BULLETIN E-290C

CBS®

GAS DIODES

GAS TRIODES
AND TETRODES
(cold cathode
and thyratron)

POWER RECTIFIERS



GAS TUBES AND POWER RECTIFIERS

GAS TUBES and POWER RECTIFIERS

CBS GAS DIODES C1

CBS gas diodes for voltage regulator and voltage reference use are available for a wide range of applications. A special engineering laboratory devoted to gaseous tube technology has developed a long series of CBS VR tubes, including many specialized types. In particular the CBS 6626 and 6627 were designed for extremely stable operation in both voltage regulator and voltage reference service.

Voltage regulator tubes and voltage reference tubes are devices designed to provide a steady voltage that is immune to fluctuations of the source voltage and load current. They stabilize the supply voltage directly. Voltage reference tubes are used in conjunction with d-c amplifier tubes for greater stability and wider operating range. For further details write for Bulletin E-267.

CBS THYRATRONS C2

CBS thyratrons, or grid control gas tubes, are designed and built with the same care and quality components as CBS rectifier tubes. While the applications of thyratrons have developed more recently, they have been rapidly expanding and they have made possible the return to the use of direct current motors in many types of operations. These applications include circuits which require adjustment of amount or timing of electric power; e.g., adjustable direct voltage or current, adjustable alternating voltage or current, power switching service, welding service, adjustable motor speed and direction of rotation.

These thyratrons offer better control, full torque at variable speeds, reversals under load, and high frequency switching as needed. Xenon gas thyratrons are especially designed for applications where high sensitivity is required, while mercury thyratrons provide maximum economy.

A wide variety of tubes is available in the rectifier and thyratron groups. The data charts supply basic specification information. Additional technical data on any of these tubes will be provided upon request.

CBS RECTIFIER TUBES C3

CBS rectifier tubes are available in several general types and ratings. The design engineer will be able to choose the exact size and type to meet virtually any circuit need, operating condition, load or job requirement. Xenon and argon filled tubes are intended for use where operating conditions call for fast warm-up and/or use under temperature extremes, Mercury tubes, where greater economy and long life are required. Both full-wave and half-wave rectifier tubes are available in all categories.

The design of equipment powered by rectifier tubes should be such as to allow for heat dissipation by providing sufficient ventilation and adequate spacing. Tube life will also be prolonged by properly designing equipment to provide rated values for anode and filament currents and voltages, plus the control of peak inverse voltages. Time delay provision is also indicated to protect some tubes from cold starting. Proper circuit design will prevent early tube failure from improper use, overloading and mechanical mishandling.

CBS rectifiers are constructed to carefully designed and conservatively rated specifications, thereby assuring excellent service life and performance.

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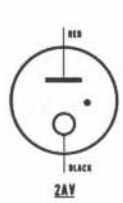
Table C1 GASEOUS DIODES

DESCRIPTION			CONSTRUCTION	MAXIMUM RATINGS				USE	TYPICAL OPERATION				
TYPE	Features and notes	Basing	Base†	Starting Current, Ma	Operating Ma Min.	Operating Ma Max.*	Ambient Temp.**	Application	Min. Supply Volts, D-C	Operating Volts, D-C	Max. Shunt Capacitor, μf	Regulation Average Volts	TYPE
OA2	Glow Tube — 150 Volts	5BO	7-pin Min.	75	5	30	−55 to +90°C	Voltage Regulator	185	150	0.1	2	OA2
OA2WA JANOA2WA USNOA2WA	Glow Tube — 150 Volts	5BO	7-pin Min.		Same as 6626 below.			Voltage Reg. & Ref.	Same as 6626. Tested for military applications.				OA2WA JANOA2WA USNOA2WA
OA3(VR75)	Glow Tube — 75 Volts	4AJ	6-pin O.	100	5	40	−55 to +90°C	Voltage Regulator	105	75	—	5	OA3(VR75)
OB2	Glow Tube — 105 Volts	5BO	7-pin Min.	75	5	30	−55 to +90°C	Voltage Regulator	133	108	0.1	1	OB2
OB2WA JANOB2WA USNOB2WA	Glow Tube — 105 Volts	5BO	7-pin Min.		Same as 6627 below			Voltage Reg. & Ref.	Same as 6627. Tested for military applications.				OB2WA JANOB2WA USNOB2WA
OB3(VR90)	Glow Tube — 90 Volts	4AJ	6-pin O.	—	5	30	—	Voltage Regulator	125	90	—	5	OB3(VR90)
OC3(VR105)	Glow Tube — 105 Volts	4AJ	6-pin O.	100	5	40	−55 to +90°C	Voltage Regulator	133	108	—	2	OC3(VR105)
OD3(VR150)	Glow Tube — 150 Volts	4AJ	6-pin O.	100	5	40	−55 to +90°C	Voltage Regulator	185	150	—	3.5	OD3(VR150)
5651	Glow Tube — 87 Volts	5BO	7-pin O.	—	1.5	3.5	−55 to +90°C	Voltage Reference	115	87	0.02 Stability = 0.1 V	3.0 max.	5651
6626 6626/OA2WA USN6626/ OA2WA	Glow Tube — 150 Volts Reliable operation under adverse conditions.	5BO	7-pin Min.	75 —	5 6	30 10	−55 to +150°C −55 to +150°C	Voltage Regulator Voltage Reference	165 165	148 148	0.1 Stability = 0.2 V	2 0.5	6626 6626/OA2WA USN6626/ OA2WA
6627 6627/OB2WA USN6627/ OB2WA	Glow Tube — 105 Volts Reliable operation under adverse conditions.	5BO	7-pin Min.	75 —	5 6	30 10	−55 to +110°C −55 to +150°C	Voltage Regulator Voltage Reference	130 130	108 107	0.1 Stability = 0.2 V	1.5 0.2	6627 6627/OB2WA USN6627/ OB2WA
6830	Glow Tube — 150 Volts	2AV	7-pin Min. with flying leads	75	5	30	−55 to +90°C	Voltage Regulator	185	150	0.1	2.0	6830
6831	Glow Tube — 105 Volts	2AV	7-pin Min. with flying leads	75	5	30	−55 to +90°C	Voltage Regulator	133	108	0.1	1.0	6831

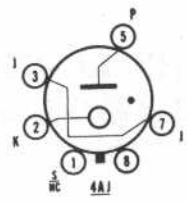
*Use sufficient series resistance to limit current at all times to not more than the rated values.

**Ambient temperature for tubes operated at maximum ratings; if ratings are decreased, the ambient temperature may be increased.

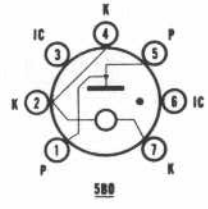
†All miniature tubes listed except types 6830 and 6831 are 2⅝ in. high and ¾ in. in diameter. Types 6830 and 6831 have the same diameter but their over-all length is greater because flying leads have been substituted for the base pins. The octal types are 4¼ in. high and 1 5/16 in. in diameter.



2AV



4AJ

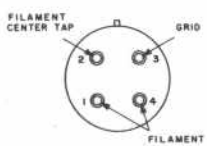


5BO

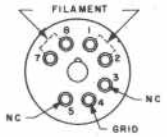
Table C2 GRID CONTROLLED GAS TUBES – THYRATRON and COLD CATHODE TYPES

DESCRIPTION		CONSTRUCTION					CATHODE			MAXIMUM RATINGS (Absolute Values)									
TYPE	Features and notes	Basing	Base, B (bayonet)	Anode cap	Length, inches	Diameter, inches	Heater-filament	Volts	Amperes	Heating time secs.	Temp. Range °C. Cond. Mercury (CM) Ambient (A)	Peak forward anode volts	Peak inverse anode volts	Peak cathode current, amps.	Average cathode current, amps.	Surge current amps.	Critical grid volts at anode volts	De-ionization time μsec.	Approx. tube drop volts	TYPE
0A4G	For calculating machines and carrier-current relay systems.	45	Octal	—	4⅛	1 9/16		Cold Cathode			Peak starter electrode Voltage = 75 to 90V	225	0.10	.025	—	—	—	70	0A4G
1C21	Similar to type OA4G but for d-c operation only.	45	Octal	—	2⅝	1 5/16		Cold Cathode			Peak starter electrode Voltage = 66 to 80V	180	0.10	.025	—	—	—	73	1C21
C1K	Xenon gas type.	55	Med. 4-pin B	—	4¼	1 9/16	Fil.	2.5	6.8	25	−55 to +75A	1000	1250	12.0	1.0	77	−4.5 at 2000	200	8	C1K
2A4G	Relay control tube.	47	Octal	—	4⅛	1 9/16	Fil.	2.5	2.5	—	−55 to +70A	200	200	1.25	0.1	—	—	—	15	2A4G
2D21	Tetrode for sensitive control. Operates direct from phototube.	52	Min. 7-pin	—	2⅛	¾	Htr.	6.3	0.6	—	−75 to +90A	650	1300	0.5	0.1	10	—	—	8	2D21
3C23	Mercury-vapor type with negative control.	3	Sm. 4-pin B	Medium	6⅛	2 1/16	Fil.	2.5	7.0	15	−40 to +80CM	1250	1250	6.0	1.5	120	—	360	15	3C23
C3J	Xenon gas type. Same as 5684.	1	Med. 4-pin B	Medium	6¼	1 1 1/16	Fil.	2.5	9.0	30	−55 to +75A	1000	1250	30	3.0	300	−6 at 1000	500	8	C3J
C3P14	Automatic inverter motor control. Xenon gas.	17	Indus. 4-pin	Medium	5 13/16	2	Htr.	14	2.55	120	−75 to +85A	1250	1250	30	3.0	300	−19 at 1100	175	9	C3P14
C3R14	Automatic inverter motor control.	17	Indus. 4-pin	Medium	5 13/16	2	Htr.	14	2.5	120	−55 to +75A	500	500	30	3.0	100	−7 at 350	200	12	C3R14
CR5	Mercury vapor type with external metal mesh grid.	19	Mogul Screw	Small	8¾	1⅝	Fil.	2.0	12	—	—	175	175	18	5.0		60V RMS out of ϕ with 110V RMS		10	CR5
C5F14	Xenon gas type. Same as type 6278.	17	Flexible leads	Flexible	4 13/16	2	Htr.	14	2.5	120	−55 to +75A	500	500	60	5.0	720	−6 at 500	200	9.25	C5F14
6D4	Relay tube or relaxation oscillator.	46	Min. 7-pin	—	2⅛	¾	Htr.	6.3	.25	—	−55 to +90A	350	350	0.11	.025	—	—	—	16	6D4
C6A	Xenon gas type.	32	Mogul Screw	Formed prong	11 23/32	2.1	Fil.	2.5	18	40	−55 to +70A	300	600	77	6.4	—	−2 at 110	—	8	C6A
C6J	Xenon gas type. Same as 5685.	14	Indus. 4-pin	Medium	9½	2 1/32	Fil.	2.5	21	30	−75 to +85A	750	1250	77	6.4	770	−3.5 at 750	500	9	C6J
C6J/A	Same as C6J except for pfv and critical grid voltage.	14	Indus. 4-pin	Medium	9½	2 1/32	Fil.	2.5	21	30	−75 to +85A	1000	1250	77	6.4	770	−4.6 at 1000	500	9	C6J/A
C6J/F	Xenon gas type.	30	Flexible with lugs	Medium	9½	2 1/32	Fil.	2.5	21	30	−75 to +85A	1000	1250	77	6.4	770	−4.6 at 1000	—	9	C6J/F
C6J/K	Xenon gas type.	14	Indus. 4-pin	Medium	9½	2 1/32	Fil.	2.5	21	60	−55 to +75A	1000	1250	77	6.4	770	−4.6 at 1000	100	11	C6J/K
C6L	Xenon gas type.	14	Indus. 4-pin	Medium	9½	2 3/32	Fil.	2.5	20	60	−55 to +75A	350	500	77	6.4	770	−2 at 250	180	10	C6L
C6M	Xenon gas type.	14	Indus. 4-pin	Medium	9½	2 1/32	Fil.	2.5	21	60	−60 to +75A	1000	1250	77	6.4	770	−7 at 1000	125	12	C6M
FG27A	Mercury-vapor type for relay control.	1	Med. 4-pin B	Medium	7¼	3	Fil.	5.0	4.5	60	+40 to +80CM	1000	1000	10	2.5	200	—	1000	16	FG27A
FG95	Same as type 5560.	43	Med. 4-pin B	Medium	7 5/16	2¼	Htr.	5.0	4.5	300	−40 to +80CM	1000	1000	15	2.5	200	—	—	16	FG95
FG97	Mercury-vapor double grid type.	53	Med. 4-pin B	Top & Side Medium	6¾	2 1/16	Fil.	2.5	5.0	5	+40 to +80CM	1000	1000	2.0	0.5	40	—	1000	16	FG97
FG105	Mercury-vapor double grid type.	56	Super Jumbo B	Large	11¼	2½ R	Htr.	5.0	10.0	300	+40 to +80CM	2500	2500	40	6.4	400	—	1000	16	FG105
KY21A	Mercury-vapor type.	57	Med. 5-pin	Stiff lead	7⅝	2¼	Fil.	2.5	10.0	30	+20 to +60CM	11000	11000	3	.75	—	−55 at 11KV	1000	15	KY21A

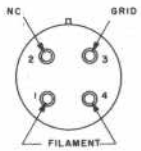
172	Mercury-vapor double grid type. Data given; top line, continuous service; bottom line, welder service.	Metal envelope with flexible leads and threaded terminal.			10¾	2¼	Htr.	5.0	10	300	+40 to +80CM +30 to +95CM	2000 750	2000 750	40 77	6.4 2.5	400 400	— —	1000 1000	16 16	**172**
CE-302	Mercury-vapor type.	57	Med. 5-pin	Small	7 1/16	2¼	Fil.	2.5	7	15	+30 to +80CM	2500	2500	1.0	0.64	70	−3.0 at 500	1000	15	**CE-302**
CE-304	Mercury-vapor type.	6	Indus. 4-pin B	Medium	12⅛	3⅛	Fil.	2.5	22.5	180	+40 to +80CM	1000	1000	125	12.5	—	−7.5 at 1000	1000	9	**CE-304**
CE-311	Mercury-vapor and gas filled type.	3	Med. 4-pin B	Medium	6⅛	2 1/16	Fil.	2.5	7	15	−40 to +80CM	1000	1000	6.0	1.5	—	−3.75 at 500	1000	15	**CE-311**
CE-320A	Mercury-vapor and gas filled type.	1	Med. 4-pin B	Medium	6¼	1⅝	Fil.	2.5	9	20	−40 to +80A	1500	1500	30	2.5	250	−4.5 at 750	1000	12	**CE-320A**
CE-323B	Mercury-vapor and gas filled type.	4	Med. 5-pin	Small	6⅝	2 1/16	Fil.	2.5	7	15	−40 to +80CM	1250	1250	6.0	1.5	—	−3.75 to 500	—	10	**CE-323B**
393A	Mercury-vapor and gas filled type.	2	Octal	Small	6⅝	2 1/16	Fil.	2.5	7	15	−40 to +80CM	1250	1250	6.0	1.5	—	−3.75 to 500	—	15	**393A**
627	Mercury-vapor type.	15	Indus. 4-pin	Medium	6⅝	2 1/16	Fil.	2.5	5	10	25 to +70CM	2500	2500	2.5	0.64	40	−20 at 1750	1000	11	**627**
873	Mercury-vapor type.	27	Jumbo 4-pin B	Medium	8½	2 5/16	Fil.	5.0	6.75	45	+40 to +80CM	3000	3000	10	2.5	90	−5.5 at 1000	1000	10	**873**
884	Relay control and relaxation oscillator.	50	Octal	—	4⅛	1 9/16	Htr.	6.3	0.6	10	−75 to +90A For Relaxation Osc. (Sweep Circuit Service) Peak Anode volts = 300. Peak Cathode Amps. = 0.3	350	—	0.3	0.075	—	—	—	16	**884**
2050	Xenon gas double grid type for sensitive control.	48	Octal	—	4⅛	1 9/16	Htr.	6.3	0.6	10	−75 to +90A	650	1300	1.0	0.1	10	—	—	8	**2050**
5528/C6L	Xenon gas type.	14	Indus. 4-pin	Medium	9½	2 3/32	Fil.	2.5	20	60	−55 to +75A	350	500	77	6.4	770	−2 at 250	180	10	**5528/C6L**
5544	Xenon gas type.	51	Super Jumbo B	Medium	7½	2⅝	Fil.	2.5	12	60	−55 to +70A	1500	1500	40	3.2	560	—	—	16	**5544**
5557/FG17	Mercury-vapor type.	3	Medium 4-pin B	Medium	6⅛	2 1/16	Fil.	2.5	5	5	+40 to +80CM	2500	5000	2	0.5	40	—	1000	16	**5557/FG17**
5559/FG57	Mercury-vapor type.	58	Small 4-pin B	Medium	6⅜	3	Htr.	5.0	4.5	300	+40 to +80CM	1000	1000	15	2.5	200	−6.5 at 1000	1000	16	**5559/FG57**
5560/FG95	Mercury-vapor type.	43	Med. 4-pin	Medium	7 15/16	2¼	Htr.	5.0	4.5	300	−40 to +80CM	1000	1000	15	2.5	200	−9 at 1000	1000	16	**5560/FG95**
5684/C3J/A	Xenon gas type.	1	Medium 4-pin B	Medium	6¼	1 1/16	Fil.	2.5	9.0	30	−55 to +75A	1000	1250	30	2.5	—	−6 at 1000	500	8.0	**5684/C3J/A**
5685/C6J/A	Xenon gas type.	14	Indus. 4-pin	Medium	9½	2 1/32	Fil.	2.5	21	60	−75 to +85A	1000	1250	77	6.4	770	−4.6 at 1000	500	9.0	**5685/C6J/A**
5696	Relay control circuits. Has short de-ionization time.	52	Min. 7-pin	—	1¾	¾	Htr.	6.3	0.15	—	−55 to +90A Typical Operating Conditions for Relay Service: A-C Anode Volts (RMS) = 117 V Peak Grid Signal Volts = 5 V Grid 1 Bias Volts (RMS) = 5 V Grid 1 Circuit Resistance = 0.1 meg.	500	500	0.1	.025	2	—	40	10	**5696**
5720/FG33	Mercury-vapor type.	58	Med. 4-pin B	Medium	7½	3	Htr.	5.0	4.5	300	+35 to +80CM	1000	1000	15	2.5	200	—	820	—	**5720/FG33**
5823	For "on" and "off" controls. Glow discharge type.	44	Min. 7-pin	—	2⅛	¾	Cold Cathode				Peak Anode and Starter Electrode Volts (Inverse and Forward) = 200 V Peak Starter Electrode Breakdown Volts = +73 to 105 V								62	**5823**
5855	High commutation factor for motor control.	Top lug = anode Side lug = grid Bottom lugs = fil.			11 21/64	3⅝	Fil.	2.5	34	60	−55 to +70A	1500	1500	160	18	2000	−5 at 1500	1000	16	**5855**
6011	Mercury-vapor and gas filled type.	1	Med. 4-pin B	Large	6¼	1⅝	Fil.	2.5	9	—	−40 to +80CM	1000	1250	30	2.5	250	—	1000	15	**6011**
6012	Motor control and low-power inverters.	49	Octal	—	4¼	1 21/32	Htr.	6.3	2.6	30	−75 to +90A	650	1300	5.0	0.5	20	−10 at 650	—	10	**6012**
6044	Xenon gas type.	31	Special	—	5½	2.2	Fil.	2.5	18	60	−55 to +100A	550	550	77	6.4	770	−2 at 250	180	12	**6044**
6278	Xenon gas type.	17	Indus. with flexible leads	Flexible lead	5⅛	2 1/32	—	14	2.5	120	−55 to +75A	500	500	60	5	—	−4.5 at 350	150	8.7	**6278**
6478	Xenon gas type.	11	Medium 4-pin	Flexible lead	4⅛	1 9/16	Fil.	2.5	7.5	15	−75 to +85A	1500	2200	20	1.5	100	−11 at 1500	80	12	**6478**
6807	Gas type with negative grid control.	51	Super Jumbo B	14	9	2⅝	Fil.	2.5	21	60	−55 to +70A	1500	1500	80	6.4	1120	−7 at 1000	700	16	**6807**



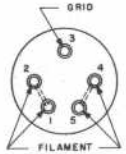
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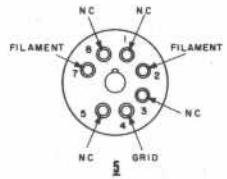
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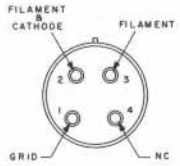
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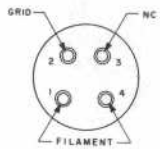
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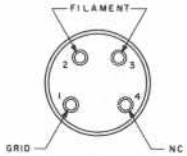
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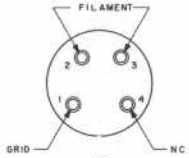
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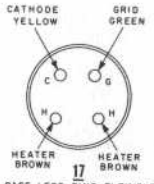
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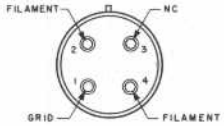
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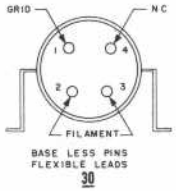
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BASE LESS PINS FLEXIBLE LEADS WITH LUGS.



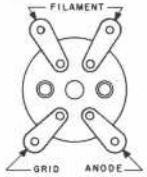
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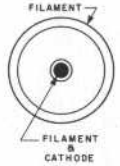
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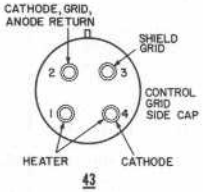
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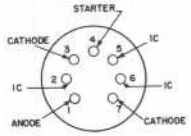
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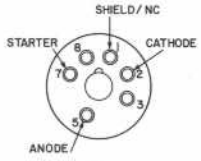
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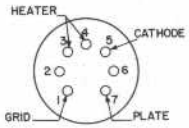
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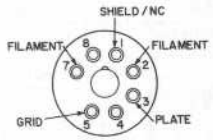
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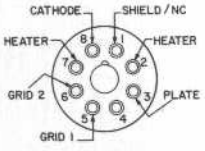
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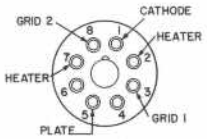
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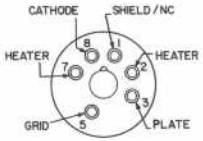
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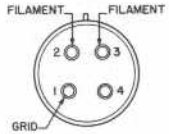
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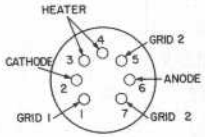
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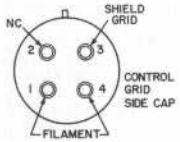
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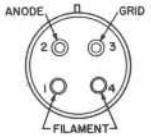
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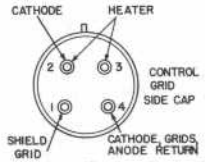
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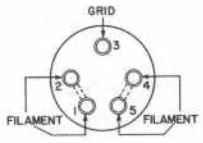
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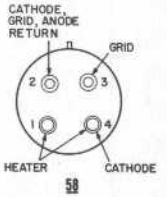
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CBS THYRATRON REPLACEMENT DIRECTORY

TO BE REPLACED		Manufacturer (Note)	Replace With CBS
Prefix	Type		Type
	C3A14	15	C3P14
EL	C3A14	4	C3P14
	3C23	14	3C23
GL	3C23	6	3C23
NL	3C23	10	3C23
WL	3C23	18	3C23
	C3J	15	C3J
EL	C3J	4	C3J
EL	C3J/A	4	5684/C3J/A
	C3P14	15	C3P14
EL	C3P14	4	C3P14
	C3R14	15	C3R14
EL	C3R14	4	C3R14
CE	CR5	2	CR5
	5C21	21	C6J
	C5F14	2	C5F14
EL	C5F14	4	C5F14
	C6A	15	C6A
EL	C6A	4	C6A
	C6J	15	C6J
EL	C6J	4	C6J
	C6J/A	15	C6J/A
EL	C6J/A	4	C6J/A
	C6J/F	15	C6J/F
EL	C6J/F	4	C6J/F
	C6L	15	C6L

TO BE REPLACED		Manufacturer (Note)	Replace With CBS
Prefix	Type		Type
EL	C6L	4	C6L
	C6M	15	C6M
EL	C6M	4	C6M
	17	20	5557
FG	17	6	5557
WL	17	18	5557
TT	17	15	5557
FG	27A	6	873
WT	210-0015	19	5557
WT	210-0062	19	5557
WT	210-0069	19	5557
WT	272	19	5557
CE	302	2	302
CE	304	2	304
CE	306	2	C6J
CE	309	2	5557
CE	311	2	3C23
CE	320A	2	302A
	323B	2	323B
UE	323B	16	323B
NL	323B	10	323B
	393A	17	393A
UE	393A	16	393A
NL	393A	10	393A
GL	393A	6	393A

TO BE REPLACED		Manufacturer (Note)	Replace With CBS
Prefix	Type		Type
CE	393A	2	393A
	627	14	627
KU	627	18	627
GL	627	6	627
NL	710	10	320A
NL	715	10	5557
ML	728	9	5557
T	873	15	873
UE	967	16	5557
	967	11	5557
	1701	12	5557
	5528	21	5528/C6L
	5528/C6L	15	5528/C6L
	5557	15	5557
AX	5557	12	5557
GL	5557	6	5557
WL	5557	18	5557
	5684	2	5684/C3J/A
WL	5684/C3J/A	18	5684/C3J/A
WL	5685	18	5685/C6J/A
	5685/C6J	4	5685/C6J/A
	6044	15	6044
	6278	15	6278
	6278/C5F14	15	6278
	6478	2	6478

Note	Manufacturer
2	Continental Electric Co.
4	Electrons, Inc.
6	General Electric
9	Machlett Laboratories
10	National Electronics
11	National Union
12	Amperex
14	R. C. A.
15	Taylor Tubes, Inc.
16	United Electronics
17	Western Electric
18	Westinghouse
19	Weltronic
20	Chatham Electronics
21	E.I.A.

Table C3 RECTIFIERS

DESCRIPTION					CONSTRUCTION				CATHODE				MAX. PLATE RATINGS (Absolute Max. unless noted)						OPERATING CONDITIONS (single phase F-W 2 tubes)		
TYPE	Vacuum (V) Mercury (M) Xenon (X) Argon (A)	Halfwave (H) Fullwave (F)	Basing Figure	Base Note: B (bayonet)	Length, Inches	Diameter, Inches	Anode Cap	Heater Filament	Volts	Amperes	Minimum Heating Time (Secs.)	Temperature range °C Cond. mercury (CM) Ambient (A)	Peak Inverse Kilovolts	Peak Amperes	Average Amperes	Surge Amperes	Max. A-C Supply Volts Plate to Plate	D-C Output Volts to Filter	Max. D-C Output Amperes	Average Tube Drop	TYPE
2X2A (1)	V	H-W	54	Sm. 4-pin	4 1/32	1 5/16	Small	Htr.	2.5	1.75	—	—	12.5†	.06†	.0075†	—	5500	4500	.002▲	—	2X2A (1)
3B	X	H-W	22	Med. 4-pin B	6¼	1 5/16	Medium	Fil.	2.5	9.0	10	−65 to +85A	1.0	25	3.0	300	—	—	—	7.0	3B
3B22/222	X	F-W	12	Med. 4-pin B	6	1.656	—	Htr.	2.5	6.25	20	−55 to +70A	.725	4.0	1.0	60	—	200	—	8.0	3B22/222
3B25	X	H-W	9	Med. 4-pin B	6 5/16	2 1/16	Medium	Fil.	2.5	5.0	15	−75 to +90A	4.5	2.0	0.5	20	3000	1400	1.0	14	3B25
3B28	X	H-W	9	Med. 4-pin B	6 5/32	2 1/16	Medium	Fil.	2.5	5.0	10	−75 to +90A	10.0 5.0	1.0 2.0	0.25 0.5	20 20	7000 3500	3200 1600	0.5 5	10	3B28
3C	X	F-W	26	4-lugs Indus. Metal	7½	2 1/32	—	Fil.	2.5	11.5	30	−55 to +75A	.725	10.0	2.5	150	—	—	—	8	3C
4B26	A	H-W	18	Mogul Screw	7	3 3/16	Stiff Lead	Fil.	2.2	18.0	—	−40 to +65A	.375	18.0	6.0	180	—	—	—	8	4B26
4B28/225	A	H-W	18	Mogul Screw	7	3 3/16	Stiff Lead	Fil.	2.2	18.0	0	−55 to +70A	.300	18.0	6.0	180	—	60	—	8	4B28/225
4B31	V	H-W	24	Super Jumbo	7	2 5/16	Medium	Htr.	5.0	5.0	120	—	16.0 16.0	12.0 0.47	0.06 0.150	Ratings for clipper diode operation Ratings for H-W rectifier					4B31
5B21	A	H-W	18	Mogul Screw	8¾	3⅛	Stiff Lead	Fil.	2.5	25.0	15	−55 to +70A	.225	90	15	500	—	60	—	8	5B21
5R4GY	V	F-W	33	Octal	5 5/16	2 1/16	—	Fil.	5.0	2.0	—	—	2.8†	0.65†	0.175†‡	—	1800 1900	1060 810	0.15▲ 0.175‡	— —	5R4GY
5Y3WGTA (1, 2)	V	F-W	33	Octal	5 5/16	2 1/16	—	Fil.	5.0	2.0	—	—	1.4†	1.8†	0.375†	2.2	800 1000	345 390	.125▲ .125‡	— —	5Y3WGTA (1, 2)
5Y3WGTB (1. 2)	V	F-W	33	Octal	3 5/16	1 5/16	—	Same as type 5Y3WGTA except for certain tests.													5Y3WGTB (1, 2)
6B	X	H-W	25	Indus. Metal	9½	2 1/32	Medium	Fil.	2.5	21	30	−75 to +85	1.25	77.0	6.4	770	—	—	—	8	6B
6C	X	F-W	26	Indus. Metal	8	2 1/32	—	Fil.	2.5	17	40	−60 to +75A	.725	25.6	6.4	360	—	—	—	8	6C
6CF	X	F-W	28	Indus. Metal	8½	2 1/32	—	Fil.	2.5	17	40	−60 to +75A	Same as 6C except for special 4-pin base 1.54" dia.								6CF
RX21A	M	H-W	34	Med. 5-pin	7⅞	2¼	Stiff Lead	Fil.	2.5	10	—	20 to 60CM	11	3	.75	—	—	—	—	15	RX21A
83	M	F-W	35	Med. 4-pin	5⅜	2 1/16	—	Fil.	5.0	3.0	—	20 to 60CM	1.55†	1.0†	—	—	450▲ 550‡	— —	.225 .225	15 15	83
FG104	M	H-W	36	Super Jumbo	11¼	3 13/16	Large	Htr.	5.0	10.0	—	Same as type 5561									FG104
CE-200A	M	F-W	12	Med. 4-pin B	6⅜	2½	—	Htr.	2.5	5 to 8	60	35 to 75CM	0.90	4.0	2.0	100	—	250	—	10	CE-200A
CE-201A	M	F-W	10	Industrial	6¾	2½	—	Htr.	Same as type CE-200A except base which is a long pin industrial type.												CE-201A
CE-202B	M	H-W	19	Mogul Screw	11¾	3⅜	Flexible	Htr.	2.5	20	180	35 to 80CM	0.90	45	15	750	—	250	—	7.5	CE-202B
CE-203	M	H-W	19	Mogul Screw	8¾	3⅜	Flexible	Htr.	2.5	20	180	40 to 100CM	0.50	45	15	750	—	150	—	6.0	CE-203
CE-205	M	H-W	19	Mogul Screw	8½	3⅜	Flexible	Htr.	2.0	11.5	180	40 to 100CM	0.90	15	5	250	—	250	—	6.0	CE-205

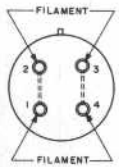
CE-206	M	H-W	19	Mogul Screw	7	3⅛	Flexible	Htr.	2.0	11.5	180	40 to 110CM	0.30	18	6.0	180	—	90	—	6.0	**CE-206**
CE-210A	M	F-W	12	Med. 4-pin B	6⅜	2½	—	Htr.	2.5	5 to 8	30	40 to 80CM	0.90	4	2	100	—	230	—	10	**CE-210A**
CE-213A	M	H-W	7	Med. 4-pin B	6¼	1⅝	Medium	Fil.	2.5	7.0	16	40 to 75CM	5.0	10	2.5	125	—	1500	—	10	**CE-213A**
CE-220/72	V	H-W	9	Med. 4-pin B	4 1⅜16	1⅜16	Small	Fil.	2.5	3.0	—	—	22.0	0.1	0.02	—	—	—	—	200	**CE-220/72**
CE-226	A	H-W	18	Mogul Screw	7	3⅜16	Stiff Lead	Fil.	2.2	17	none	−40 to +65A	0.375	18	6.0	180	—	90	—	8	**CE-226**
CE-235	A	H-W	18	Mogul Screw	8¾	3⅜	Stiff Lead	Htr.	2.5	25	—	−55 to +65A	.230	45	15	500	—	60	—	8	**CE-235**
CE-235A	A	H-W	18	Mogul Screw	8	3⅜	Flexible	Same as type CE-235 except for Anode lead.													**CE-235A**
CE-249C	M	H-W	7	Med. 4-pin B	7⅜	2 1⅛16	Medium	Fil.	2.5	7.5	30	20 to 70CM	8.5	2.5	0.64	25	—	—	—	10	**CE-249C**
CE-258B	M	H-W	20	2-pin	7⅝	2⅝	Medium	Fil.	2.5	7.5	30	25 to 70CM	7.5	2.5	0.64	—	—	—	—	15	**CE-258B**
575A	M	H-W	13	Jumbo	11 1⅛16	3⅜	Medium	Fil.	5.0	10.0	30	20 to 50CM	15.0	6.0	1.5	60	—	4800	1.5	10	**575A**
673	M	H-W	8	Super Jumbo	11⅜	3⅜16	Medium	Fil.	5.0	10.0	30	25 to 55CM 30 to 50CM	10.0 15.0	7.0 10.0	1.75 2.5	100	7000 10600	3200 4800	3.5 3.0	16 16	**673**
816	M	H-W	9	Sm. 4-pin	4 1⅛16	1⅜16	Small	Fil.	2.5	2.0	10	20 to 60CM	7.5	0.5	0.125	5.0	5200	2400	0.25	15	**816**
857B	M	H-W	2-flex. leads	Special	19⅞	7⅛	Large	Fil.	5.0	30	60	30 to 40CM 25 to 60CM	220 10.0	40 40	10 10	400 400	15400 7000	7000 3200	20 20	15 15	**857B**
866A	M	H-W	9	Sm. 4-pin B	6 3⁄16	2 1⁄16	Medium	Fil.	2.5	5.0	15	25 to 60CM 25 to 70CM	10.0 5.0	1.0 1.0	0.25 0.25	— —	7000 3400	3200 1600	0.5 0.5	15 15	**866A**
866JR	M	H-W	21	Med. 4-pin B	5¼	2¼	—	Fil.	2.5	2.5	30	20 to 60CM	5.0	0.5	0.125	—	—	—	—	15	**866JR**
869B	M	H-W	37	Special 3-pin	14 1⁄16	5⅛	Large	Fil.	5.0	19.0	60	30 to 40CM	20.0	10.0	2.5	100	1400	6300	5.0	15	**869B**
827A	M	H-W	13	Jumbo	8½	2 5⁄16	Medium	Fil.	5.0	7.5	30	20 to 60CM 20 to 70CM	10.0 5.0	5.0 5.0	1.25 1.25	50 50	7000 3400	3200 1600	2.5 2.5	10 10	**827A**
875A			13	Jumbo	11 1⁄16	3⅜	Medium	Fil.					Same as type 575A								**875A**
1616	V	H-W	9	Sm. 4-pin	6 1⁄16	2 1⁄16	Medium	Fil.	2.5	5.0	—	—	6.0	0.8	0.13	—	—	—	—	—	**1616**
5550/ FG415	Ignitron A 300KVA◆	H-W	Metal Envelope Water Cooling		17⅞	2.13	—	Ignitor: Voltage=200 Current=30A				—	0.9	1200 RMS	12.2	3360	—	—	—	30	**5550/ FG415**
5551A	Ignitron B 600 KVA◆	H-W	Metal Envelope Water Cooling		23¾	4¼	—	Ignitor: Voltage=200 Current=30A				— —	0.50	480	18	8000	—	—	—	26	**5551A**
5552A	Ignitron C 1200 KVA◆	H-W	Metal Envelope Water Cooling		27¼	5¾	—	Ignitor: Voltage=200 Current=30A				—	0.5	1600	100	6000	—	—	—	28	**5552A**
5553B	Ignitron D 2400 KVA◆	H-W	Metal Envelope Water Cooling		31⅜	7½	—	Ignitor: Voltage=200 Current=30A				—	1.5	2400	112	30000	—	—	—	36	**5553B**
5555/ FG238B	Ignitron 2400 KVA◆	H-W	Metal Envelope Water Cooling		27⅞	5⅛	—	Ignitor: Voltage=150 Current=40A				—	2.1	1200	150	9000	—	—	—	16.2	**5555/ FG238B**
5558/ FG32	M	H-W	38	Med. 4-pin B	7	3	Medium	Htr.	5.0	4.5	300	30 to 60CM	5.0	15	2.5	200	—	—	—	15	**5558/ FG32**
5642	HV Pulse Type for TV	H-W	39	Subminiature	2.16	⅜	Stiff Lead	Fil.	1.25	0.2	—	—	10	.005	.00025	—	8000 pk pulse	12000 dblr.	.00015	— —	**5642**
5561/ FG104	M	H-W	36	Super Jumbo	11¼	3 1⅜16	Large	Htr.	5.0	10.0	300	40 to 80CM 25 to 50CM	3.0 10.0	40 16	6.4 4.0	160 160	2000	950	12.8	15	**5561/ FG104**
5690 (2, 3)	V	F-W	40	Octal	4¼	1 2⁄32	—	Htr.	12.6 6.3	1.2 2.4	—	—	1.12	.375 per plate	.0625 per plate	— —	700‡ 700▲	305‡ 415▲	.0075‡ .055▲	— —	**5690** (2, 3)
6004 (1, 2)	V	F-W	41	Octal	4 1⁄16	1 5⁄16	—	Fil.	5.0	2.0	—	—	1.4	1.8†	0.375†	—	800 1000	345 390	.125▲ .125‡	— —	**6004** (1, 2)
6202 (2)	V	F-W	42	Min. 7-pin	2⅝	¾	—	Htr.	6.3	0.6	—	—	1.25★ .85△	1.45†	0.2†	— —	450‡ 325▲	375‡ 365▲	.05‡ .05▲	— —	**6202** (2)

Table C3 continued

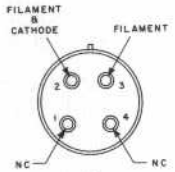
Table C3 Rectifiers continued

DESCRIPTION					CONSTRUCTION			CATHODE				MAX. PLATE RATINGS (Absolute Max. unless noted)					OPERATING CONDITIONS (single phase F-W 2 tubes)			
TYPE	Vacuum (V) Mercury (M) Xenon (X) Argon (A)	Halfwave (H) Fullwave (F)	Basing Figure	Base Note: B (bayonet)	Length, Inches	Diameter, Inches	Anode Cap	Heater Filament	Volts	Amperes	Minimum Heating Time (Secs.)	Temperature range °C Cond. mercury (CM) Ambient (A)	Peak Inverse Kilovolts	Peak Amperes	Average Amperes	Surge Amperes	Max. A-C Supply Volts Plate to Plate	D-C Output Volts to Filter	Max. D-C Output Amperes	Average Tube Drop	TYPE
6484	X	F-W	16	Jumbo	11.07	3 1 3/16	Medium	Fil.	5.0	10.0	3	—	15	6.0	1.5	60	—	—	—	10	**6484**
6663/ 6AL5 (1)	V	F-W	42	Min. 7-pin	1¼	¾	—	Htr.	6.3	0.3	—	—	250	.054	.009	300	10 Volt drop at 60 mA				**6663/ 6AL5** (1)
8008	M	H-W	8	Super Jumbo	8¾	2 5/16	—	Fil.	5.0	7.5	—	20 to 60CM 20 to 70CM	10 5	5.0 5.0	1.25 1.25	— —	7000 3400	3200 1600	2.5 2.5	— —	**8008**
8013A	V	H-W	23	Sm. 4-pin	6 1/16	2 1/16	—	Fil.	2.5	5.0	—	—	40	0.15	0.02	.50	—	—	—	—	**8013A**
8020	V	H-W	9	Med. 4-pin B	8	2 5/16	—	Fil.	5.0	6.0	—	—	40	0.75	0.1	—	—	—	—	—	**8020**

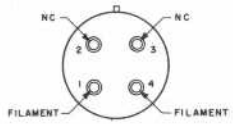
†Design Center Value
‡Choke input
◆Two tubes in inverse-parallel connection
▲Capacitor input
★Altitudes up to 40,000 feet
△Altitudes from 40,000 to 60,000 feet
□Excluding flexible leads
1 Special construction to resist shock and vibration
2 High altitude operation permitted at full ratings
3 Long life expectancy



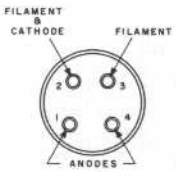
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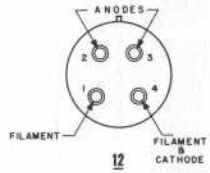
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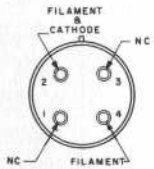
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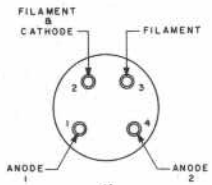
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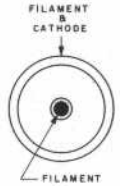
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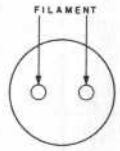
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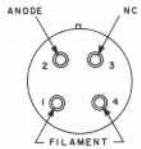
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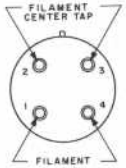
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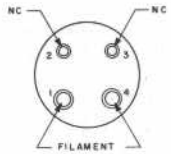
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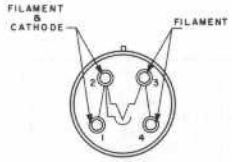
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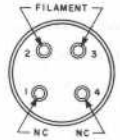
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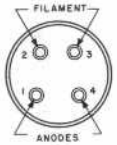
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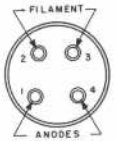
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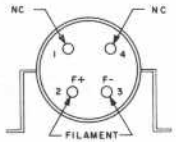
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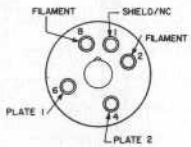
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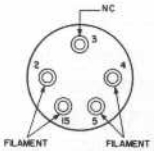
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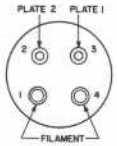
BASE LESS PINS FLEXIBLE LEADS TO FIT NO. 10 STUDS
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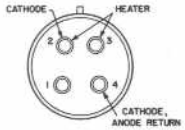
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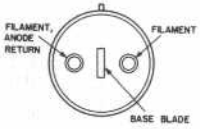
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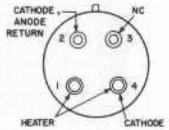
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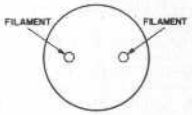
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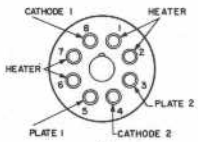
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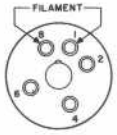
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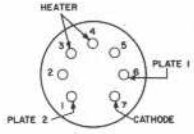
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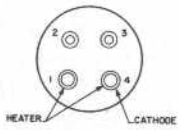
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CBS RECTIFIER REPLACEMENT DIRECTORY

TO BE REPLACED		Manufacturer (Note)	Replace With CBS
Prefix	Type		Type
EL	1C	4	3B22
	2B26		866JR
	2RA15	2	203
	3B		3B
EL	3B	4	3B
	3B22		3B22
WL	3B22/1C	18	3B22
	3B28		3B28
CE	3B28	2	3B28
GL	3B28	6	3B28
EL	3C	4	6484
	4B24		6484
	4B25		6C
	4B26		4B26
	4B27		201A
	4B28		225
	4B31		4B31
	5B21		5B21
R	6A	2	226
	6B		6B
EL	6B	4	6B
WE	6B	17	6B
	6C		6C
EL	6C	4	6C
	6CF		6CF
EL	6CF	4	6CF
R	15A	2	235
G	48	8	225
G	49	8	226
	72N	2	72
RKR	72	13	72
G	83	8	235A
	100R		8020
CE	200	2	200A
CR	200	2	200A
CE	200A	2	200A

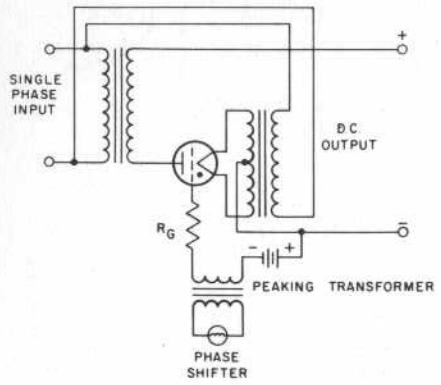
TO BE REPLACED		Manufacturer (Note)	Replace With CBS
Prefix	Type		Type
CE	201	2	201A
CE	201A	2	201A
CE	202	2	202B
CE	202B	2	202B
CE	203	2	203
CE	205	2	205
CE	206	2	206
CE	207	2	207
CE	210	2	210A
CE	210A	2	210A
CE	211	2	211A
CE	211A	2	211A
CE	213	2	213A
CE	213A	2	213A
CE	215	2	203
CE	220	2	72
CE	221	2	6CF
CE	222	2	3B22
CE	224	2	6484
CE	225	2	225
Z	225	16	866A
CE	226	2	226
CE	228	2	3B28
CE	235	2	235
CE	235A	2	235A
	249C		249C
CE	249C	2	249C
WE	249C	17	249C
	258B		258B
T	258B	15	258B
WE	258B	17	258B
WT	280	19	206
WE	289B	17	226
WT	310	19	203
WE	319A	17	872A
F	353	5	872A

TO BE REPLACED		Manufacturer (Note)	Replace With CBS
Prefix	Type		Type
F	353A	5	872A
GL	512	6	575A
WT	568	19	213A
WT	571	19	201A
T	575A	15	575A
WL	575A	18	575A
	578		8020
NL	602	10	211A
NL	604	10	6484
NL	617	10	205
NL	618	10	6B
NL	618P	10	6B
NL	623	10	203
NL	625	10	202B
WT	644	19	200A
	866	14	866A
	866A	14	866A
CE	866A	2	866A
DR	866A	7	866A
EE	866A	3	866A
GL	866A	6	866A
HF	866A	12	866A
ML	866A	9	866A
RK	866A	13	866A
T	866A	15	866A
UE	866A	16	866A
WL	866A	18	866A
T	866JR	15	866JR
	872	14	872A
T	872A	15	872A
DR	872A	7	872A
EE	872A	3	872A
F	872A	5	872A
GL	872A	6	872A
ML	872A	9	872A
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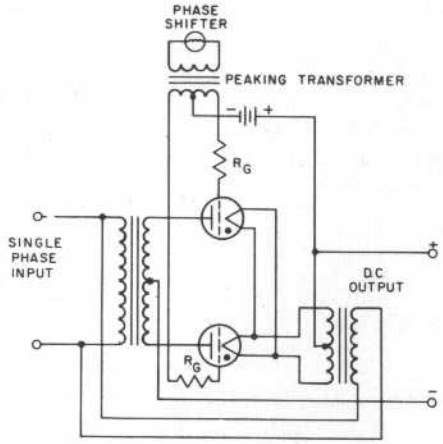
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RK	872A	13	872A
UE	872A	16	872A
WL	872A	18	872A
T	875A	15	575A
	972		872A
	972A		872A
	2000		226
	5892		6B
R	6137B	15	8013B
R	6146	15	8008
	6277		3B28
	6484		6484
	8008	14	8008
CE	8008	2	8008
DR	8008	7	8008
EE	8008	3	8008
GL	8008	6	8008
ML	8008	9	8008
UE	8008	16	8008
WL	8008	18	8008
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GL	8013A	6	8013A
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DR	8020	7	8020
EE	8020	3	8020
GL	8020	6	8020
WL	8020	18	8020
	189048	6	225
	189049	6	226
	217283	6	235
	289414		225
	289416		226
	766776		235

Note	Manufacturer
2	Continental Electric Co.
3	Electronic Enterprises
4	Electrons, Inc.
5	Federal
6	General Electric
7	General Electronics
8	Gordos
9	Machlett Laboratories
10	National Electronics
11	National Union
12	Amperex
13	Raytheon
14	R. C. A.
15	Taylor Tubes, Inc.
16	United Electronics
17	Western Electric
18	Westinghouse
19	Weltronic

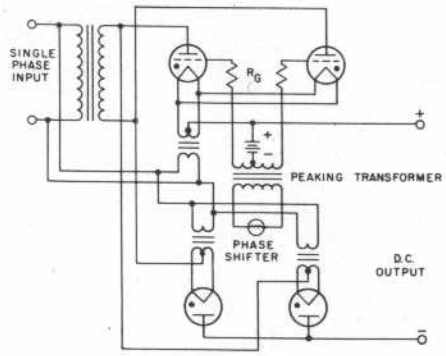
GRID-CONTROLLED RECTIFIER CIRCUITS



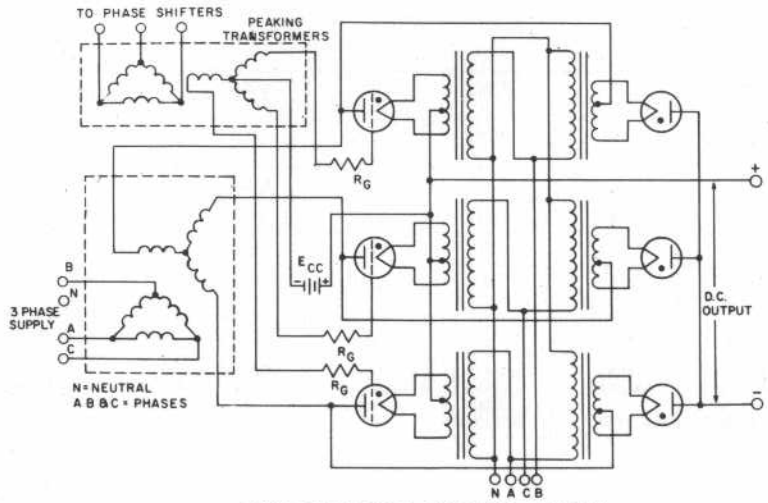
HALF-WAVE SINGLE-PHASE



FULL WAVE SINGLE PHASE



SERIES SINGLE PHASE



SERIES THREE-PHASE QUADRATURE OPERATION

The circuits shown here are more or less fundamental and are not intended for electrical design.

In addition to these circuits, there are variations such as six-phase types and others.

It should be noted that the direct current output from phase shifting or back-phasing requires more filtering than rectifiers operating under average conditions.

Phase shifting methods are commonly known to the trade; one of the most satisfactory types being a wound armature and wound field of the Selsyn type operating from single-phase or three-phase as determined by the phase shift necessary to give the voltage output control desired.

The phase shifter then feeds the isolation transformers, which are the peaking type so as to give positive initiation of tube conduction. Filament transformers in the above circuits should, most desirably, be connected to the same phase that each tube is operating from in multi-phase circuits.

Where Thyratrons and Rectifiers are used in paired operation they should be chosen for common characteristics such as arc drop, average current, peak current, temperature considerations, and de-ionization time.

Mercury type tubes can be used where temperature conditions are moderate and ventilation good. However, where frequencies are high and large ambient temperatures exist, or rapid duty cycles are used at high currents, xenon gas type tubes will give the most satisfactory service.

VOLTAGE AND CURRENT RELATIONSHIPS IN RECTIFIER CIRCUITS

V=D.C. OUTPUT VOLTAGE
I=D.C. OUTPUT CURRENT
F=SUPPLY FREQUENCY

CIRCUIT	AC PLATE VOLTAGE	PEAK INVERSE VOLTAGE	AVERAGE ANODE CURRENT PER TUBE	PEAK ANODE CURRENT		PRINCIPAL HARMONIC FREQUENCY
				Inductive Load	Resistive Load	
Fig. 1 Single-phase, half-wave	2.22V	3.14V	I	.....	3.14 I	F
Fig. 2 Bi-phase, half-wave	1.11V	3.14V	.5 I	I	1.57 I	2F
Fig. 3 Bi-phase, full-wave	1.11V	1.57V	.5 I	I	1.57 I	2F
Fig. 4 Three-phase, half-wave	.854V	2.09V	.33 I	I	1.21 I	3F
Fig. 5 Three-phase, full-wave	.427V	1.04V	.33 I	I	1.04 I	6F
Fig. 6 Six-phase, half wave	.740V	2.08V	.167 I	I	1.04 I	6F
Fig. 7 Three-phase double Y, with interphase trans.	.854V	2.09V	.167 I	I	1.21 I	6F
Fig. 8 Quarter-phase, half-wave, Scott connection	.785V	2.22V	.250 I	I	1.11 I	4F

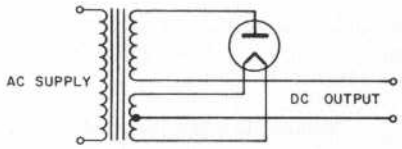


Fig. 1 Single phase, half wave

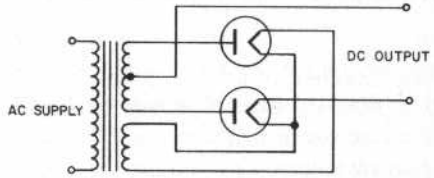


Fig. 2 Bi-phase, half wave or single-phase, full wave

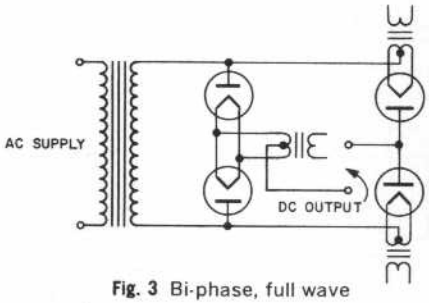


Fig. 3 Bi-phase, full wave

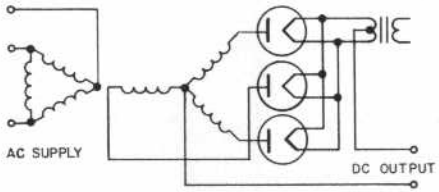


Fig. 4 Three phase, half wave

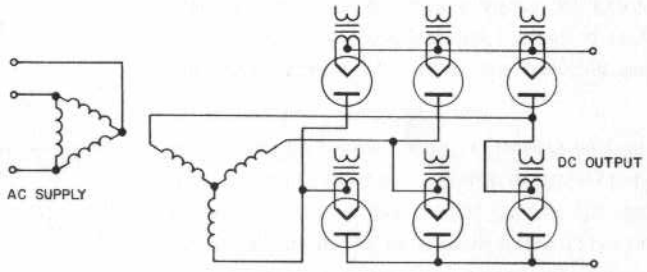


Fig. 5 Three phase, full wave

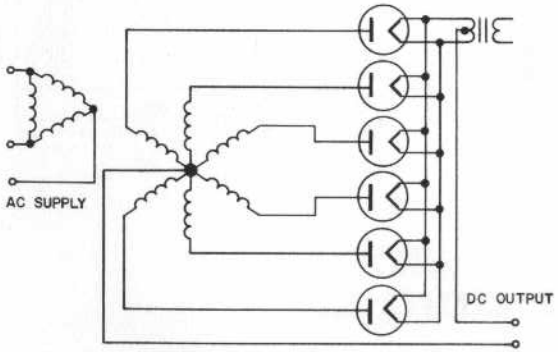


Fig. 6 Six phase, half wave

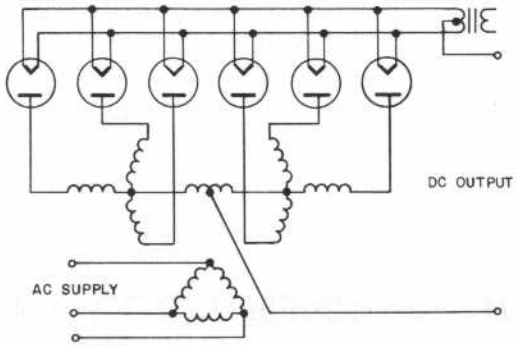


Fig. 7 Three phase, double Y with interphase transformer

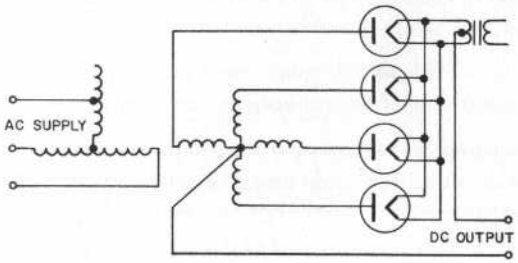


Fig. 8 Quarter phase, half wave, Scott connection

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