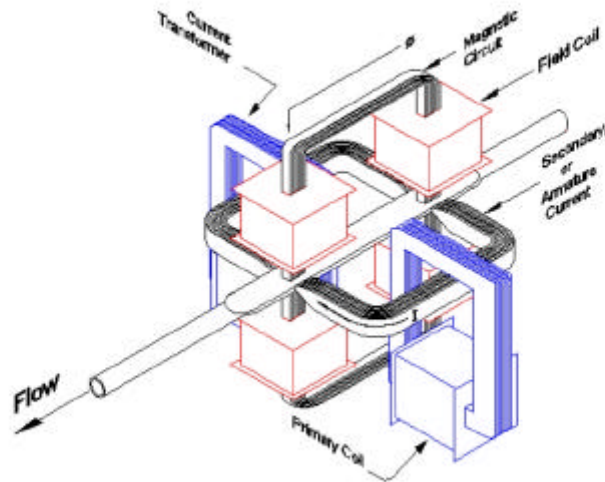


A.C. ELECTROMAGNETIC CONDUCTION PUMPS

In the conduction type electromagnetic pump, the liquid metal is a conductor of the electricity. When current passes through the pumping section perpendicular to the magnetic field, a force is produced in the liquid metal within the pumping section that is at right angles to the current and the magnetic field.

DIRECTION

The diagram below shows how the current and flux are produced in the CEI two stage electromagnetic pump.



TWO STAGE ELECTROMAGNETIC PUMP

Two current transformers, connected additively, supply the current in the secondary conductor (bus bars). The current flows through the pumping section wall horizontally across the liquid metal and out the other wall. This forms a continuous current path which flows across one pumping sections and returns through the other pumping section. The bus bars are attached to the pumping section using high temperature brazing compounds.

The magnetic flux in the pumping section is produced by coils on each leg of the two U-shaped laminated magnetic iron cores. The cores are positioned so that the two flattened portions of the pumping section are in the air gaps. The flux flows vertically downward through one pumping section and returns through the other.

The flow rate of all CEI AD conduction-type electromagnetic pumps is positively controlled from zero to maximum by a variable transformer. A capacitor is used for power factor correction. The following table shows the dimensions and weight of the variable transformers and capacitors.

A.C. ELECTROMAGNETIC CONDUCTION PUMPS

Variable Transformer Specifications For Electromagnetic Pumps

Pump Style	Number Req'd	KVA	Dimensions			Weight Pounds (kilos) Crated	CEI Part Number
			Inches (millimeters)				
			Length	Width	Height		
I-VI	1	7.8	15 (380)	15 (380)	9.25 (235)	84 (38)	C59465

Capacitor Specifications

Pump Style	Number Req'd	KVAR	Dimensions			Weight Pounds (kilos) Crated	CEI Part Number
			Inches (millimeters)				
			Length	Width	Height		
I	2	7.5	10 (254)	8 (203)	11 (279)	56 (25)	C59462
II, V	1	10	12 (305)	10 (254)	11 (279)	62 (28)	C64203
III	1	5	12 (305)	6 (153)	11 (279)	37 (17)	C59463
IV	1	2.5	8 (203)	6 (153)	11 (279)	28 (13)	C63237
VI	1	7.5	10 (254)	8 (203)	11 (279)	56 (25)	C59462

Since the pump is symmetrical, flow is easily reversed by reversing the direction of the magnetic field without changing the direction of the current flow. This can be accomplished by including switching equipment during installation or by changing two connections in the terminal box on Style III, IV, V and VI pumps.

Standard pumps require an electrical supply of 240 Volts, single phase, 60 Hertz. Special construction is available to allow operation on 480 VAC, 60 Hertz power supply.

A photograph of a CEI Style V Electromagnetic Pump is shown on the next page.

APPLICATIONS

The performance curves shown on page 7 were obtained with potassium-sodium (NaK) alloy. For fluid temperatures above 900 °F, pump performance with potassium, sodium and NaK will be very similar. CEI pumps will handle metals including sodium, potassium, rubidium, cesium, lithium, and their alloys. The following table provides physical specifications for each pump. Performance is shown on the graphs.

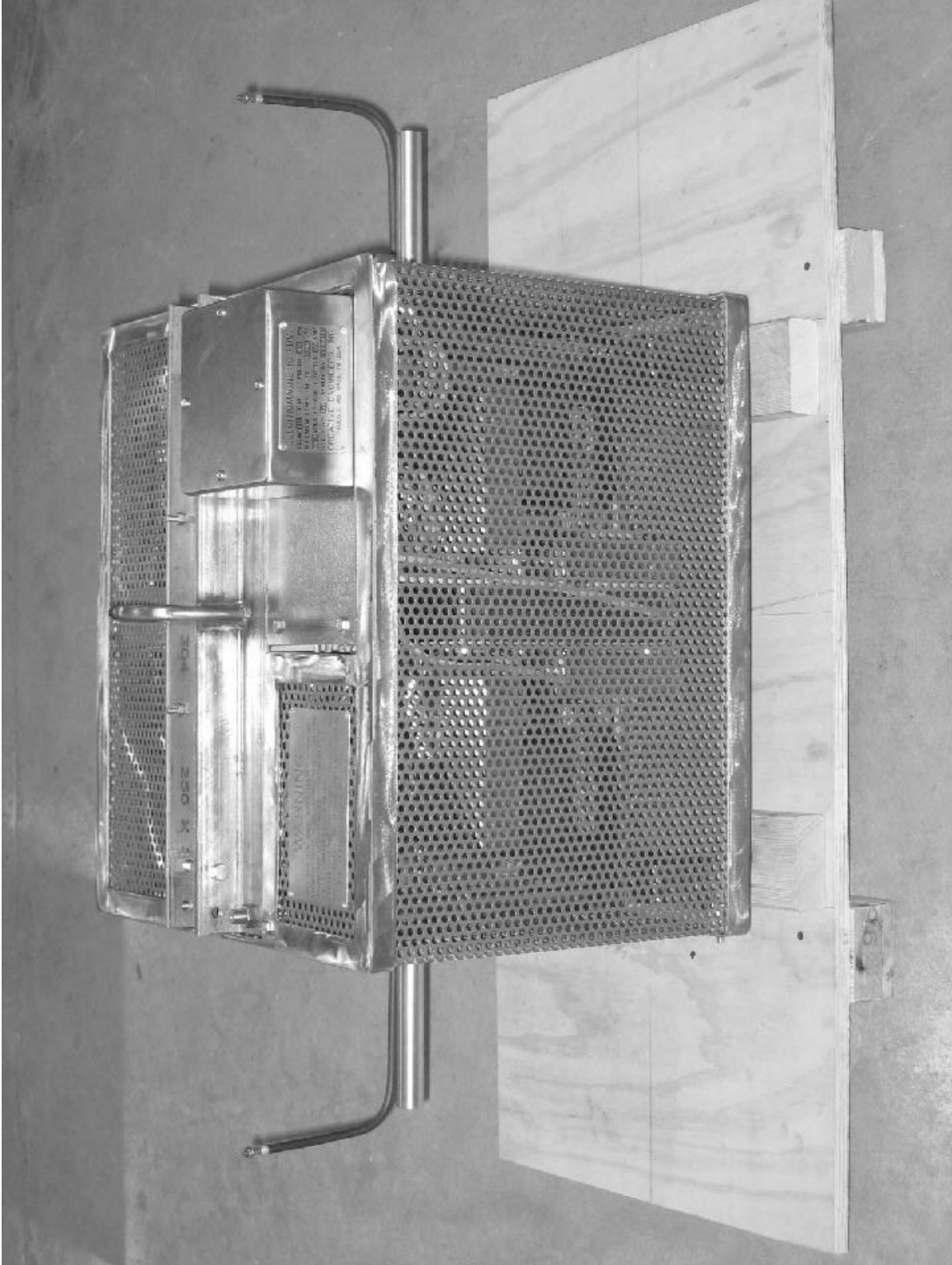
A.C. ELECTROMAGNETIC CONDUCTION PUMPS

Pump Style	Cage Dimensions Inches (millimeters)			Tube Size Inches (millimeters)			Pump Weight Crated LB (KG)
	Length	Width	Height	OD	Thickness	Length	
I	18 (457)	18 (457)	15 (381)	3/8 (9.5)	0.049 (1.24)	24 (610)	265 (120)
II	18 (457)	18 (457)	15 (381)	3/8 (9.5)	0.049 (1.24)	24 (610)	265 (120)
III	15 (381)	17 (432)	12 (305)	1/2 (12.7)	0.049 (1.24)	24 (610)	150 (68)
IV	15 (381)	17 (432)	12 (305)	1/2 (12.7)	0.049 (1.24)	24 (610)	150 (68)
V	22 (559)	20 (508)	22 (559)	1 (25.4)	0.049 (1.24)	36 (914)	360 (164)
VI	22 (559)	20 (508)	22 (559)	1 (25.4)	0.049 (1.24)	36 (914)	360 (164)

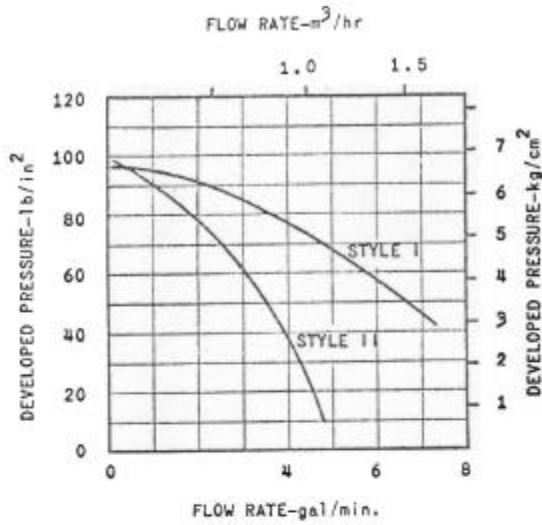
The pumps will operate at any point on or below the maximum curves. The pump is a pressure device; and with a fixed applied voltage, flow will be established according to the pressure drop in the system external to the pump.

The performance of any given pump will vary somewhat with the type of fluid, temperature and materials of construction. Effective pumping in the conductive-type electromagnetic pump requires that the liquid metal wet the pump tube. It is best to select a pump with a maximum performance above the expected normal operating point or to specify required performance and details of the application so that the appropriate pump may be recommended.

A.C. ELECTROMAGNETIC CONDUCTION PUMPS



A.C. ELECTROMAGNETIC CONDUCTION PUMPS

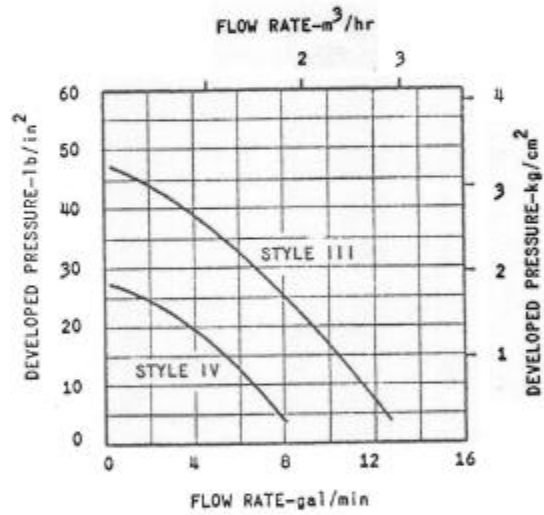


STYLE I -
PART NO. 501010
MAX TEMP 1000°F-538°C
MAX KW 5.0 @ 240V

STYLE II -
PART NO. 510001
MAX TEMP 1500°F-816°C
MAX KW 5.0 @ 240V

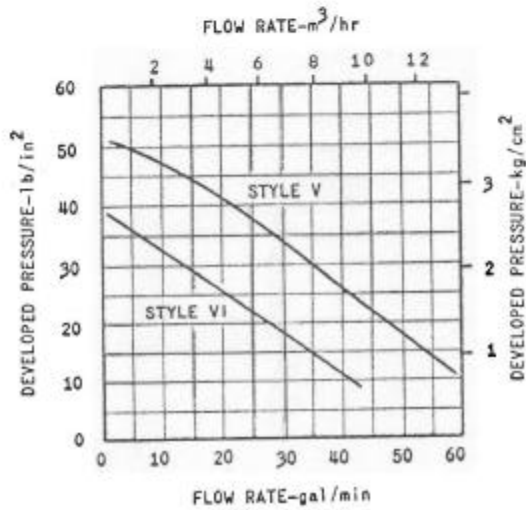
STYLE III -
PART NO. 500861
MAX TEMP 1000°F-538°C
MAX KW 3.0 @ 240V

STYLE IV -
PART NO. 510000
MAX TEMP 1500°F-816°C
MAX KW 3.0 @ 240V



STYLE V -
PART NO. 500760
MAX TEMP 1000°F-538°C
MAX KW 8.0 @ 240V

STYLE VI
PART NO. 500990
MAX TEMP 1500°F-816°C
MAX KW 8.0 @ 240V



A.C. ELECTROMAGNETIC CONDUCTION PUMPS

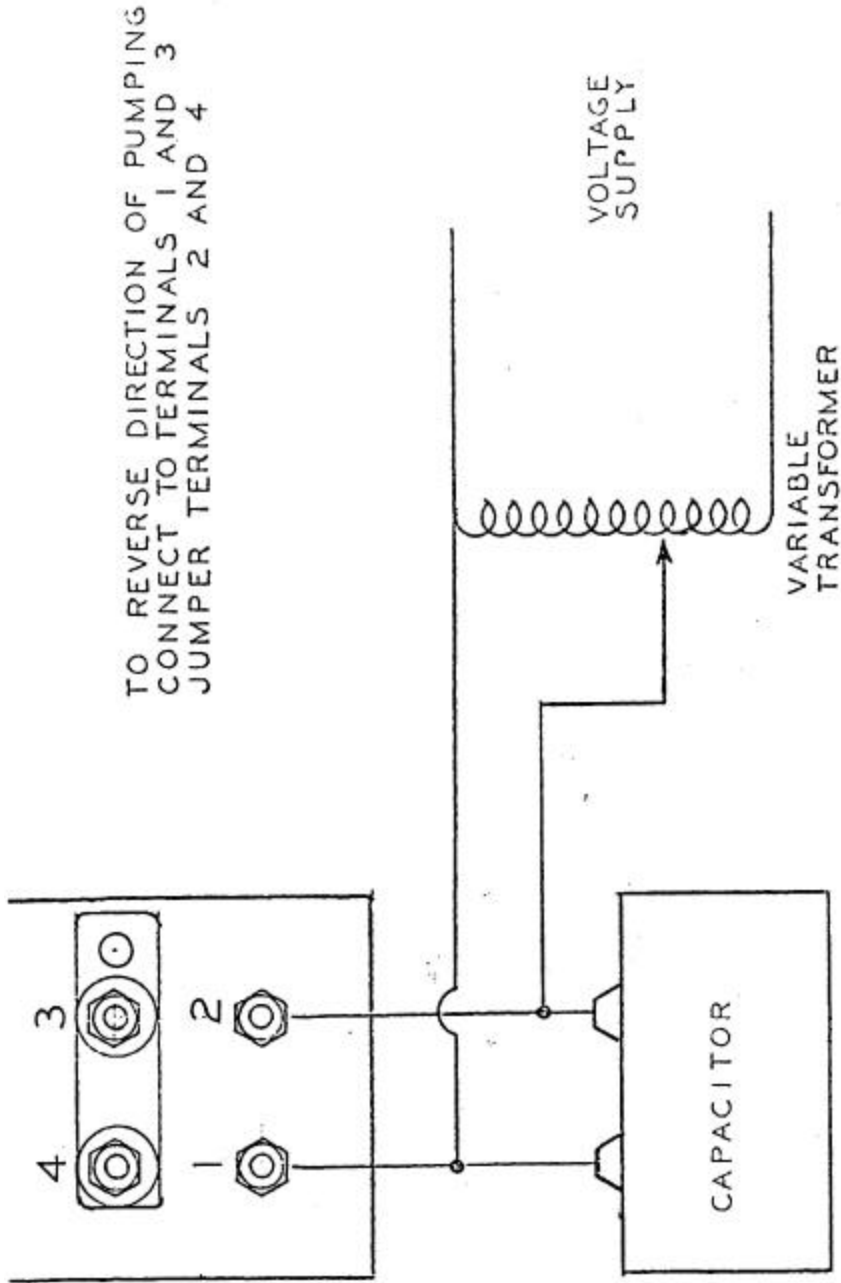
The temperature effect depends on the materials of construction and the fluid being pumped. The odd numbered pumps (Style I, III, V) are affected least by temperature. A slight improvement in operation will be noted up to approximately 1,000 °F (540 °C), after which a slight reduction in performance will result compared to the even numbered pumps. A sharp reduction in performance will occur in the even numbered pumps (Style II, IV, VI) below 800 °F due to the magnetic effect of the nickel used to achieve higher temperature limits.

A Type 316 stainless steel pump tube is normally supplied. Other tube materials may be used provided they are non-magnetic and are compatible with the fluid to be pumped.

INSTALLATION

Pump installation is quite simple, whether it is to be used in a continuous loop or in an open system. The pump is supplied with flush tube ends for welding to connecting piping. An eye hook or hanger is provided from which to hang the pump. The pump is too heavy to be supported by the connecting piping. The pump is able to be supported from the bottom; however, provisions must be made to maintain air circulation through the pump cage. For operation over 1,200 °F (650 °C), cooling must be provided for Styles II, IV, VI pumps. Cooling can be accomplished by placing a fan under the pump and blowing air through the bottom of the cage. Compressed air may also be used providing it is dry and oil free.

A wiring diagram on the following page shows the connections to the pump and the interconnections to the required auxiliary equipment. The auxiliary equipment required to operate the pump consists of a capacitor to correct the power factor and auto-transformer to vary the power.



WIRING DIAGRAM

R2708

A.C. ELECTROMAGNETIC CONDUCTION PUMPS

The important factors which determine where the pump should be placed in a system are as follows:

1. The pump must be located in such a position that it will be flooded before and during operation to prevent the high secondary armature current from overheating the pump tube. An inlet pressure at the suction end of the pump of a least two feet of liquid metal above the vapor pressure should be maintained.
2. Piping stress due to thermal expansion and contraction of the system must not place a strain on the pump in such a manner as to rupture or cause permanent distortion of the pumping section. The pump is modeled in the run as a straight piece of tube with one vertical hanger at the pump frame support.
3. The maximum rated operating temperature of the pump must not be exceeded. Ambient temperature should be maintained below 150 °F. For maximum life, forced air cooling should be supplied on all pumps which will handle fluid at temperatures above 1,400 °F continuously. An open construction is used on the pump to permit natural circulation of air for cooling.

All CEI conduction pumps are supplied with special tubular electrical heating elements for preheating purposes when pumping a material which is solid at room temperature. An applied voltage of 220 volts will provide 250 watts to the Style I, II, III and IV pumps and 375 watts to the Style V and VI pumps. The heater should be used only for preheating and should be turned off when the pump is operating.

The pumping sections of all CEI conduction type electromagnetic pumps are flattened to a predetermined shape and excess internal pressure will tend to round this shaped area. The internal pressure below which no deformation will occur are given in the following table.

	Maximum Internal Pressure for EM Pumps in PSI (kg/cm ²)		
	Maximum Service Temperature		
	70°F (21°C)	1000F (534C)	1500F (816C)
Style I & II (316)	144 (10.1)	118 (8.3)	9 (0.6)
Style I & II (304)	144 (10.1)	105 (7.4)	10 (0.7)
Style III & IV (316)	300 (21.1)	245 (17.2)	19 (1.3)
Style III & IV (304)	300 (21.1)	219 (15.3)	22 (1.5)
Style V & VI (316)	64 (4.5)	53 (3.7)	4 (0.3)
Style V & VI (304)	64 (4.5)	47 (3.3)	4 (0.3)

If the cover gas or liquid metal vapor is trapped in the pumping section, pumping will stop immediately; and the secondary current will cause rapid heating of the pump tube. To prevent damage, a relay should be provided which will shut off power to the pump when the flow drops below a preset value.

A.C. ELECTROMAGNETIC CONDUCTION PUMPS

Dissolved oxide in alkali metals has no effect on pump performance. However, precipitation or plugging in the flow system will produce a restriction and pressure drop which will change the flow rate.