Franklin Electric
Bluffton, Indiana 46714

SERVICE DATA
PAGE 290,741
Date: September 22, 1980
Supersedes 8-15-79

SUBMERSIBLE MOTORS

INSTALLATION and FIELD SERVICE

Single and Three Phase Water Well Pump Motors 4" • 6" and 8" Diameter

This manual describes the correct installation of Franklin Submersible Water Well Pump Motors and provides the electrical and mechanical information to aid in checking installations.

HOW TO USE THIS MANUAL

This manual is arranged with the first part devoted to installation information with checking or service aid in the latter pages.

Maximum benefit when checking installation will be derived from this manual when preliminary tests are made as outlined on Page 8 before referring to the trouble shooting procedure.

Motor maintenance information does not appear in this manual since the Franklin Water Lubricated Motor does not normally require periodic maintenance.

WARNING: A faulty motor or wiring can be a serious electrical shock hazard if it or surrounding water are accessible to human contact. To avoid this danger, connect the motor frame to the power supply grounding terminal with copper conductor no smaller than the circuit conductors unless the motor and surrounding water are inaccessible, as in a drilled well. In all installations connect above ground metal plumbing to the power supply ground per National Code Article 250-80 to prevent electrical shock hazard.

TABLE OF CONTENTS

*Revised information this issue.

Overload Protection Of Three Phase Submersible Motors

Characteristics of submersible motors differ from standard motors and special overload protection is required. If the motor is stalled, the overload protector must trip within approximately 10 seconds to protect the motor windings. When using three phase submersible motors, the installer must provide special extra-quick trip protectors which are of the ambient compensated type. Ambient compensation is necessary to provide adequate locked rotor protection at low temperatures and to avoid nuisance tripping at high temperatures. The tables below list current selection and settings for several brands. However, with some restrictions protectors by Arrow-Hart, Delta, Hoagland, Rowan, Siemens-Allis, Telemecanique, and others may be used with prior specific selection and approval of the Franklin factory.

4" DIA. MOTORS • 60 HZ(1)

APPROVED OVERLOAD HEATERS							(5) Heinemann Circuit Breaker Rating	Approved Overload Relay Westinghouse	
H.P.	Volts	Starter Size	Furnas	(2) Furnas Innova 45	A-B	(3) G.E.		(6) Relay	(4) Ampere Setting
1½	200	00	K42	K43	J-23	L8.25A	8.1	FT13-8	6.7
	230	00	K39	K42	J-22	L6.80A	7.0	FT13-8	5.8
	460	00	K29	K31	J-15	L3.43A	3.5	FT13-3.6	2.9
	575	00	K27	K28	J-13	L2.82A	2.9	FT13-2.4	2.3
2	200	0	K49	K52	J-25	L10.0B	9.9	FT13-8	8.0
	230	0	K43	K49	J-24	L9.10A	8.6	FT13-8	7.0
	460	00	K33	K34	J-17	L4.63A	4.3	FT13-3.6	3.5
	575	00	K29	K32	J-15	L3.43A	3.4	FT13-3.6	2.8
3	200	0	K54	K57	J-29	L14.7B	14.4	FT13-12	11.8
	230	0	K52	K55	J-28	L12.2B	12.5	FT13-12	10.2
	460	0	K37	K41	J-21	L6.18A	6.3	FT13-5.4	5.1
	575	0	K34	K36	J-19	L5.10A	5.1	FT13-5.4	4.2
5	200	1	K61	K63	J-33	L22.0B	22.0	FT13-18	18.0
	230	1	K58	K61	J-32	L18.1B	19.1	FT13-18	15.6
	460	0	K49	K50	J-25	L9.10A	9.6	FT13-8	7.8
	575	0	K41	K43	J-23	L7.50A	7.7	FT13-8	6.3
7½	200	1	K69	K70	J-38	L32.2B	34.0	FT13-32	27.7
	230	1	K64	K68	J-36	L29.3B	29.5	FT13-24	24.0
	460	1	K54	K57	J-29	L14.7B	14.7	FT13-12	12.0
	575	1	K50	K54	J-27	L12.2B	11.8	FT13-12	9.6
10	460	1	K58	K61	J-32	L19.9B	19.4	FT13-18	15.8
	575	1	K55	K58	J-30	L14.7B	15.5	FT13-18	12.7

FOOTNOTES:

(1) Square D ambient compensated overload relays may also be used. For Square D size 1, 2, or 3 specify form Y59, which designates special overload relays, and use same heater number as Furnas: where size 00 or 0 is listed, use size 1. For Cutler Hammer control use G.E. heaters and heater block.
(2) Innova 45 heater selections apply with the trip current adjustment in the nominal position, where it must be kept.
(3) General Electric relay trip adjustment should not be set higher than 100% when using these heaters.
(4) Westinghouse Instrument relay ampere setting should never be set higher than listed.
(5) When selecting Heinemann Relay, time delay curve No. 2 must be specified.
(6) For Westinghouse overload relay, a letter will follow the first two figures, "A" for starter mounting or "P" for panel mounting, for example FT13A-12 or FT13P-12.

6" DIA. MOTORS • 60 HZ(1)

5	200	1	K-60	K-62	J-33	L19.9B	20.2	FT13-18	16.6
	230	1	K-57	K-61	J-32	L18.1B	18.3	FT13-18	14.9
	460	0	K-43	K-50	J-25	L9.10A	9.1	FT13-8	7.5
	575	0	K-39	K-42	J-22	L7.50A	7.3	FT13-8	5.9
7½	200	1	K-67	K-68	J-37	L29.3B	29.1	FT13-24	23.7
	230	1	K-63	K-67	J-36	L26.5B	26.3	FT13-24	21.5
	460	1	K-53	K-56	J-29	L13.5B	13.1	FT13-12	10.7
	575	1	K-49	K-52	J-26	L10.0B	10.5	FT13-12	8.5
10	200	2	K-72(5)	K-73(5)	J-39	L39.0B	38.9	FT23-36	31.8
	230	2	K-69(5)	K-72(5)	J-38	L35.2B	35.2	FT23-36	28.8
	460	1	K-57	K-60	J-32	L18.1B	17.6	FT13-18	14.4
	575	1	K-54	K-56	J-29	L14.7B	14.1	FT13-12	11.5
15	200	3	K-76(6)	K-77(6)	J-43	L52.0B	55.2	FT23-54	45.0
	230	2	K-74	K-75	J-42	L46.4B	50.0	FT23-54	40.8
	460	2	K-63(5)	K-67(5)	J-35	L24.1B	25.0	FT13-24	20.4
	575	2	K-60(5)	K-62(5)	J-33	L19.9B	20.1	FT13-18	16.4
20	200	3	K-77	K78	J-45	L71.0B	74.2	FT33-72	60.6
	230	3	K-76(6)	K-78(6)	J-44	L62.2B	67.1	FT33-72	54.9
	460	2	K-69	K-70	J-38	L32.2B	33.6	FT23-36	27.4
	575	2	K-64	K-67	J-35	L26.5B	26.8	FT13-24	21.9
25	200	3	K-85	K-86	J-70	L86.6B	89.5	FT43-110	73.2
	230	3	K-78	K-83	J-46	L78.7B	81.1	FT33-72	66.2
	460	2	K-72	K-73	J-40	L39.0B	40.5	FT23-36	33.1
	575	2	K-69	K-70	J-37	L32.2B	32.4	FT23-36	26.4
30	200	4	K-87(7)	K-89(7)	J-72	L107C	112.0	FT43-110	92.0
	230	3	K-86	K-88	J-71	L107C	101.0	FT43-110	82.8
	460	3	K-73(6)	K-76(6)	J-41	L46.4B	50.6	FT33-48	41.4
	575	3	K-72(6)	K-73(6)	J-39	L39.0B	40.5	FT33-48	33.1
40	460	3	K-76		J-44	L62.2B	66.0	FT33-72	54.0
	575	3	K-73		J-42	L52.0B	52.8	FT33-48	43.2
50	460	3	K-78		J-46	L78.7B	82.5	FT33-72	67.5
	575	3	K-76		J-44	L62.2B	66.0	FT33-72	54.0

FOOTNOTES:

(1) Square D ambient compensated overload relays may also be used. For Square D size 1, 2, or 3 specify form Y59, which designates special overload relays, and use same heater number as Furnas; where size 00 or 0 is listed, use size 1. For Cutler Hammer control use G.E. heaters and heater block.
(2) Innova 45 heater selections apply with the trip current adjustment in the nominal position, where it must be kept.
(3) General Electric relay trip adjustment should not be set higher than 100% when using these heaters.
(4) Westinghouse Instrument relay ampere setting should never be set higher than listed.
(5) Use size 1¾ Furnas starter with this motor rating.
(6) Use size 2½ Furnas starter with this motor rating.
(7) Use size 3½ Furnas starter with this motor rating.
(8) When selecting Heinemann Relay, time delay curve No. 2 must be specified.
(9) For Westinghouse overload relay, a letter will follow the first two figures, "A" for starter mounting or "P" for panel mounting, for example FT13A-12 or FT13P-12.

8" DIA. MOTORS • 60 HZ

40	460	3	K-76		J-43	L62.2B
50	460	3	K-78		J-45	L78.7B
60	460	4	K-85(1)		J-46	L86.6B
75	460	4	K-87(1)		J-71	L107C
100	460	4	K-94		J-74	L155C

FOOTNOTES:

(1) Furnas size 3½ may be used for 60 & 75 H.P.

TABLE 5 CURRENT & FUSE REQUIREMENTS

SUPER STAINLESS MOTORS 2 AND 3 WIRE

Rating		Size	Service Factor	Circ. Brk or Std. Fuse Size (Amp.)	Dual Element Fuse Size
HP	Volt				
¼	115	4"	1.85	20	8
	230	4"	1.85	15	4
⅓	115	4"	1.75	25	10
	230	4"	1.75	15	5
½	115	4"	1.60	30	15
	230	4"	1.60	15	7
¾	230	4"	1.50	20	9
1	230	4"	1.40	25	12
1½	230	4"	1.30	30	15

MT-3 — SINGLE PHASE MOTORS

Rating		Size	Service Factor	Circ. Brk. or Std. Fuse Size (Amp.)	Dual Element Fuse Size
HP	Volt				
¼	115	4"	1.85	25	10
	230	4"	1.85	15	5
⅓	115	4"	1.75	30	12
	230	4"	1.75	15	6.25
½	115	4"	1.60	40	15
	230	4"	1.60	20	8
¾	115	4"	1.50	45	20
	230	4"	1.50	25	10
1	230	4"	1.40	30	12

MT — SINGLE PHASE MOTORS

Rating		Size	Service Factor	Circ. Brk. or Std. Fuse Size (Amp.)	Dual Element Fuse Size
HP	Volt				
¼	115	4"	1.85	20	8
	230	4"	1.85	15	4
⅓	115	4"	1.75	25	10
	230	4"	1.75	15	5
½	115	4"	1.6	30	15
	230	4"	1.6	15	7
¾	115	4"	1.5	40	17.5
	230	4"	1.5	20	9
1	230	4"	1.4	25	12
1½	230	4"	1.3	30	15
2	230	4"	1.25	35	15
3	230	4"	1.15	45	20
5	230	4"	1.0	80	30
5	230	6"	1.15	80	35
7½	230	6"	1.15	100	45
10	230	6"	1.15	150	60

THREE PHASE MOTORS

Rating		Size	Service Factor	Circ. Brk. or Std. Fuse Size (Amp.)	Dual Element Fuse Size
HP	Volt				
1½	200	4"	1.3	20	9
	230	4"	1.3	20	8
	460	4"	1.3	15	4
	575	4"	1.3	15	3
2	200	4"	1.25	25	10
	230	4"	1.25	20	10
	460	4"	1.25	15	5
	575	4"	1.25	15	4
3	200	4"	1.15	35	15
	230	4"	1.15	30	15
	460	4"	1.15	15	7
	575	4"	1.15	15	6
5	200	4"	1.15	50	25
	230	4"	1.15	45	20
	460	4"	1.15	25	10
	575	4"	1.15	20	8
	200	6"	1.15	50	25
	230	6"	1.15	45	20
	460	6"	1.15	25	10
	575	6"	1.15	20	8
7½	200	4"	1.15	80	35
	230	4"	1.15	70	30
	460	4"	1.15	35	15
	575	4"	1.15	30	12
	200	6"	1.15	70	30
	230	6"	1.15	70	30
	460	6"	1.15	30	15
	575	6"	1.15	25	12
10	460	4"	1.15	45	20
	575	4"	1.15	40	20
	200	6"	1.15	100	40
	230	6"	1.15	80	35
	460	6"	1.15	40	20
	575	6"	1.15	35	15
15	200	6"	1.15	150	60
	230	6"	1.15	125	60
	460	6"	1.15	60	30
	575	6"	1.15	50	25
20	200	6"	1.15	200	80
	230	6"	1.15	175	70
	460	6"	1.15	80	35
	575	6"	1.15	70	30
25	200	6"	1.15	225	100
	230	6"	1.15	200	90
	460	6"	1.15	100	45
	575	6"	1.15	80	35
30	200	6"	115	300	125
	230	6"	1.15	250	110
	460	6"	1.15	125	50
	575	6"	1.15	100	40
40	460	6"	1.15	150	70
	575	6"	1.15	125	60
	460	8"	1.15	175	70
50	460	6"	1.15	200	90
	575	6"	1.15	150	70
	460	8"	1.15	200	90
60	460	8"	1.15	225	100
75	460	8"	1.15	300	125
100	460	8"	1.15	400	175

CAUTION **Three Phase Motors require the use of three (3) Quicktrip Overload Protectors in the Starter. Refer to page 2. Failure to use these specified quicktrip overloads will void warranty.**

CABLE SELECTION

SINGLE PHASE MOTOR MAXIMUM CABLE LENGTH (Motor to Service Entrance) (2) Table 6

Motor Rating		Copper Wire Size (1)								
Volts	HP	14	12	10	8	6	4	2	0	00
115	¼	165	263	411	645	1000	1540	2340		
	⅓	134	212	333	522	810	1240	1890	2550	
	½	100	159	249	390	608	930	1410	1910	
230	¼	661	1040	1650	2580	4020	6140	9355		
	⅓	533	850	1350	2110	3290	5025	7650		
	½	404	641	1003	1575	2450	3750	5710		
	¾	293	473	740	1161	1810	2760	4210	5680	
	1	248	392	617	968	1507	2300	3510	4730	5920
	1½	205	326	510	801	1248	1920	2930	3950	4940
	2	180	286	449	703	1096	1675	2550	3440	4300
	3		229	359	563	877	1339	2041	2750	3440
	5			216	315	490	750	1142	1540	1925
	7½				270	362	553	842	1136	1420
	10					250	425	650	875	1100

CAUTION: Use of wire size smaller than listed will void warranty.

FOOTNOTES:

(1) If aluminum conductor is used, multiply lengths by 0.5. Maximum allowable length of aluminum is considerably shorter than copper wire of same size.

(2) The portion of the total cable which is between the service entrance and a 3 ø motor starter should not exceed 25% of the total maximum length to assure reliable starter operation. Single phase control boxes may be connected at any point of the total cable length.

THREE PHASE MOTOR MAXIMUM CABLE LENGTH (Motor to Service Entrance) (2) Table 7

Motor Rating		Copper Wire Size (1)										
Volts	HP	14	12	10	8	6	4	2	0	00	000	0000
200 V 60 Hz or 50 Hz	1.5	320	510	800	1260							
	2	250	390	610	960	1500						
	3	180	290	450	710	1110	1690					
	5			300	470	730	1110	1690				
	7.5				340	530	810	1230	1660			
	10				250	390	600	920	1240	1540		
	15					270	410	630	850	1060	1270	
	20						320	480	650	810	970	1150
	25							390	530	660	790	930
	30								430	540	640	750
230 V 60 Hz and 220 V 50 Hz	1.5	430	680	1070	1680							
	2	320	510	790	1250	1940						
	3	240	380	600	940	1470	2240					
	5		250	390	620	960	1470	2230				
	7.5			290	450	700	1070	1630	2200			
	10				340	520	800	1220	1640	2050		
	15					360	550	830	1130	1410	1680	
	20						420	640	860	1070	1280	1510
	25						340	520	700	870	1040	1230
	30							420	570	710	850	1000
460 V 60 Hz and 380 V 50 Hz (Divide lengths by 1.4 for 380 V 60 Hz)	1.5	1720										
	2	1280	2030									
	3	960	1530	2400								
	5	630	1000	1570	2470							
	7.5	460	730	1150	1800	2810						
	10		550	850	1340	2090	3190					
	15			590	920	1430	2190	3340				
	20				700	1100	1670	2550	3440			
	25				570	890	1360	2070	2800	3500		
	30					730	1110	1690	2280	2850	3400	
	40						850	1300	1750	2190	2610	3070
	50						680	1040	1400	1750	2090	2450
	60							870	1180	1470	1760	2070
	75								950	1190	1420	1670
	100									890	1060	1240
575 V 60 Hz	1.5	2640										
	2	1860										
	3	1490	2370									
	5	980	1560	2440								
	7.5	720	1150	1800	2820							
	10	540	850	1340	2090							
	15		590	920	1440	2245						
	20			700	1090	1700	2600					
	25				890	1390	2130	3240				
	30				730	1130	1730	2640	3560			
	40					870	1330	2030	2730	3280		
	50						1060	1620	2190	2620	3128	
	60						900	1360	1840	2210	2640	3100
	75							1100	1490	1790	2130	2510
	100								1110	1330	1590	1860

SPLICING SUBMERSIBLE CABLES

When the drop cable must be spliced or connected to the motor leads, it is necessary that the splice be water tight. This splice can be made with commercially available potting or heat shrink splicing kits or by careful tape splicing.

Tape splicing should use the following procedure.

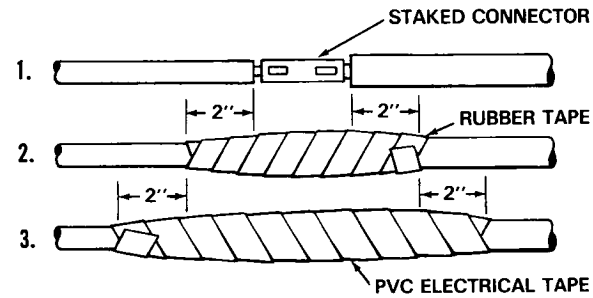
A) Strip individual conductor of insulation only as far as necessary to provide room for a stake type connector or a neatly twisted joint. If a twisted joint is used, it is essential that it be soldered. Tubular connectors of the staked type are preferred. (If connector O.D. is not as large as cable insulation, build-up with rubber electrical tape.)

B) Tape individual joints with rubber electrical tape, using two layers; the first extending one inch beyond each end of the conductor insulation end, the second layer one inch beyond the ends of the first layer. Wrap tightly, eliminating air spaces as much as possible.

C) Tape over the rubber electrical tape with #33 Scotch electrical tape, Minnesota Mining Co., (or equivalent), using two layers as in step "B" and making each layer overlap the end of the preceding layer by at least one inch.

In the case of a cable with three conductors encased in a single outer sheath, tape individual conductors as described, staggering joints.

Total thickness of tape should be no less than the thickness of the conductor insulation.



LOCKED ROTOR KVA CODE

In some cases, local codes and/or inspectors may require the code letter for Locked Rotor KVA for the particular rating motor being installed. KVA is also required to determine the size or type of power supply transformers, controls or wiring. The KVA code is printed on the motor nameplate.

The code letter tabulation printed here can also be found in the National Electrical code or in National Electrical Manufacturers Association Standards.

TABLE 8

Code Letter	Locked Rotor KVA/HP	Code Letter	Locked Rotor KVA/HP
A	0 - 3.14	K	8.0 - 8.99
B	3.15 - 3.54	L	9.0 - 9.99
C	3.55 - 3.99	M	10.0 - 11.19
D	4.0 - 4.49	N	11.2 - 12.49
E	4.5 - 4.99	P	12.5 - 13.99
F	5.0 - 5.59	R	14.0 - 15.99
G	5.6 - 6.29	S	16.0 - 17.99
H	6.3 - 7.09	T	18.0 - 19.99
J	7.1 - 7.99	U	20.0 - 22.39
		V	22.4 and up

Example: Consider Model 236 1129 000, a 7½ HP, 460 volt motor with locked rotor current of 68.5 amperes. Volts per phase (Y connected) are 460/1.73. Phase = 3. The locked rotor KVA/HP is then.

$$\frac{460 \times 68.5 \times 3}{1.73 \times 1000 \times 7\frac{1}{2}} = 7.29$$

From the table, note 7.29 is J code.

WATER TEMPERATURE

With proper water flow past the motor, Franklin submersible motors are designed to operate up to nameplate amperage rating in water as hot as 86°F (30°C). If the water temperature exceeds 86°, reduce the load by changing pumps or throttling the pump discharge.

TABLE 9

Reduced motor loading in water over 30°C (86°F)

Water Temperature	Approximate Allowable % of Maximum Nameplate Amps. Through 3 HP	5 through 15 HP	Over 15 HP
35°C (95°F)	100%	100%	90%
40°C (104°F)	100%	90%	80%
45°C (113°F)	90%	80%	70%
50°C (122°F)	80%	70%	60%
55°C (130°F)	70%	60%	45%

Do not use submersible motors in water over 55°C (130°F).

SUBMERSIBLE MOTOR COOLING

When the pump is set below any screen openings or below the bottom of the casing a top feeding well condition can exist which reduces the rate of cooling water flow past the motor.

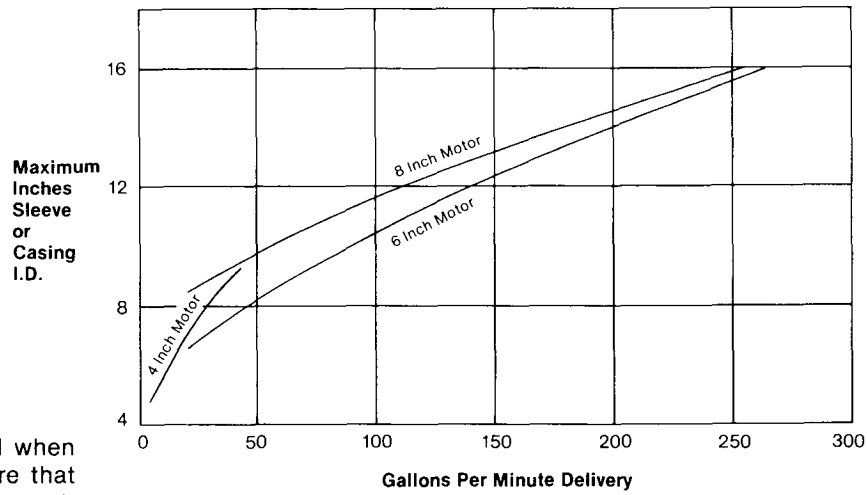
If the flow rate is less then specified a flow inducer sleeve or an alternate method of increasing water velocity past the motor must be used for proper cooling.

MINIMUM VELOCITY PAST THE MOTOR

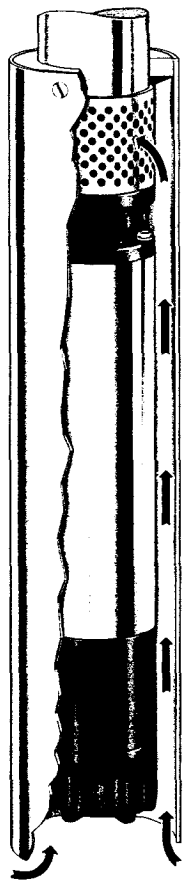
4" dia. motor — .25 ft./sec.
6" dia. motor — .5 ft./sec.
8" dia. motor — .5 ft./sec.

A flow inducer sleeve should always be used when the pump is in a large body of water. Make sure that such an installation is grounded as warned on page 1.

COOLING FLOW REQUIREMENTS

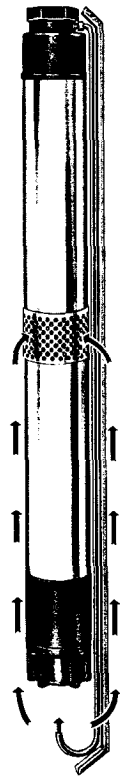


FLOW INDUCER SLEEVE



A flow inducer sleeve is a tube over the motor, closed off above the pump intake and extended to the bottom of the motor or lower. The sleeve material is corrosion resistant metal or heavy plastic.

FLOW INDUCER DISCHARGE TUBE



If the casing is too small for a flow sleeve and the pump cannot be raised a tube may be installed as follows:

a) Tap a ¼" tube (ID) into the pump outlet (below check valve).
b) Clamp it to the pump and motor
c) Aim tube upward so flow is introduced 1 foot below the motor
d) Protect tube with spacers and angle iron.

USE OF CHECK VALVES

It is recommended that check valves be used in all submersible pump installations. A line check valve should be installed in the discharge pipe within 25 feet of the pump, if the pump is not made with a built-in check valve.

Immediate motor or pump failure, or shortened service life can be the result of the following conditions.

a. **Backspin** — when no check valve is used or when a check valve becomes defective, the water in the drop pipe can flow back down when the pump stops. This backflow can keep thrust on the motor while it comes to a stop which can cause excessive thrust bearing wear.

b. **Up thrust** — when no check valve is used or the valve leaks the pump starts each time at no head. Many pumps exert an upward thrust on the impeller stack at low heads which can lift the rotor of the motor until the developing water column causes down thrust. Repeated up thrust at each start can cause wear and failure unless the pump construction prevents upward shaft movement.

c. **Water hammer** — if the lowest check valve is more than 30 Ft. above the well water level, the weight of the falling water column draws a vacuum or evacuates a void below the check valve when the pump stops. On the next pump start, water moving at a high velocity fills this void and strikes the closed check valve and the stationary water in the pipe causing a hydraulic shock. This shock can split pipes, break joints or damage the pump and motor.

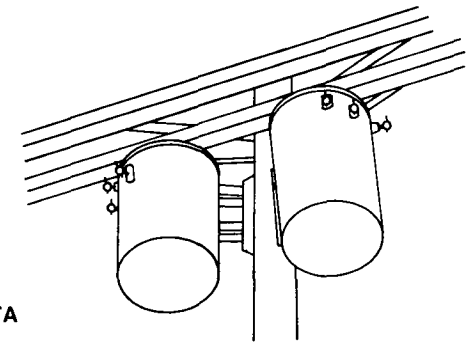
THREE PHASE POWER UNBALANCE

A full three phase supply is recommended for all three phase motors, consisting of three individual transformers or one three phase transformer. So-called "open" delta or wye connections using only two transformers can be used, but are more likely to cause problems from current unbalance.

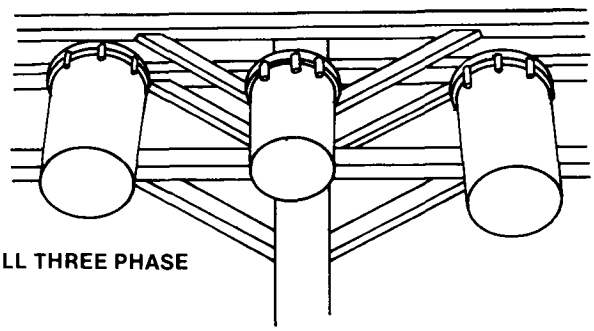
Transformer ratings should be no smaller than listed in the table for supply power to the motor alone.

Open Wye or Delta systems often suffer from line unbalance, which can cause poor motor performance, nuisance overload tripping, or premature motor failure. For the best performance current unbalance should not exceed 5 percent.

If the unbalance can not be corrected by rolling leads, contact the power company.



OPEN DELTA



FULL THREE PHASE

TABLE 10

TRANSFORMER CAPACITY REQUIRED FOR SUBMERSIBLE MOTORS

Sumersible 3 ø Motor HP Rating	Total Effective KVA Required	Smallest KVA Rating — Each Transformer	
		Open WYE or DELTA 2 Transformers	WYE or DELTA 3 Transformers
1½	3	2	1
2	4	2	1½
3	5	3	2
5	7½	5	3
7½	10	7½	5
10	15	10	5
15	20	15	7½
20	25	15	10
25	30	20	10
30	40	25	15
40	50	30	20
50	60	35	20
60	75	40	25
75	90	50	30
100	120	65	40

Unbalance Formula

$$\text{Percent Current Unbalance} = \frac{\text{Max difference from average} \times 100}{\text{average}}$$

Example:
Currents are 80, 79, 84 amps (Lines 1-2 & 3)

$$\text{Avg. Currents} = \frac{80 + 79 + 84}{3} = 81$$

$$\text{Percent Current Unbalance} = \frac{84 - 81}{81} \times 100 = 3.7\%$$

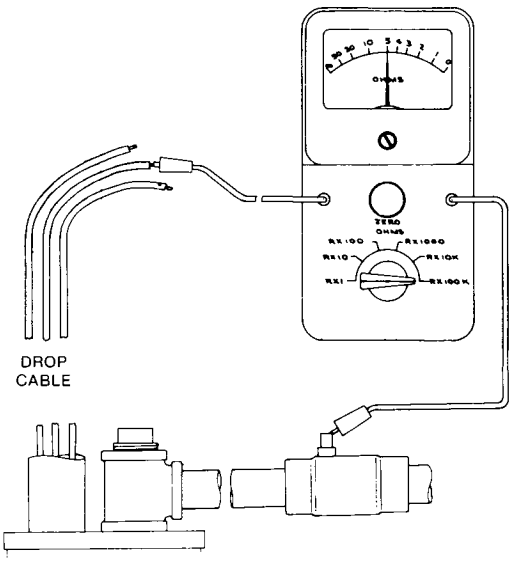
PRELIMINARY TESTS

WHAT IS TO BE DONE	APPLIES TO	HOW IT IS TO BE DONE	WHAT IT MEANS
Measure resistance from any cable to ground.	1 Ph. 3 Ph.	Ohms will be per Table 1.	1. If the ohm value is normal, the motor windings are not grounded and the cable insulation is not damaged. 2. If the ohm value is below normal, either the windings are grounded or the cable insulation is damaged. Check the cable at the well seal as the insulation is sometimes damaged by being pinched.
Measure resistance between all leads.	1 Ph. 3 Ph.	Ohms will be per Table 2 and/or Table 3.	1. If all ohm values are normal, the motor windings are neither shorted nor open, and the cable colors are correct. 2. If any one ohm value is less than normal, the motor is shorted. 3. If any one ohm value is greater than normal, the winding or the cable is open, or there is a poor cable joint or connection. 4. If some ohm values are greater than normal and some less, the leads are mixed. See page 12 to verify cable colors.

HOW TO MEASURE OHM VALUES BETWEEN LEADS AND GROUND (Insulation Resistance) · See Figure 2

1. Set the scale lever to R x 100K and set the ohmmeter on zero.
2. **CAUTION** Open master breaker and disconnect all leads from control box or pressure switch (Q-D type control, remove lid) to avoid damage to meter or electric shock hazard. Connect one ohmmeter lead to any one of the motor leads and the other to the metal drop pipe. If the drop pipe is plastic, connect the ohmmeter lead to the well casing. See Fig. 4, page 12 for the Q.D. type control.

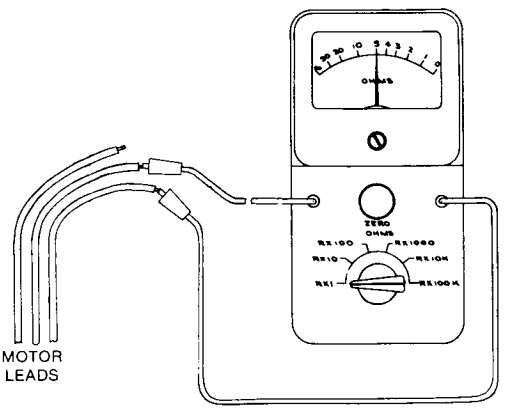
Figure 2
MEASURING INSULATION RESISTANCE



HOW TO MEASURE RESISTANCE BETWEEN LEADS

1. Set the scale lever to R x 1 for values under 10 ohms. For values over 10 ohms, set the scale lever to R x 10. Zero balance the ohmmeter as described above.
2. **CAUTION** Open master breaker and disconnect all leads from control box or pressure switch (Q-D type control, remove lid) to avoid damage to meter or electric shock hazard. Connect the ohmmeter leads as shown in Figure 3, below. See Figure 4, page 12 for the Q.D. type control.

Figure 3
MEASURING WINDING RESISTANCE



"Q-D" means "Quick-Disconnect" Control Box

WINDING RESISTANCE READINGS

TABLE 1 NORMAL OHM AND MEGOHM VALUES (INSULATION RESISTANCE) BETWEEN ALL LEADS AND GROUND

Insulation resistance does not vary with rating. All motors of all H.P., voltage, and phase rating have the same value of insulation resistance.

CONDITION OF MOTOR AND LEADS	OHM VALUE	MEGOHM VALUE
A New Motor (without drop cable).	20,000,000 (or more)	20.0
A used motor which can be reinstalled in the well.	10,000,000 (or more)	10.0
MOTOR IN WELL. Ohm readings are for drop cable plus motor.		
A new motor in the well.	2,000,000 (or more)	2.0
A motor in the well in reasonably good condition.	500,000 - 2,000,000	0.5 - 2.0
A motor which may have been damaged by lightning or with damaged leads. Do not pull the pump for this reason.	20,000 - 500,000	0.02 - 0.5
A motor which definitely has been damaged or with damaged cable. The pump should be pulled and repairs made to the cable or the motor replaced. The motor will not fail for this reason alone, but it will probably not operate for long.	10,000 - 20,000	0.01 - 0.02
A motor which has failed or with completely destroyed cable insulation. The pump must be pulled and the cable repaired or the motor replaced.	less than 10,000	0 - 0.01

WINDING RESISTANCE MEASURING

When measured as shown in Figure 3 page 8, motor resistance only should fall within the values in Table 3 page 10. When measured through the drop cable the size and length of the cable must be known and the correct cable resistance from Table 2 subtracted from the ohmmeter reading to get the winding resistance for comparison with Table 3.

TABLE 2 TOTAL RESISTANCE OF DROP CABLE (OHMS)

The values below are for copper conductors. If aluminum conductor drop cable is used, the resistance will be higher for each foot of cable of the same size. To determine the actual resistance of aluminum drop cable, divide the ohm readings from this chart by 0.61. This chart shows total resistance of cable from control box to motor and back.

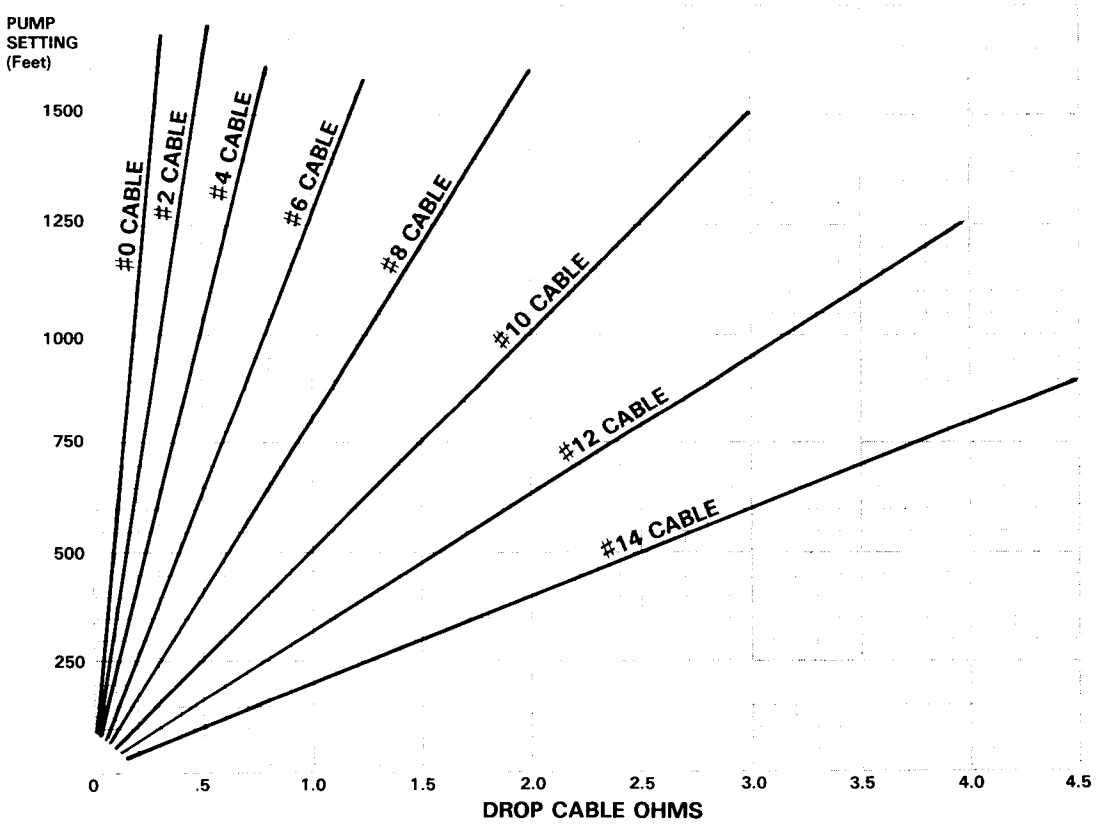


TABLE 3 MOTOR RESISTANCE

SINGLE PHASE MOTORS

Winding Resistance Motor Only (Ohms)

SUPER STAINLESS MOTORS

			3-WIRE		2-WIRE
HP	Dia.	Volts	Main Wdg. Blk.-Yel.	Start Wdg. Red.-Yel.	Wdg.
¼	4"	115	1.9-2.3	8.1-10.0	1.8-2.3
	4"	230	7.5-9.2	32.8-40.2	7.5-9.2
⅓	4"	115	1.5-1.9	5.7- 7.1	1.5-1.9
	4"	230	6.0-7.4	23.4-28.6	6.0-7.4
½	4"	115	1.0-1.3	3.8- 4.7	1.0-1.3
	4"	230	4.2-5.2	15.5-19.6	4.2-5.2
¾	4"	230	2.7-3.4	11.0-13.6	2.7-3.4
1	4"	230	2.2-2.8	9.5-11.7	2.2-2.8
1½	4"	230	1.5-1.9	6.2- 8.5	1.5-1.9

			MT-3 MOTORS		MT MOTORS	
HP	Dia.	Volts	Main Wdg. Blk.-Yel.	Start Wdg. Red-Yel.	Main Wdg. Blk.-Yel.	Start Wdg. Red-Yel.
¼	4"	115	2.2- 2.9	8.1- 9.9	2.1- 2.8	4.5- 6.0
	4"	230	8.9-11.6	34.0-42.0	8.6-11.7	22.9-30.7
⅓	4"	115	1.6- 2.1	5.6- 6.8	1.8- 2.4	3.9- 5.7
	4"	230	6.1- 7.8	23.2-28.4	6.9-10.0	16.6-23.5
½	4"	115	1.0- 1.5	4.0- 5.0	1.1- 1.5	3.0- 4.7
	4"	230	4.6- 6.1	15.9-19.5	4.4- 6.0	14.0-19.5
¾	4"	115	0.9- 1.1	3.2- 4.0	0.7- 1.0	2.1- 3.0
	4"	230	3.2- 4.2	12.6-15.4	2.8- 4.2	8.5-12.3
1	4"	230	2.5- 3.2	9.3-11.4	2.7- 3.8	8.1-13.1

HP	Dia.	Volts	Lbs. Thrust		Main Wdg. Blk.-Yel.	Start Wdg. Red-Yel.
1½	4"	230	900		1.5 -2.5	6.2 -8.6
2	4"	230	900		1.6 -2.3	5.2 -7.1
3	4"	230	900		.9 -1.5	3.0 -4.6
5	4"	230	900		.68-1.0	2.1 -2.8
5	6"	230	1500		.55- .68	1.3 -1.6
7½	6"	230	1500		.36- .50	.92-1.2
10	6"	230	3500		.27- .33	.80- .98

NOTE: Add resistance of drop cable when checking pump in well.

THREE PHASE MOTORS

Resistance Motor Only (Ohms) any 2 leads

HP	Dia.	Lbs. Thrust	200V	230V	460V	575V
1½	4"	900	2.4 -3.4	3.2 -4.1	11.3 -15.0	15.1 -26.0
2	4"	900	1.9 -2.4	2.4 -3.0	9.7 -12.0	13.6 -18.9
3	4"	900	1.3 -1.7	1.8 -2.2	7.0 - 8.7	11.0 -13.6
5	4"	900	.70- .94	.93-1.2	3.6 - 4.4	5.6 - 6.9
7½	4"	900	.55- .68	.76- .93	2.4 - 3.4	3.5 - 5.1
10	4"	900	—	—	1.8 - 2.3	2.8 - 3.5
5	6"	1,500	.70- .88	.87-1.1	3.1 - 4.1	5.7 - 7.0
7½	6"	1,500	.48- .59	.56- .71	2.1 - 2.9	4.0 - 4.8
10	6"	3,500	.28- .46	.35- .55	1.5 - 2.1	2.5 -3.2
15	6"	3,500	.19- .24	.27- .37	1.1 - 1.4	1.7 - 2.2
20	6"	3,500	.15- .22	.19- .27	.77- 1.1	1.2 - 1.6
25	6"	3,500	.10- .19	.13- .21	.53- .81	.91- 1.3
30	6"	3,500	.08- .14	.11- .15	.40- .59	.70- .95
40	6"	3,500	—	—	.38- . 54	.64- .80
50	6"	3,500	—	—	.28- .40	.47- .65
40	8"	10,000	—	—	.264-.282	—
50	8"	10,000	—	—	.184-.216	
60	8"	10,000	—	—	.150-.166	
75	8"	10,000	—	—	.114-.126	—
100	8"	10,000	—	—	.078-.090	—

TABLE 4 MOTOR CURRENT

(1) Current - Motor Running Under Load (Max. Amps.)

SUPER STAINLESS MOTORS

			3-WIRE			2-WIRE
HP	Dia.	Volts	Yellow	Black	Red	Black
¼	4"	115	7.2	7.2	0	7.2
	4"	230	3.6	3.6	0	3.6
⅓	4"	115	8.9	8.9	0	8.9
	4"	230	4.4	4.4	0	4.4
½	4"	115	11.9	11.9	0	11.9
	4"	230	5.9	5.9	0	5.9
¾	4"	230	8.0	8.0	0	8.0
1	4"	230	9.6	9.6	0	9.6
1½	4"	230	11.5	11.0	1.8	13.1

MT-3 MOTORS			MT MOTORS		
Yellow	Black	Red	Yellow	Black	Red
9.2	9.2	0	7.7	7.7	0
4.6	4.6	0	3.8	3.8	0
11.6	11.6	0	8.9	8.9	0
5.8	5.8	0	4.8	4.8	0
14.8	14.8	0	11.8	11.8	0
7.4	7.4	0	5.9	5.9	0
19.0	19.0	0	16.2	16.2	0
8.5	9.5	0	8.1	8.1	0
11.8	11.8	0	9.3	9.3	0

			MOTORS A.76 AND LATER		
Yellow	Black	Red	Yellow	Black	Red
11.6	10.5	1.5	11.6	11.2	1.8
14.5	13.5	2.5	13.2	12.0	2.8
19.4	17.5	3.0	16.5	14.8	5.0
26.2	21.5	8.0	27.5	23.2	9.2
29.5	28.4	4.0	—	—	—
41.0	38.0	6.0	—	—	—
52.0	48.0	10.8	—	—	—

Current Under Load (Amps.) - any lead

200V	230V	460V	575V
7.4	6.4	3.2	2.6
9.4	8.2	4.1	3.3
13.1	11.4	5.7	4.6
20.0	17.4	8.7	7.0
30.8	26.8	13.4	10.7
—	—	17.6	14.1
19.1	16.6	8.3	6.6
27.5	23.9	11.9	9.5
36.8	32.0	16.0	12.8
53.6	46.6	23.3	18.6
70.2	61.0	30.5	24.4
86.3	75.0	37.5	30.0
105.8	92.0	46.0	36.8
—	—	60.0	48.0
—	—	75.0	60.0
—	—	60.0	—
—	—	75.0	—
—	—	89.0	—
—	—	110.0	—
—	—	148.0	—

(1) NOTE: For current values of 208/220, 440, or 550V motors use tables for 230, 460 or 575 volt motors.

CONTROL BOXES

Single phase three wire submersible motors require the use of above ground control boxes for starting and thermal protection. Operation of motors without control boxes or with incorrect boxes can result in failure of motors and voids warranty.

Control boxes contain starting capacitors, starting relay, overload protector and in some sizes running capacitors. The overload protector is mounted inside the starting capacitor case in control boxes through 1½ H.P., and separately on larger ratings.

Ratings through 1 H.P. may use either a current or a potential type starting relay, while larger ratings use potential relays. All Franklin control boxes contain connection diagrams and checking instructions.

CAUTION Be certain that control box H.P., and voltage match the motor.

Comparison of Operation of Relays.

Current Relays — control box models

280 _ _ _ _ _ 98 and 280 _ _ _ _ _ 03

Before power is applied the starting relay contacts are open. When power is applied the high main winding current through the relay coil immediately closes the contacts, energizing the start winding and starting the motor. As the motor comes up to running speed, current through the relay coil gradually drops and allows the contacts to open the start winding circuit, and the motor completes acceleration and runs on the main winding.

Potential Relays — All other models

Before the power is applied the starting relay contacts are closed. When the power is applied, both start and main motor windings are energized, and the motor starts. At this instant the voltage across the start winding is relatively low. This low valve of voltage across the start winding is not enough to pick up (open the contacts of) the starting relay.

As the motor comes up to speed, the voltage across the start winding (and the starting relay coil) increases. This higher voltage is enough to pick up the starting relay and open its contacts. This opens the starting circuit and the motor continues to run on the main winding alone, or the main plus running capacitor circuit.

Because of transformer action when the motor is running, there is a voltage generated in the start winding. This voltage is applied to the coil of the starting relay. As long as the motor runs normally this generated voltage is high enough to keep the starting relay picked up (contacts open) and keeps the start winding circuit cut off from the line voltage.

Current and potential relay boxes will operate in any position, but should be mounted upright for best dust and moisture resistance.

MOUNTING CONTROL BOX IN EXTREME TEMPERATURES

The control box should never be mounted in the direct sunlight or in high temperature locations, as this will cause unnecessary tripping of the overload protector. The control boxes are designed to operate in a maximum ambient temperature of 50°C (122°F).

When the control box is mounted in extremely cold locations, there will be a reduction in the motor starting torque because of the action of the cold on the electrolytic starting capacitor. At minus 25°F, the starting torque is about 80% normal immediately and 90% after a few seconds. We recommend that when the control box is mounted where the temperature may go below minus 25°F, that a small enclosure be built around the control box and a small light bulb be left burning inside the enclosure.

2-WIRE MOTOR SOLID STATE CONTROLS

Solid State Starting Switch

The solid state starting switch energizes the starting circuit when power is applied to the motor. When the motor has accelerated to running speed, the switch opens the starting circuit. The switch operation is properly matched to each motor for reliable starting with varying line voltage and pump inertia.

When the motor is de-energized the switch will reset and be ready for the next starting cycle. This "reset" time is the length of off time that is required before the motor can be restarted. Reset time is approximately one to five seconds to assure a positive restart of the motor, depending on motor temperature and other factors.

The starting switch on and reset time has been designed to prevent the start winding from overheating in the case of an extremely fast start and stop cycling. (Due to a water-logged tank.)

Winding Protection

The thermal protector is positioned on the motor winding, which responds to current passing through it and heat received from the motor winding and ambient temperature. When the protector reaches a predetermined point corresponding to a maximum safe winding temperature, the protector opens and interrupts the circuit. When the winding temperature returns to a more reasonable safe limit, the protector will automatically reset.

Extreme Fast Cycling (Due to Water-Logged Tank)

The solid state starting switch will reset within one to five seconds after the motor is stopped. If an attempt is made to restart the motor before the starting switch has reset, the motor may not start; however, there will be current flow through the main winding until the overload protector interrupts the circuit. The time for the protector to reset is longer than the reset of the starting switch. Therefore, the start winding switch will have closed and the motor will operate. However, in just a few cycles the same condition will occur.

When a severely water-logged condition does occur, the user will be alerted to the problem during the off time (overload reset time) since the pressure will drop drastically. When the water-logged tank condition is detected the condition should be corrected to prevent nuisance tripping of the overload protector.

CONTROL BOXES

Identification Of Cables When Color Code Is Missing

(FOR SINGLE PHASE 3-WIRE UNITS ONLY)

PROCEDURE

If the colors on the individual drop cables cannot be found; that is, if no colored threads are visible and no identifying ribs are present and the leads cannot be identified, proceed as follows:

1. Disconnect all three drop cables from the control box. For temporary identification, tie tags to them and give each a number — 1, 2 and 3.
2. With an ohmmeter, measure the following three values of "unknown" ohms. Then match the item with the "unknown" item on the left with the "known" item on the right to determine the color of cables 1, 2 and 3.

"Unknown"	"Known"
Cable 1 to cable 2 (----ohms)	Lowest - Black to yellow
Cable 1 to cable 3 (----ohms)	Intermed.-Red to yellow
Cable 2 to cable 3 (----ohms)	Highest-Black to red

3. Note that "yellow" cable is that used to obtain lowest and intermediate readings and that "red" cable is that used to obtain highest and intermediate readings.

EXAMPLE

Suppose that the ohm readings were:

1 to 2 measures 6 ohms (highest)
1 to 3 measures 4 ohms (intermediate)
2 to 3 measures 2 ohms (lowest)

The actual ohm values are not important. What is important is which reading is highest, intermediate and lowest. This method will work regardless of the actual value of the ohm readings.

Cable 3 was used to obtain both the intermediate and lowest ohm reading. This is the yellow cable.

Cable 1 is the cable used to obtain the intermediate and highest ohm readings. This is the red cable.

METER CONNECTIONS FOR MOTOR TESTING

Figure 4

Q.D. Control Box

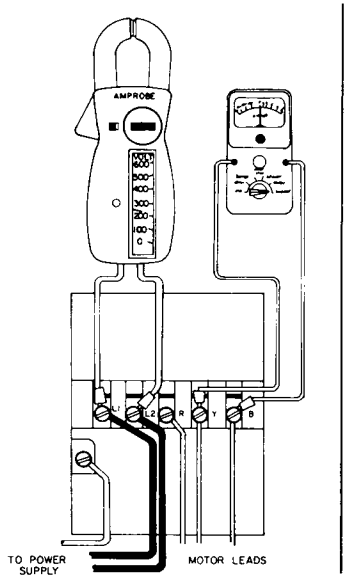


Figure 5

Non Q.D. Terminal Board

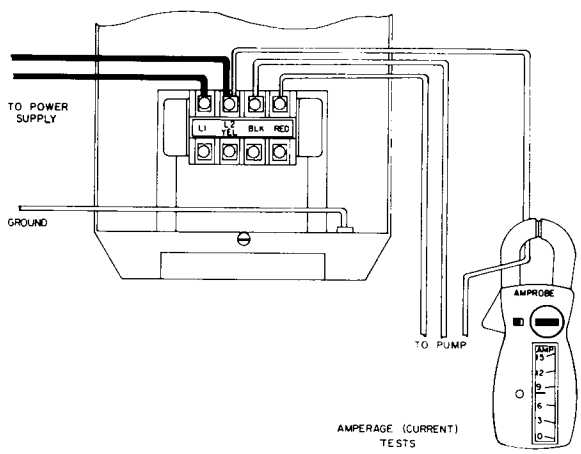
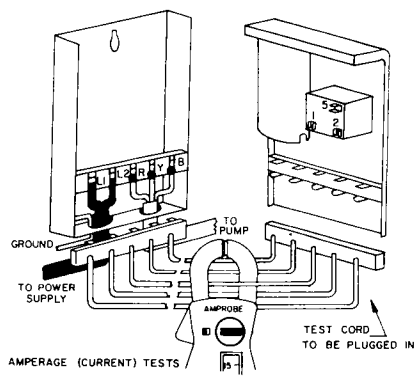


Figure 6

Q.D. Control Box



Checking Motor with "QD" Type Control Box

1. Remove cover to break all motor connection. CAUTION: L_1 and L_2 are still connected to power.
2. To check VOLTAGE: Use voltmeter on L_1 and L_2 as shown in Figure 4.
3. To check CURRENT (amps):
   (a) Connect test cord (150961 901) between control box cover and wall plate (See Fig. 6).
   (b) Use hook-on ammeter as shown.
   OR - If test cord is not available, without removing control box cover, use hook-on ammeter at fuse box or pressure switch.

CONTROL BOX PARTS LIST

Q.D. CONTROL BOX COMPONENTS

HP	Volt (1)	Relay (1) (4)	Capacitor (2)	Super Stainless & MT3 Motors (3) Capacitor - Overload Ass'y (1)	Overload
¼	115	155 031 101	275 461 122 110v. 159-191 mfd.	151 033 971	151 496 971
	230	155 031 102	275 461 123 220v. 43-53 mfd.	151 033 972	151 496 972
⅓	115	155 031 101 or 155 252 103	275 461 122 110v. 159-191 mfd.	151 033 973	151 496 973
	230	155 031 102 or 155 252 101	275 461 123 220v. 43-53 mfd.	151 033 974	151 496 974
½	115	155 031 101 or 155 252 105	275 461 101 110v. 250-300 mfd.	151 033 975	151 496 975
	230	155 031 102 or 155 252 102	275 461 108 220v. 59-71 mfd.	151 033 976	151 496 976
¾	230	155 031 102 or 155 252 103	275 461 106 220v. 86-103 mfd.	151 033 978	151 496 978
1	230	155 031 102 or 155 252 104	275 461 107 220v. 105-126 mfd.	151 033 979	151 496 979
1½	230	155 031 102	275 461 107 220v. 105-126 mfd. Run Capacitor 290 527 111 370v. 5 mfd.	151 033 980	151 496 977

FOOTNOTES:

(1) Control boxes supplied with voltage relays are designed to operate on nominal 230v systems. For 208v systems or where line voltage is between 200v and 210v substitute 208V relay part no. 155 031 103 and cable 2 sizes larger.

Control boxes equipped with current relays will work on both 208 and 230 volt systems and the current relay need not be changed. However, 2 sizes larger cable should be used.

(2) Capacitors and capacitor-overload ass'y. are provided in plastic cases. Two inch diameter assemblies may be substituted for old style 1-3/8" dia. assemblies by bending control box terminal bracket.

(3) Super stainless control box parts may be used on MT & MT-3 motors.

(4) Voltage relay kits, 115 volt, 115 031 901 and 220 volt, 115 031 902 will replace either current or voltage relays.

INTEGRAL HORSEPOWER CONTROL BOX COMPONENTS • 230 VOLT(1)

Motor Rating HP-Dia.	Control Box (1) Model No.	Capacitors (4) Part No.	Mfd. Limits	Volts	Qty.	Overload (2) Part No.	Relay(10) Part No.
1½ - 4"	282 1001 201	275 464 106 S 275 466 101 R (6)	145 - 175 10	220 370	1 1	275 411 106 S 275 411 103 R	155 031 102
	282 3001 200	275 461 107 S 275 466 101 R (6)	104 - 126 10	220 370	1 1	151 496 920 151 033 925 (3)	155 031 102
	282 3007 202 or 282 3007 102	275 461 107 S 275 479 102 R	104 - 126 10	220 370	1 1	151 496 922 151 033 946 (3)	155 031 102
2 - 4"	282 1011 201	275 468 115 S (6) 275 466 102 R (6)	189 - 227 15	220 370	1 1	275 411 107 S 275 411 102 R	155 031 102
	282 3011 201	275 464 113 S 275 466 108 R (6)	104 - 126 20	220 370	1 1	275 411 107 S 275 411 112 R	155 031 102
	282 3018 202	275 464 113 S 275 479 105 R	104 - 126 20	220 370	1 1	275 411 107 S 275 411 112 R	155 031 102
3 - 4"	282 1022 201	275 464 106 S 275 466 101 R (6)	145 - 175 10	220 370	2 2	275 411 108 S 275 406 107 R	155 031 102
	282 3021 201	275 464 106 S 275 475 101 R (6)	145 - 175 35	220 370	1 1	275 411 108 S 275 406 120 R	155 031 102
	282 3028 202	275 463 111 S 275 481 102 R	208 - 250 35	220 370	1 1	275 411 108 S 275 406 120 R	155 031 102
5 - 4"	282 1032 201	275 468 116 S (7) 275 466 102 R (6)	108 - 130 15	330 370	2 4	275 411 109 S (6) 275 406 103 R	155 031 102 (9)
	282 1132 201	275 468 105 S (6) 275 466 102 R (6)	144 - 176 15	330 370	1 4	275 411 102 S 275 406 103 R	155 031 102 (9)
	282 1139 202	275 468 118 S 275 479 103 R	216 - 259 15	330 370	1 4	275 411 102 S 275 406 103 R	155 031 102 (9)
5 - 6"	282 2002 201 Prior to 1975	275 468 116 S (8) 275 466 102 R (6)	108 - 136 15	330 370	4 2	155 083 103 (6)	155 031 102 (9)
	282 2002 201	275 468 117 S 275 466 102 R (6)	130 - 154 15	330 370	2 2	155 083 103 (6)	155 031 102 (9)
	282 2009 202	275 468 117 S 275 479 103 R	130 - 154 15	330 370	2 2	155 249 102	155 031 601
7½ - 6"	282 2012 201 Prior to 1975	275 468 117 S 275 466 102 R (6)	130 - 154 15	330 370	4 3	155 083 104 (6)	155 031 102 (9)
	282 2012 201	275 468 117 S 275 466 102 R (6)	130 - 154 15	330 370	3 3	155 083 104 (6)	155 031 102 (9)
	282 2019 202	275 468 117 S 275 479 103 R	130 - 154 15	330 370	3 3	155 249 101	155 031 601
10 - 6"	282 2029 202	275 468 117 S 275 479 103 R	130 - 154 15	330 370	4 5	155 249 103	155 031 601 (5)

FOOTNOTES:

(1) Lightning arrestor 150 814 902 suitable for all control boxes.

(2) These overload mounting kits required on control box date code B71 or prior.
1½ Hp - 305 050 901
2 HP - 305 051 901
3 HP - 305 052 901
5 HP - 305 053 901

(3) Capacitor & overload ass'y.

(4) Run cap or main wdg. protector (R)
Start cap or start wdg. protector (S)

(5) 2 required.

(6) These parts may be replaced as follows:

Old	New
275 468 105	275 468 118
275 466 101	275 479 102
275 466 102	275 479 103
275 466 108	275 479 105
275 475 101	275 481 102
275 481 101	275 481 102
275 465 115	275 464 113
275 411 109	275 411 102
155 083 103	305 070 902
155 083 104	305 070 901

(7) Replace 2 of 275 468 116 with 1 of 275 468 118

(8) Replace 4 of 275 468 116 with 2 of 275 468 117

(9) Replace with 115 031 601

(10) For 208v systems or where line voltage is between 200v and 210 volts special low voltage relays are required. Use relay part 155 031 103 in place of part 155 031 102 and use relay part 155 031 602 in place of part 155 031 601. Also use cable 2 sizes larger.

CONTROL BOXES
Checking and Repairing Procedures

CAUTION TURN POWER OFF AND DISCHARGE CAPACITORS BEFORE USING OHMMETER

Test or Procedure	Non Q.D. Control Box	Q.D. Control Box
A. General Procedures	1. Disconnect line. 2. Inspect for damaged or burned parts, loose connections, etc. 3. Check for misconnections against diagram in control box. 4. If problem has not been found, check motor per Table 3 and control box as indicated below.	1. Remove cover to disconnect motor from line. CAUTION L_1 and L_2 are still connected to power source. 2. Same. 3. Same. 4. Same, except motor leads are disconnected when cover is removed.
B. Use of Ohmmeter	1. Ohmmeter such as Simpson Model #372 or #260, Triplett Model #630 or #666 may be used. 2. Whenever scales are changed, short ohmmeter leads and "zero balance" meter.	
C. Ground (Insulation Resistance) Test	1. Ohmmeter Setting: Highest scale (usually R x 100K or R x 10,000). 2. Terminal Connections: One ohmmeter lead to "Ground" terminal on control box and touch other lead to each of the other terminals on terminal board. 3. Ohmmeter Reading: Pointer should remain at (∞) and not deflect.	1. Same 2. One ohmmeter lead to frame of control box lid and other to terminals on control box lid. 3. Same
D. Overload Protector	1. Ohmmeter Setting: R x 1 2. Terminal Connections: Connect one ohmmeter lead to Terminal Black and other lead to: (a) Terminal L_1 in four-terminal boxes. (b) Terminal L_2 in five-terminal boxes. 3. Ohmmeter Reading: Should be 0 to 0.5 ohms maximum.	1. Same 2. Terminal Connections: Connect ohmmeter leads between Terminals Black and L_2 (extreme left side under capacitor and second terminal from right). 3. Same
E. Capacitor Tests	1. Ohmmeter Setting: R x 1,000 2. Terminal Connections: One ohmmeter lead to relay terminal #1 and other to black terminal on terminal board.	1. Same 2. Terminal Connections: (a) One ohmmeter lead to relay terminal #1. (b) Other ohmmeter lead to black terminal on lid (extreme left side of lid under capacitor).
	3. Ohmmeter Reading: Pointer should swing toward "zero" and "float" back to (∞). Capacitor is shorted if pointer does not move back to (∞), open if it does not move from (∞). 4. If reading is not as above, disconnect capacitor from overload and test each component.	
F. Relay Coil Test (potential relays only)	1. Ohmmeter Setting: R x 1,000 (or R x 100) 2. Terminal Connections: #5 and #2 on Relay. 3. Ohmmeter Reading: **For 115 Volt Boxes** / **For 230 Volt Boxes** G.E. .7 - 1.8 (700-1800 ohms) / 4.5 - 7.0 (4500-7000 ohms) Cardinal .55 - .85 (550- 850 ohms) / 2.8 - 4.2 (2800-4200 ohms)	
G. Relay Contact Test (potential relays only)	Most cases of inoperative relay contacts can be detected as follows: 1. Ohmmeter Setting: R x 1. 2. Terminal Connections: Terminal #1 and Terminal #2 on Relay. 3. Ohmmeter Reading: Should be "zero". Note: This test verifies "making" of contacts. If it is desired to test "opening" and closing of contacts: a. Connect control box components in control box as indicated on diagram in control box cover. b. Connect three leads from motor of correct rating to control box terminal board. c. Connect power source voltage to L_1 & L_2. d. Current in Red lead should momentarily be a high value - then drop (within one second) to values on page 10.	Same for all, except attach five conductor test cord to connect control box lid to wall mounted terminals for reading current in red lead. Check current as shown on page 10.
H. Relay Coil Test (current relays only)		1. Ohmmeter setting: RX1 2. Terminal connections: #1 & #3 3. Ohmmeter reading: Less than 1 ohm
I. Relay Contact Test (current relays only)		1. Ohmmeter setting: RX1000 2. Terminal connections: #2 & #4 3. Ohmmeter Reading: Infinity (∞) 4. Relay contact test verifies that contacts are open. To check closing of contacts, attach 5 conductor test cord to connect control box lid to wall mounted terminals. While applying power, monitor current in Red lead, current should be a high value then drop within one second to zero amps.

TROUBLE SHOOTING PROCEDURE

Motor Does Not Start

Cause of Trouble	Checking Procedure	Corrective Action
A. No power or incorrect voltage.	Using voltmeter check the line terminals. Voltage must be ± 10% of rated voltage.	Contact power company if voltage is incorrect.
B. Fuses blown or circuit breakers tripped.	Check fuses for recommended size and check for loose, dirty or corroded connections in fuse receptable. Check for tripped circuit breaker.	Replace with proper fuse or reset circuit breaker.
C. Defective pressure switch.	Check voltage at contact points. Improper contact of switch points can cause voltage less than line voltage.	Replace pressure switch or clean points.
D. Control box malfunction.	For detailed procedure, see page 14.	
E. Defective wiring.	Check for loose or corroded connections. Check motor lead terminals with voltmeter for power.	Correct faulty wiring or connections.
F. Bound pump.	Locked rotor conditions can result from misalignment between pump and motor or sand bound pump. Amp readings 3 to 6 times higher than normal will be indicated.	Sand bound pump can sometimes be corrected by temporarily reversing black and red leads in control box of 3-wire motors. If pump does not rotate freely, it must be pulled.
G. Defective cable or motor.	For detailed procedure see pages 8 and 9.	

Motor Starts Too Often

A. Pressure switch.	Check setting on pressure switch and examine for defects.	Reset limit or replace switch.
B. Check valve, stuck open.	Damaged or defective check valve will not hold pressure.	Replace if defective.
C. Waterlogged tank. (air supply)	Check air volume control or snifter valve for proper operation.	Clean or replace. Drain and recharge tank.
D. Leak in system.	Check system for leaks.	Replace damaged pipes or repair leaks.

TROUBLE SHOOTING PROCEDURE

Motor Runs Continuously

Cause of Trouble	Checking Procedure	Corrective Action
A. Pressure switch.	Switch points may be "welded" in closed position. Pressure switch may be set too high.	Clean points or replace switch, or readjust setting.
B. Low level well.	Pump may exceed well capacity. Shut off pump, wait for well to recover. Check static and drawdown level from well head.	Throttle pump output or reset pump to lower level. Do not lower if sand may clog pump.
C. Leak in system.	Check system for leaks.	Replace damaged pipes or repair leaks.
D. Worn pump.	Symptoms of worn pump are similar to those of drop pipe leak or low water level in well. Reduce pressure switch setting, if pump shuts off worn parts may be at fault. Sand is usually present in tank.	Pull pump and replace worn impellers, casing or other close fitting parts.
E. Loose or broken motor shaft.	No or little water will be delivered if coupling between motor and pump shaft is loose or if a jammed pump has caused the motor shaft to shear off.	Check for damaged shafts if coupling is loose and replace worn or defective units.
F. Pump screen blocked.	Restricted flow may indicate a clogged intake screen on pump. Pump may be installed in mud or sand.	Clean screen and reset at less depth. It may be necessary to clean well.
G. Check valve stuck closed.	No water will be delivered if check valve is in closed position.	Replace if defective.

Motor Runs But Overload Protector Trips

A. Incorrect voltage.	Using voltmeter, check the line terminals. Voltage must be within ± 10% of rated voltage.	Contact power company if voltage is incorrect.
B. Overheated protectors.	Direct sunlight or other heat source can make control box hot causing protectors to trip. The box must not be hot to touch.	Shade box, provide ventilation or move box away from heat source.
C. Defective control box.	For detailed procedure see page 14.	
D. Defective motor or cable.	For detailed procedure see pages 8 and 9.	
E. Worn pump or motor.	Check running current per table 4.	Replace pump and/or motor.