Federal's

MINIATURE SELENIUM RECTIFIER

Handbook

FEDERAL TELEPHONE & RADIO

FTR

TWENTY-FIVE CENTS

Federal's

MINIATURE
SELENIUM RECTIFIER
HANDBOOK

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No patent liability is assumed with respect to the commercial use of the circuits and rectifier information contained in this booklet.

Foreword

Selenium rectifiers have been providing reliable, efficient, and economical operation in industrial equipment for over twenty years. Sturdy, rugged, and compact, these rectifiers, in many cases, live as long as the equipment in which they are used with some reports indicating years of unattended, continuous service with no sign of failure. Developed by a European associate of International Telephone and Telegraph Corporation in 1928, and introduced in this country ten years later by Federal Telephone and Radio Corporation, they are finding increasing applications in every field where conversion from a-c to d-c is either necessary or desirable.

Until recently the selenium rectifier has been limited in its general usefulness to industrial applications. This limitation resulted from the fact that the allowable back voltage of a conventional cell was only about 18 volts rms. Hence when used in higher voltage applications, such as radio and television where 117 volt input is employed, they were relatively expensive and bulky compared to the equipment.

Federal Telephone and Radio Corporation, which has carried out continuous research on selenium rectifiers for over a decade, then developed a high back-voltage plate in miniature size, which could be utilized in conventional radio power supplies. This unit, known as Federal's miniature selenium rectifier, combining the advantages listed above with small size and low cost, immediately was widely accepted by the industry with over 30 manufacturers incorporating it into their radio sets during the first year.

Replacing the power transformer and rectifier tubes, Federal miniature selenium rectifier found even wider application in television, where it made possible the design of the low cost, size, weight receiver. The total weight of a typical 7" TV receiver is only 26 pounds, the approximate weight of the power transformer alone in previous sets providing the same service.

Starting with only four types, Federal's miniature selenium rectifier line has now grown to over 15—with still more to come as manufacturers, engineers, servicemen, and amateurs visualize new, improved circuits that such a rectifier provides.

Federal has always been ready to assist designers in perfecting these circuits, either through the use of existing miniature stacks, or when necessary, by developing new types. For this purpose, Federal has organized a modern laboratory in which each circuit is thoroughly investigated and its special requirements determined.

America's oldest and largest manufacturer of selenium rectifiers, Federal stresses quality, service, and reliability. Continuous research carried on by a staff of expert engineers has enabled Federal to develop better rectifiers at a lower cost.

Fundamental Circuits Using *Federal* MINIATURE SELENIUM RECTIFIERS

Federal miniature selenium rectifiers can be utilized in power supplies in virtually the same manner as the vacuum tube diode. For reasons that will be outlined subsequently, many circuits which were previously considered impractical, and hence rarely used, now have new significance and can be employed with great advantage. For example voltage multiplier circuits, which eliminate the need for power transformers in many applications, were practically non-existent in commercial sets heretofore, but have already been widely used since the introduction of the miniature rectifier.

The characteristics of the selenium rectifier that have caused this re-evaluation of rectifier circuits are 1) no filaments required 2) small size 3) can be installed anywhere under the chassis and 4) larger RMS current capacity relative to its equivalent tube. It boils down to this: The miniature selenium rectifier is as simple and economical to insert into an equipment design as a resistor or a condenser and therefore the use of an additional rectifier or two to achieve an improvement in performance is usually justified. This, of course, was not true when tubes were employed.

The well known half-wave rectifier circuit, shown in figure 1, is the simplest and most widely employed. The use of a selenium rectifier, rather than a tube, in this circuit permits the use of a higher capacity filter condenser—since the rectifier has a higher RMS current carrying capacity. By utilizing condensers of larger capacity, better regulation and higher d-c voltages can be obtained. To increase the life of all the components in this circuit, it is recommended that a peak current limiting resistor, which also can be selected to serve as a fuse in case of a short circuit, be inserted in series with the rectifier.

The half wave circuit, though very simple and economical, is also relatively inefficient and in applications where a higher degree of efficiency is necessary, the full wave center tap circuit shown in figure 2 or the full wave bridge rectifier shown in figure 3 can be employed. The bridge circuit requires four rectifying arms, but makes continuous use of the transformer. The center tap circuit uses only two rectifying arms but only one-half of the transformer secondary is in use during each half cycle. Therefore the potential from either end of the full wave secondary to center tap must be equal to the full bridge secondary voltage, to achieve the same d-c output. As a result, with all other factors being equal, the transformer used in the center

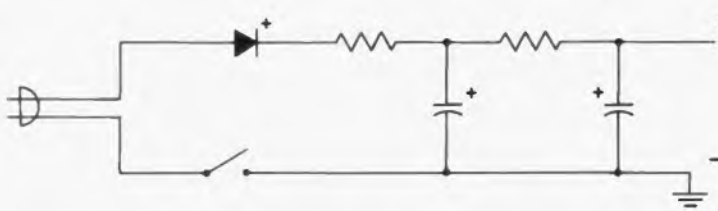


FIG.1 SCHEMATIC DIAGRAM OF HALF-WAVE RECTIFIER CIRCUIT

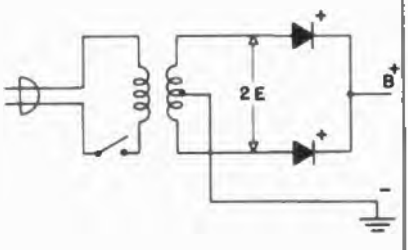


FIG.2 SCHEMATIC DIAGRAM OF THE FULL WAVE, CENTER TAP CIRCUIT

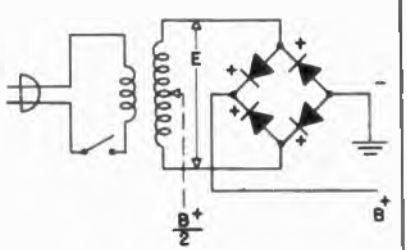


FIG.3 SCHEMATIC DIAGRAM OF THE FULL WAVE, BRIDGE CIRCUIT

tap circuit requires a power rating 1.4 times greater than that used in the bridge circuit.

One additional advantage of the bridge circuit is that a full wave, half-voltage circuit can be used in conjunction with the bridge to supply a one-half voltage, too, when necessary (as shown by dashed line in figure 3). In the full-wave circuit a power wasting bleeder resistor would have to be used to obtain this voltage.

Voltage Multiplier Circuits

Where potentials exceeding the peak line voltage are desired, voltage multiplier circuits can be utilized to attain this potential without the use of heavy, expensive power transformers. Whereas there is no theoretical limit to the maximum voltage that can be obtained by this means, practical considerations limit their use to approximately three to four times the peak line voltage or about 500 volts for a 117 volt, 60 cycle input.

Two types of doubler circuits are shown in figures 4 and 5. The one indicated in figure 4 is known as the full-wave doubler and operates in the following manner: When the line voltage polarity is such that point 1 is at positive potential with respect to point 2, a current will flow, as indicated by the solid arrows, through rectifier SR_1, thus charging condenser C_a so that point A is positive with respect to point O. During the next half cycle, when point 2 becomes positive with respect to point 1, SR_2 becomes conductive and condenser C_b charges negatively (as shown by the dotted arrows) with respect to point O. The potential difference between points A and B at the end of a full cycle (if the condenser did not discharge) would therefore be

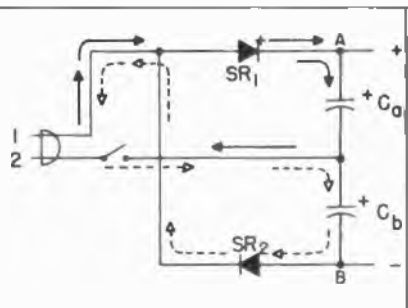


FIG. 4a SCHEMATIC DIAGRAM OF THE FULL WAVE, DOUBLER CIRCUIT

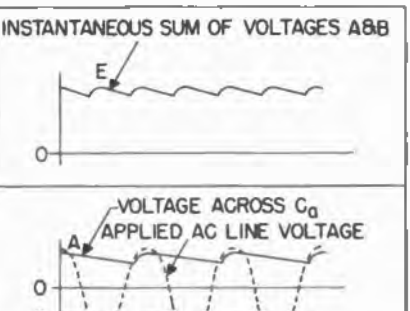


FIG. 4b WAVE FORM OF THE FULL WAVE, DOUBLER CIRCUIT

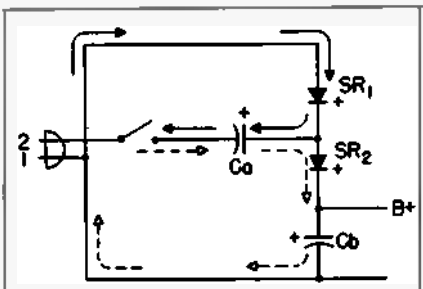


FIG. 5A SCHEMATIC DIAGRAM OF THE HALF-WAVE DOUBLER

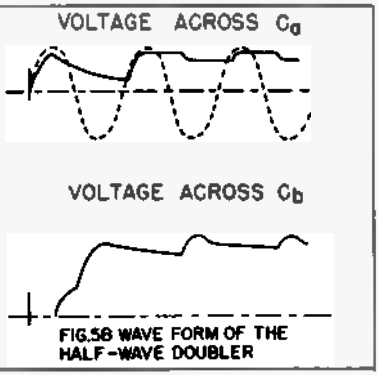


FIG. 5B WAVE FORM OF THE HALF-WAVE DOUBLER

twice the peak line voltage. Actually, of course, one condenser discharges during its negative half cycle, so that the cumulative wave-form is as shown in figure 4b.

The other type of doubler circuit, known as the half-wave doubler operates on a different principle. Assume that point 1 in figure 5a is positive with respect to point 2 during the initial half cycle. In this case charging current will flow in the direction shown by the solid arrows through rectifier SR_1, until condenser C_a assumes a charge equal to the peak potential of the line. During the next half cycle, as point 2 becomes positive with respect to point 1, the charge of condenser C_a will add its potential to that of the line and current will flow through rectifier SR_2, as indicated by the dotted arrows, charging condenser C_b to a potential equal to that of the line plus that across condenser C_a. The voltage across C_b therefore is equal to twice the peak line voltage (if condenser C_a does not discharge). Condenser C_b recharges up only during one half of the cycle, and hence the resulting wave-form of this circuit will be as shown in figure 5b. It should be noted that with all other factors being equal, the half wave circuit provides poorer voltage regulation, and lower ripple frequency, than the full wave doubler.

The principle of the half wave doubler can be extended to higher order voltage multiplier circuits, that is the voltage across C_b can be added on to a succeeding rectifier condenser circuit to provide triple peak line voltage output, and this latter condenser potential added to another circuit and so on until the desired degree of multiplication is attained. Figure 6 shows the schematic diagrams of a voltage tripler and quadrupler circuit. Characteristic curves of these circuits, as well as the others covered in this section, are given for individual selenium rectifiers later in this handbook.

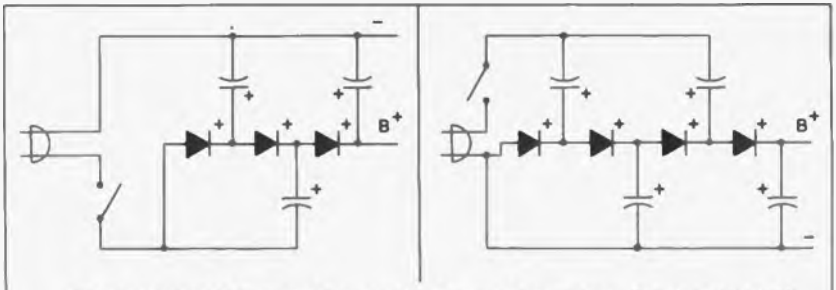
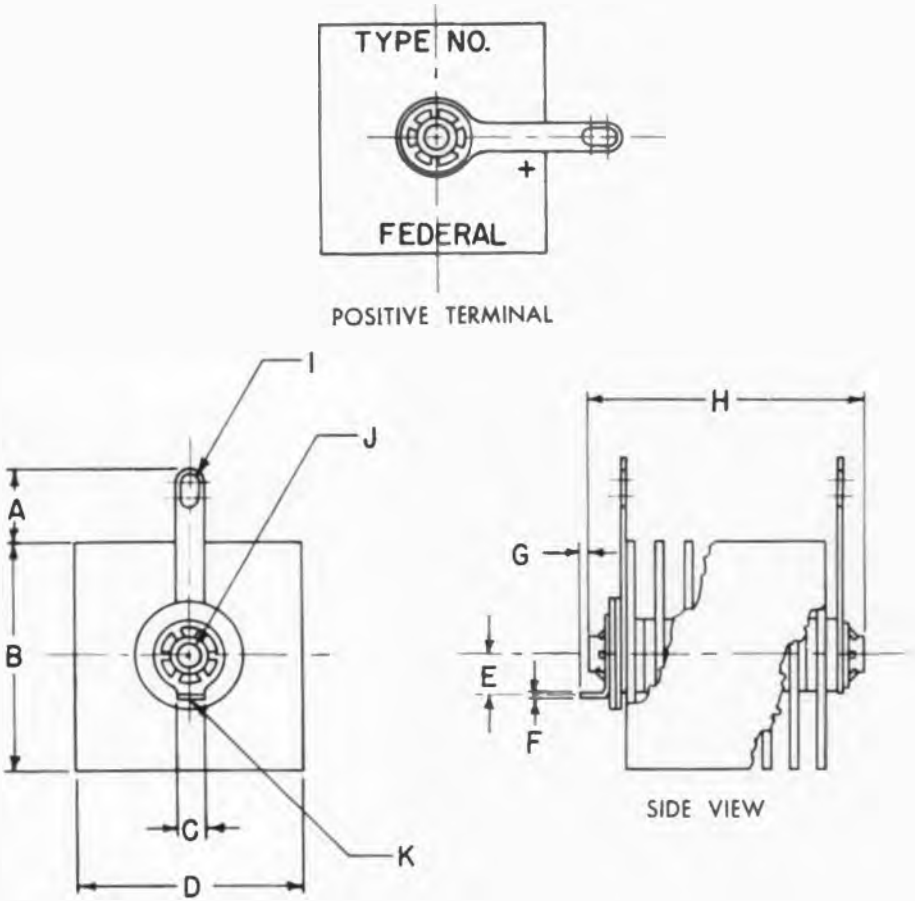


FIG. 6 SCHEMATIC DIAGRAM OF THE HALF WAVE TRIPLER (LEFT) AND QUADRUPLER (RIGHT)

DIMENSIONAL DIAGRAM



Reference should be made to the dimensional diagram shown above for the determination of the dimensions of any selenium rectifier included in this book, unless indicated to the contrary for a particular type of rectifier. Rectifiers can be obtained without the locking lug (dimension G) by omitting the letter "A" from the Federal type number—for example 403D2625 instead of 403D2625A—when the rectifier is ordered. It should also be noted that the diagram shows only one type of miniature Selenium Rectifier construction. Some rectifiers may vary slightly from this construction. However the dimensions specified are, in every case, the maximum that will be encountered.

Federal MINIATURE SELENIUM RECTIFIER

TYPE 402D3200A

50 MA, 130 V

CHARACTERISTICS

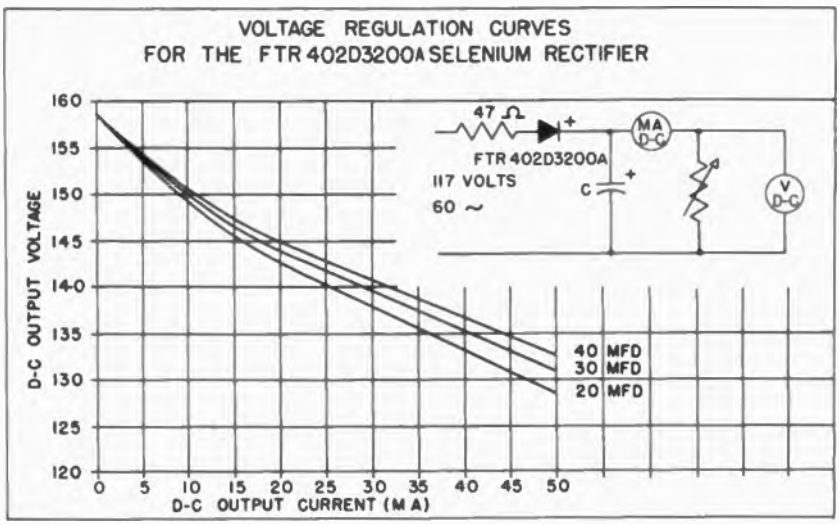
Max. RMS Input Voltage	130
Max. Peak Inverse Voltage	380
Max. Peak Current (Ma)	600
Max. RMS Current (Ma)	125
Max. D-C Current (Ma)	50
Approx. Rectifier Voltage Drop	5
Minimum Series Resistance	47
Maximum Plate Operating Temperature	85°C

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A	19/64	D	1	G	1/16±1/64	J	5/32
B	1	E	17/64	H	3/4	K	.177
C	5/32	F	1/32	I	5/64x5/32		

CIRCUIT APPLICATION

The FTR 402D3200A miniature selenium rectifier can be employed in a variety of ways to cut down costs and improve performance of electronic equipment. In one tube sets, such as phonograph oscillators or FM super-regenerative adaptors, this rectifier can be used in a half-wave circuit to supply the B+ for the set, thus saving the price of a more expensive, higher rated rectifier. In larger sets, this rectifier can be used in a separate bias supply to improve the performance of the equipment at very little increase in unit cost. The characteristic curves of the 402D3200A rectifier in a half-wave circuit are shown below.



Federal MINIATURE SELENIUM RECTIFIER

TYPE 402D3452A

65 MA, 130 V

CHARACTERISTICS

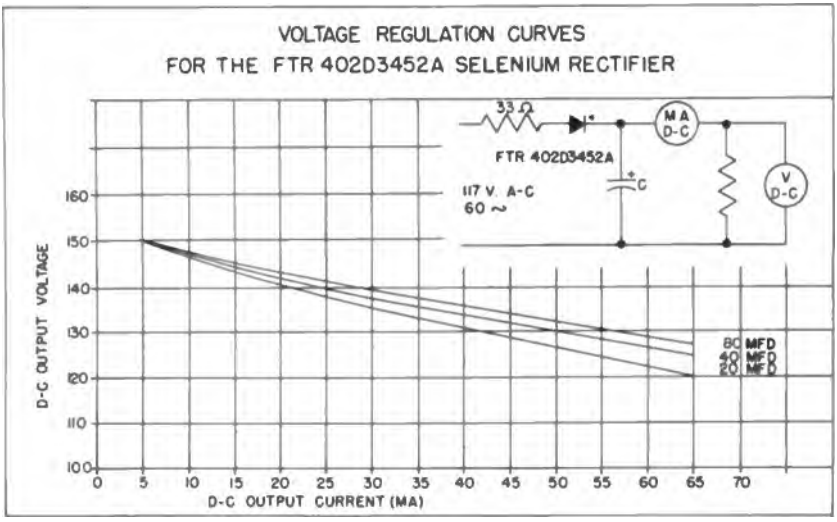
Max. RMS Input Voltage	130
Max. Peak Inverse Voltage	380
Max. Peak Current (Ma)	750
Max. RMS Current (Ma)	160
Max. D-C Current (Ma)	65
Approx. Rectifier Voltage Drop	5
Minimum Series Resistance	33
Maximum Plate Operating Temperature	85°C

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A 19/64	D 1	G ..1/16±1/64	J 5/32
B 1	E 17/64	H 3/4	K 177
C 5/32	F 1/32	I 5/64x5/32	

CIRCUIT APPLICATION

The FTR 402D3452A miniature selenium rectifier can be used in the power supply of most 5 tube a-c/d-c sets. In addition, Federal can supply a negative coefficient resistor with this rectifier to be inserted in the filament string—serving a two fold purpose. One is the maintenance of filament circuit continuity—normally designed to include the rectifier tube filament—and the second is to eliminate initial surges of current when filaments are cold. This latter feature will extend the life of all the tubes and the pilot light in the set. The characteristic curves of the FTR 402D3452A rectifier in a half-wave circuit are shown below.



Federal MINIATURE SELENIUM RECTIFIER

TYPE 402D3150A

(RMA #RS75*)

75 MA, 130 V

CHARACTERISTICS

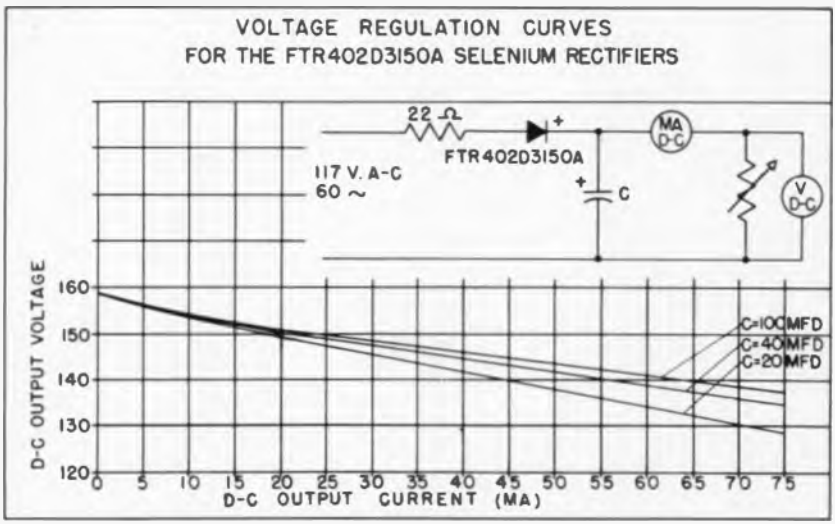
Max. RMS Input Voltage	130
Max. Peak Inverse Voltage	380
Max. Peak Current (Ma)	900
Max. RMS Current (Ma)	220
Max. D-C Current Output (Ma)	75
Approx. Rectifier Voltage Drop	5
Minimum Series Resistance	22
Max. Operating Temperature	85°C

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A	19/64	D	1	G	1/16±1/64	J	5/32
B	1	E	17/64	H	7/8	K	.177
C	5/32	F	1/32	I	5/64x5/32		

CIRCUIT APPLICATION

The FTR 402D3150A miniature selenium rectifier has found application in three way portable and small radio sets. Its use in three way portables is particularly of interest since the set then starts instantly when in the a-c/d-c position as well as while in the battery position. Furthermore replacement of an existing rectifier tube with a selenium rectifier can be simply accomplished—merely remove the tube and connect the positive side of the rectifier to the cathode pin, the negative side to the plate pin, add limiting resistor of 27 ohms and the installation is complete. The characteristic curves of this rectifier are shown below.



*Proposed

Federal MINIATURE SELENIUM RECTIFIER

TYPE 403D2625A

(RMA #RS100*)

100 MA, 130 V

CHARACTERISTICS

Max. RMS Input Voltage	130
Max. Inverse Peak Voltage	380
Max. Peak Current (Ma)	1200
Max. RMS Current (Ma)	325
Max. D-C Current (Ma)	100
Approx. Rectifier Voltage Drop	5
Minimum Series Resistance	22
Max. Plate Operating Temperature	85°C

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A 23/64	D 1-13/64	G .. 1/16 ± 1/64	J 5/32
B 1-9/32	E 17/64	H 7/8	K ..... .177
C 5/32	F 1/32	I 5/64x5/32	

CIRCUIT APPLICATION

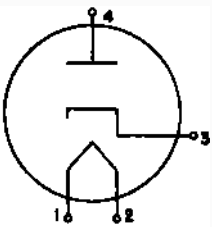
The FTR 403D2625A miniature selenium rectifier is used in many television, FM, AM, or phonograph sets. Unless a supply is known to require less than 75 Ma, (in which case the 402D3150A or 402D3452A can be used) this rectifier should be used to replace the following rectifier tubes: 25Z5, 35W4, 35Z3, 35Z4, 35Z5, 45Z5, 50Y6, and 50Z7. When it is used to re-

RESISTOR VALUES FOR 10 RECTIFIER TUBES
REPLACED BY FEDERAL'S MINIATURE SELENIUM RECTIFIER

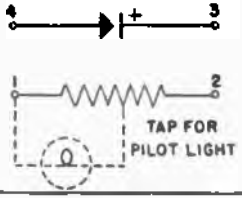
Tube	Resistor	Watts
25Z5	85 ohm	15
25Z6	85 ohm	15
35W4	230 ohm	10
35Y4	230 ohm	10
35Z3	230 ohm	10
35Z4	230 ohm	10
35Z5	230 ohm	10
45Z5	300 ohm	10
50Y6	330 ohm	15
50Z7	330 ohm	15

If pilot light is used, tap down on above resistor 10 to 25 ohm according to current used in filament string. Across this 10 to 25 ohm resistor, use a #47 pilot light.

TUBE BEING REPLACED



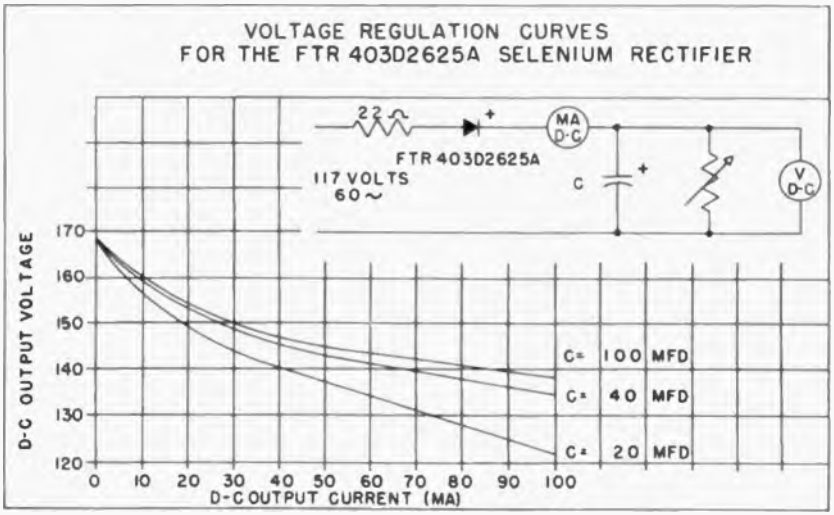
RECTIFIER AND RESISTOR CIRCUIT

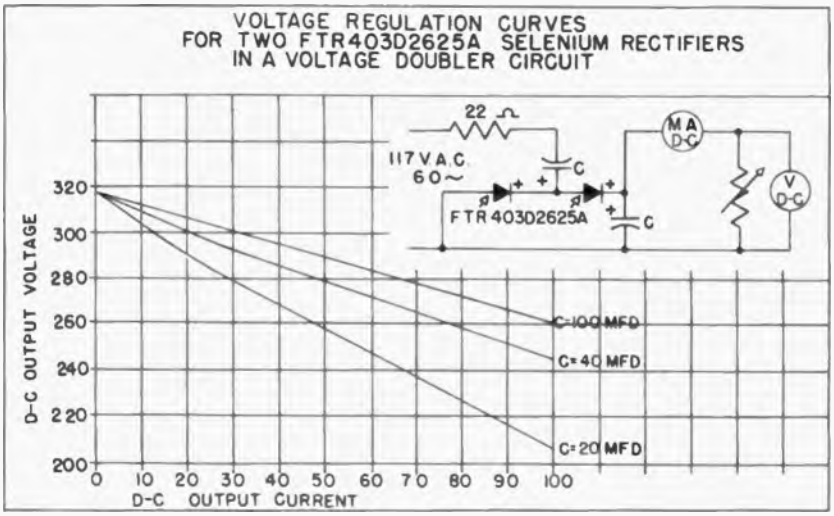


*Proposed

CIRCUIT APPLICATION (Continued)

place a tube, since this rectifier does not require a filament, a resistor must be added in the circuit to preserve filament continuity, maintain the proper filament current, and provide pilot light potential (or another tube can be used in circuit to improve overall performance). This resistance varies for different type rectifier tubes, and the chart (on previous page) compiled by Federal, indicates the correct resistance values for each type of tube. Shown below are the characteristic curves of this rectifier in a half-wave, and half-wave doubler circuit are shown.





Federal MINIATURE SELENIUM RECTIFIER

TYPE 403D2787A

(RMA #RS150*)

150 MA, 130 V

CHARACTERISTICS

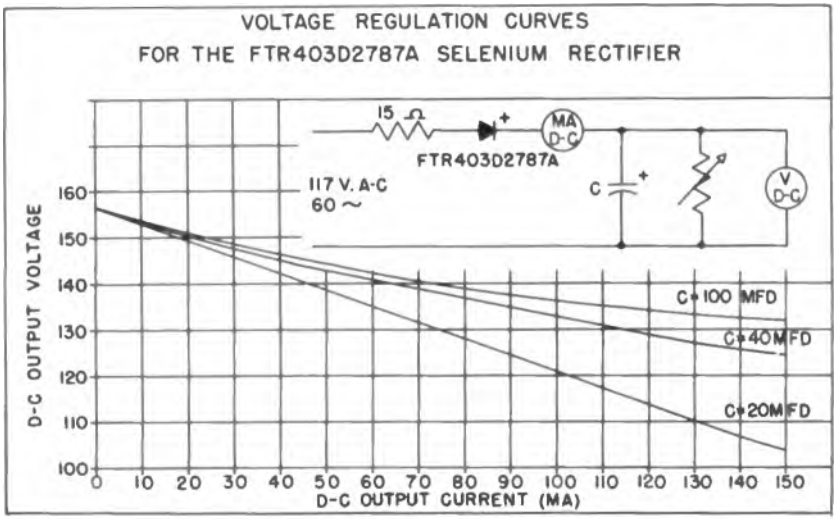
Max. RMS Input Voltage	130
Max. Peak Inverse Voltage	380
Max. Peak Current (Ma)	1200
Max. RMS Current (Ma)	425
Max. D-C Current Output (Ma)	150
Approx. Rectifier Voltage Drop	5
Minimum Series Resistance	15
Max. Plate Operating Temperature	85°C

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A	23/64	D	1-13/64	G	1/16±1/64	J	5/32
B	1-9/32	E	17/64	H	1-1/16	K	.177
C	5/32	F	1/32	I	5/64x5/32		

CIRCUIT APPLICATION

The FTR 403D2787A miniature selenium rectifier is used in half-wave rectifier circuits in larger radio sets and in combination AM, FM, and phonograph units. The characteristic curves of the 403D2787A rectifier are shown below. It is also used in voltage doubler and tripler circuits in television. Reference should be made to the voltage doubler, tripler, and quadrupler curves shown for the FTR 404D2795A for an approximation of the voltage and current obtained with this rectifier.



*Proposed

Federal MINIATURE SELENIUM RECTIFIER

TYPE 404D2795A

(RMA #RS200*)

200 MA, 130 V

CHARACTERISTICS

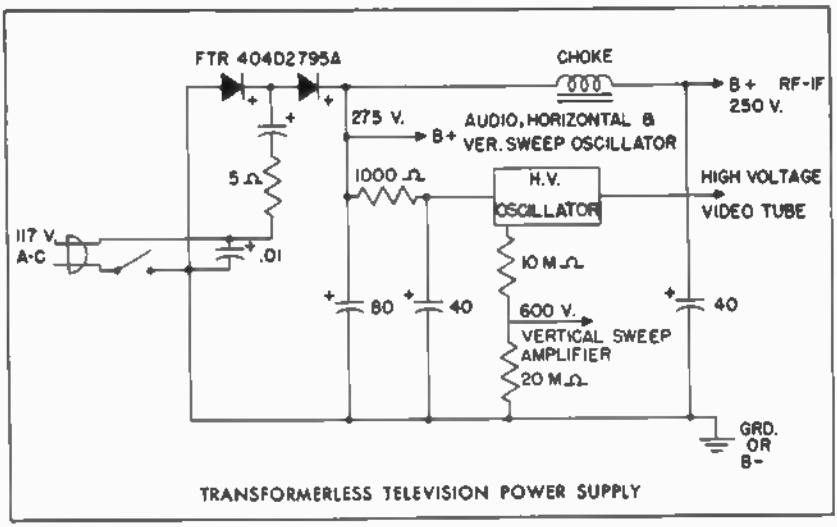
Max. RMS Input Voltage	130
Max. Inverse Peak Voltage	380
Max. Peak Current (Ma)	2000
Max. RMS Current (Ma)	550
Max. D-C Current (Ma)	200
Approx. Rectifier Voltage Drop	5
Minimum Series Resistance (Ohms)	5
Max. Plate Operating Temperature	85°C

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A	7/16	D	1-17/32	G	1/16±1/64	J	5/32
B	1-17/32	E	17/64	H	1-1/16	K	.177
C	5/32	F	1/32	I	3/32x3/16		

CIRCUIT APPLICATION

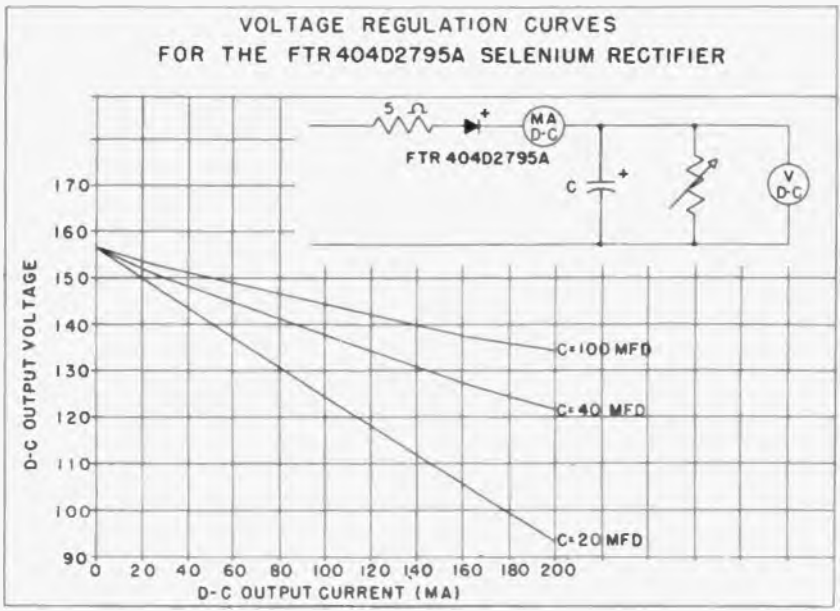
The FTR 404D2795A miniature selenium rectifier has been widely employed in both larger combination AM, FM, and phonograph radio sets and in 7" and 10" television sets. In particular the voltage doubler circuit has been utilized in low cost television sets to provide all the necessary B+ voltages without the use of a power transformer as shown in the circuit below. On succeeding pages the characteristic curves for the half-wave rectifier, half-wave doubler, half-wave tripler, and half-wave quadrupler circuits are given for the FTR 404D2795A rectifier.

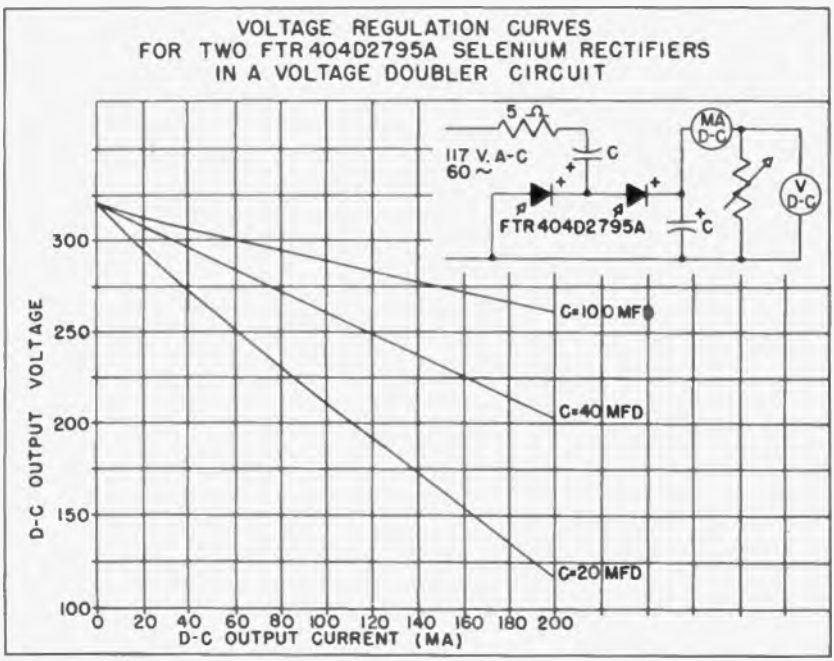


TRANSFORMERLESS TELEVISION POWER SUPPLY

*Proposed

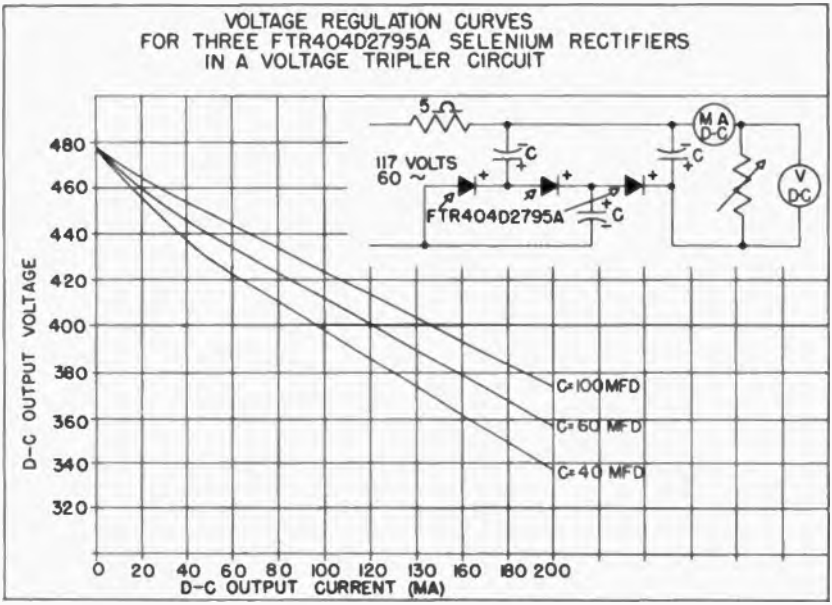
CHARACTERISTIC CURVES OF FTR 404D2795A

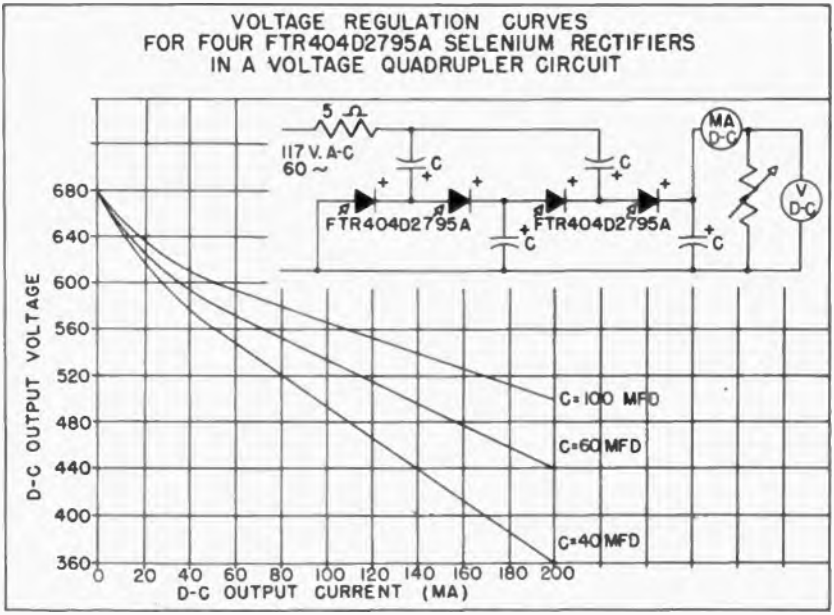




CHARACTERISTIC CURVES OF FTR 404D2795A

(Continued)





Federal MINIATURE SELENIUM RECTIFIER

TYPE 404D3450A

250 MA, 130 V

CHARACTERISTICS

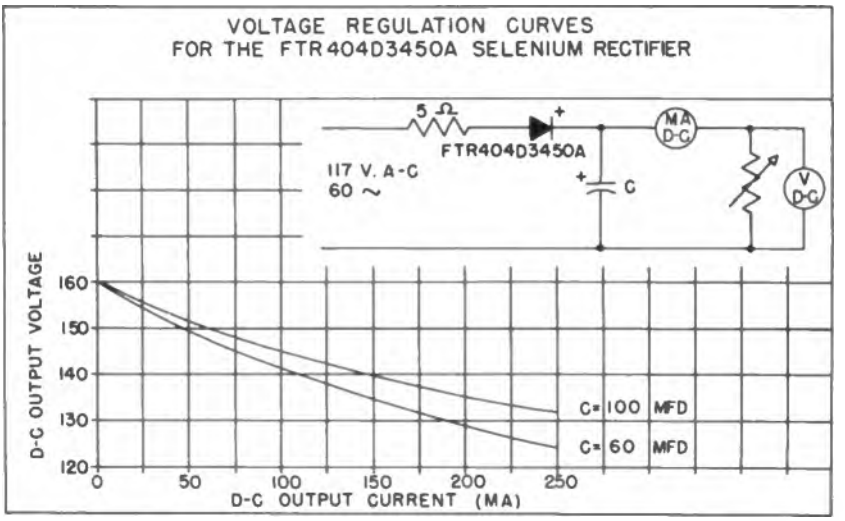
Max. RMS Input Voltage	130
Max. Inverse Peak Voltage	380
Max. Peak Current (Ma)	2000
Max. RMS Current (Ma)	625
Max. D-C Current (Ma)	250
Approx. Rectifier Voltage Drop	5
Minimum Series Resistance (Ohms)	5
Max. Plate Operating Temperature	85°C

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A 7/16	D 1-17/32	G ..1/16±1/64	J 5/32
B 1-17/32	E 17/64	H 1-5/16	K ..... .177
C 5/32	F 1/32	I 3/32x3/16	

CIRCUIT APPLICATION

The FTR 404D3450A has the same field of application as the 404D2795A and is used in circuits where current exceeding 200 ma is required. For example, if the supply shown on p. 14 for the 404D2795A rectifier is to be used for a combination set, the additional current required for the AM, FM, or phonograph unit can be obtained by use of the 404D3450A rectifier in place of the 200 ma type. The characteristic curves for this rectifier in a half-wave circuit are shown below.



Federal MINIATURE SELENIUM RECTIFIER

TYPE 438D3427A

400 MA, 130 V

CHARACTERISTICS

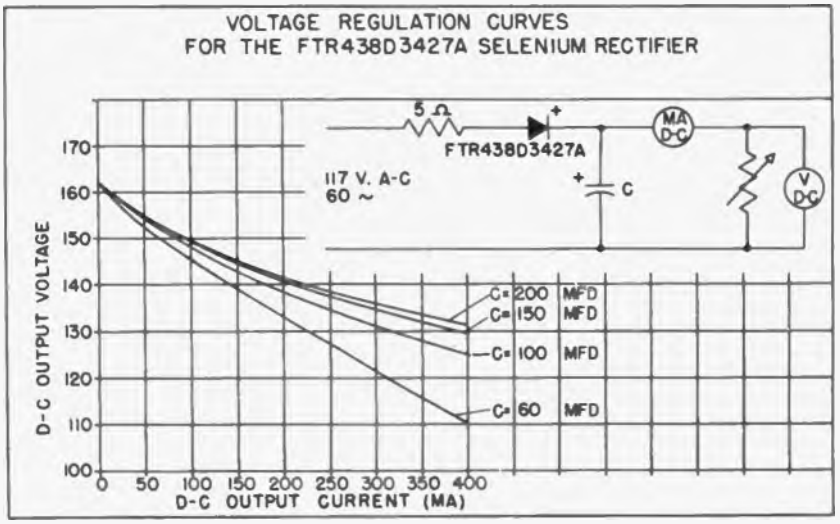
Max. RMS Input Voltage	130
Max. Peak Inverse Voltage	380
Max. Peak Current (Ma)	3500
Max. RMS Current (Ma)	1000
Max. D-C Current (Ma)	400
Approx. Rectifier Voltage Drop	5
Minimum Series Resistance	5
Max. Plate Operating Temperature	85°C

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A 7/16	D 3-1/16	G ..1/16±1/64	J 5/32
B 1-17/32	E 17/64	H 1-1/16	K ..... .177
C 5/32	F 1/32	I 3/32x3/16	

CIRCUIT APPLICATION

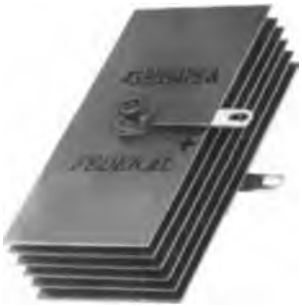
The FTR 438D3427A permits the use of a simple, economical half-wave rectifier circuit to power television receivers. Heretofore, this was not practical since it involved the use of a 400 ma rectifier tube which is extremely bulky and expensive. Hence higher voltages had to be employed to attain the necessary power with lower currents. However, with the Federal 400 ma selenium rectifier it is possible to power 7" and 10" television sets with the use of a simple half-wave rectifier. The characteristic curves of a half-wave rectifier using this 438D3427A are shown below.



Federal MINIATURE SELENIUM RECTIFIER

TYPE 438D3428A

500 MA, 130 V



CHARACTERISTICS

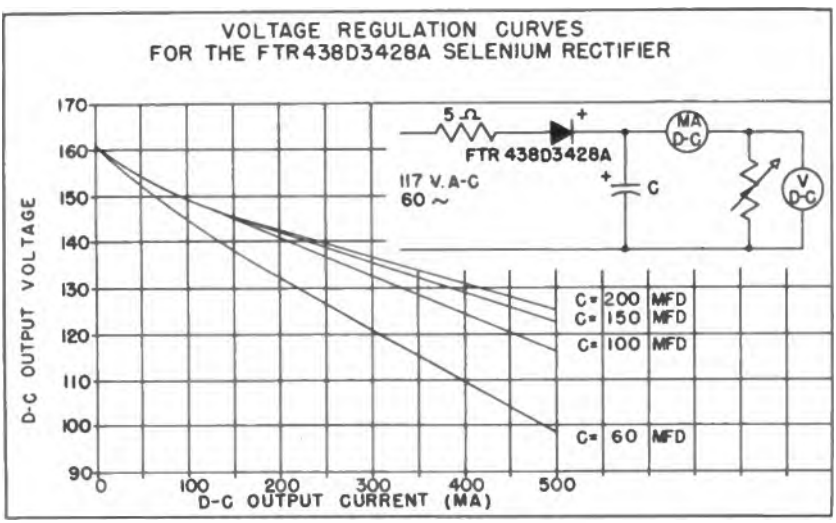
Max. RMS Input Voltage	130
Max. Peak Inverse Voltage	380
Max. Peak Current (Ma)	3500
Max. RMS Current (Ma)	1250
Max. D-C Current (Ma)	500
Approx. Rectifier Voltage Drop	5
Minimum Series Resistance	5
Max. Plate Operating Temperature	85°C

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A	7/16	D	3-1/16	G	1/16±1/64	J	5/32
B	1-17/32	E	17/64	H	1-5/16	K	.177
C	5/32	F	1/32	I	3/32x3/64		

CIRCUIT APPLICATION

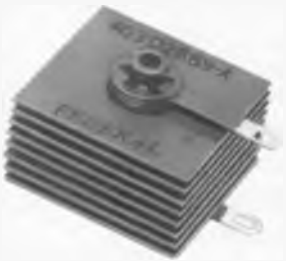
The FTR 438D3428A miniature selenium rectifier is used in the same applications as the 438D3427A in circuits where over 400 ma is required such as power supplies for larger television and combination sets. It can also be used in d-c filament supplies and to operate small d-c motors, fans, and other d-c appliances, particularly in areas where recent conversion from d-c to a-c power has made many of these appliances useless. The characteristic curves of this rectifier are shown below.



Federal MINIATURE SELENIUM RECTIFIER

TYPE 403D2889A

100 MA, 160 V



CHARACTERISTICS

Max. RMS Input Voltage	160
Max. Peak Inverse Voltage	440
Max. Peak Current (Ma)	1200
Max. RMS Current (Ma)	325
Max. DC Current Output (Ma)	100
Approx. Rectifier Voltage Drop	9
Minimum Series Resistance	22
Max. Plate Operating Temperature	85°C

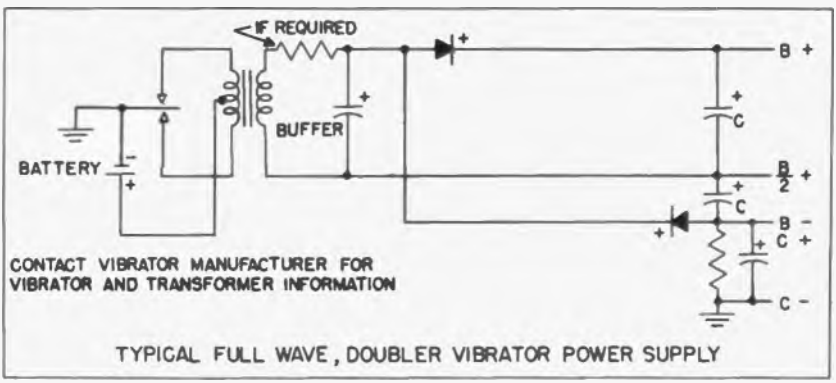
DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A 23/64	D 1-11/64	G ..1/16 ± 1/64	J 5/32
B 1-9/32	E 17/64	H 1	K 177
C 5/32	F 1/32	I ....5/64 x 5/32	

CIRCUIT APPLICATION

The FTR 403D2889A Miniature Selenium rectifier is one of a series of rectifiers (the others to be described in subsequent pages) developed for use in vibrator power supplies. Selenium rectifier vibrator supplies, due to the low voltage drop across the rectifier and the fact that no filaments are required, are up to 40% more efficient in appropriate circuits than dynamotor or rectifier tube supplies providing the same output. This is a very important factor, particularly in mobile radio and television applications since this efficiency is reflected into an equivalent degree of less battery current drain.

To attain maximum efficiency, the full wave doubler circuit, shown below, is usually used in these vibrator supplies. For this reason, most of the rectifier types developed for this application are manufactured with two rectifiers assembled together—to eliminate two assembly line operations for the equipment manufacturer. An exception to this is the 403D2889A rectifier, which is a single unit, manufactured in this way so that the rectifiers may be placed side by side in the chassis rather than lengthwise. The characteristic curves for this rectifier are the same as shown on page 22 for 403D240A rectifier—the latter being two 403D2889A's assembled together.



TYPICAL FULL WAVE, DOUBLER VIBRATOR POWER SUPPLY

Federal MINIATURE SELENIUM RECTIFIER

TYPE 402D3239A

75 MA, VIBRATOR DOUBLER

CHARACTERISTICS

(as applied to a single section)

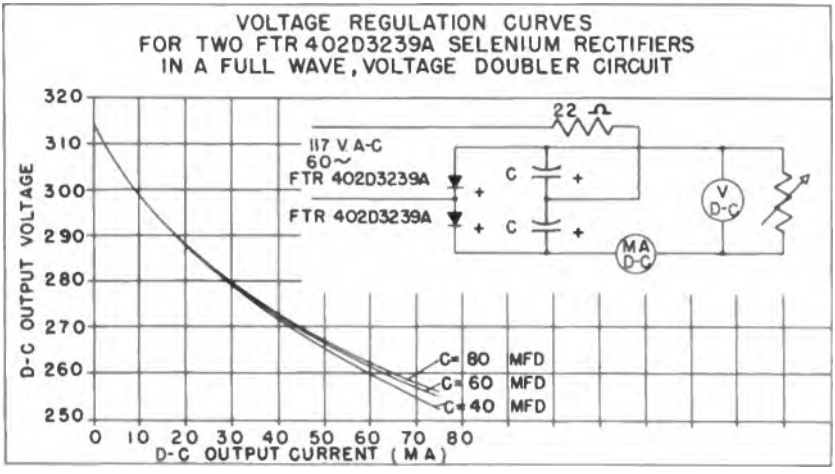
Max. Input RMS Voltage	160
Max. Peak Inverse Voltage	440
Max. Peak Current (Ma)	900
Max. RMS Current (Ma)	220
Max. D-C Current Output (Ma)	75
Approx. Rectifier Voltage Drop	9
Minimum Series Resistance	22
Max. Plate Operating Temperature	85°C

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A	19/64	D	1	G	1/16±1/64	J	5/32
B	1	E	17/64	H	1-11/16	K	.177
C	5/32	F	1/32	I	5/64x5/32		

CIRCUIT APPLICATION

The FTR 402D3239A miniature selenium rectifier was developed for application in 75 Ma vibrator power supplies. Characteristic curves for this rectifier when employed in a full wave doubler circuit with a 117 volt, 60 cycle input are shown below. It should be noted, however, that the output of a vibrator transformer secondary in many cases will not be equal to 117 volts and hence the selenium rectifiers developed for use in vibrator power supplies have a higher RMS voltage rating—allowing for variations in vibrator outputs. For an input other than 117 volts the designer must interpolate the curves shown below to obtain an approximation of the output to be expected. An additional factor that should be considered when utilizing these curves is that the data was taken with a 60 cycle sine wave input—while the vibrator may operate at a different frequency and have a square waveform.



Federal MINIATURE SELENIUM RECTIFIER

TYPE 403D3240A

100 MA, VIBRATOR DOUBLER

CHARACTERISTICS

(as applied to a single section)

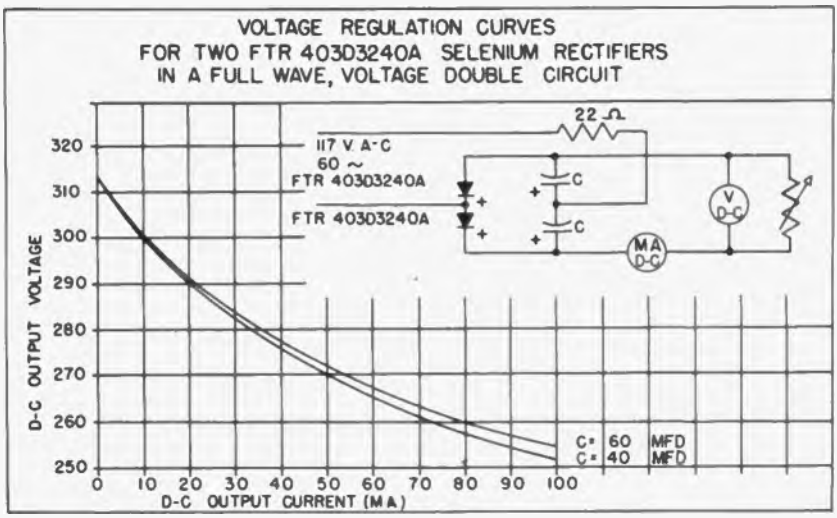
Max. Input RMS Voltage	160
Max. Peak Inverse Voltage	440
Max. Peak Current (Ma)	1200
Max. RMS Current (Ma)	325
Max. D-C Current Output (Ma)	100
Minimum Series Resistance (Ohms)	22
Max. Plate Operating Temperature	85°C

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A 23/64	D 1-13/64	G ..1/16±1/64	J 5/32
B 1-9/32	E 17/64	H 1-11/16	K ..... .177
C 5/32	F 1/32	I 5/64x5/32	

CIRCUIT APPLICATION

The FTR 403D3240A miniature selenium rectifier was developed for use in 100 ma vibrator power supplies. This unit is actually two 403D2889A units assembled together. The characteristic curves for this rectifier employed in a full wave doubler circuit with a 117 volt input are shown below. As indicated in the "Circuit Application" of the 402D3239A rectifier, in many cases a 117 volt and sine wave input will not be obtained from the vibrator transformer secondary—in which case the designer must approximate the output to be expected.



Federal MINIATURE SELENIUM RECTIFIER

TYPE 404D3241A

200 MA, VIBRATOR DOUBLER

CHARACTERISTICS

(as applied to a single section)

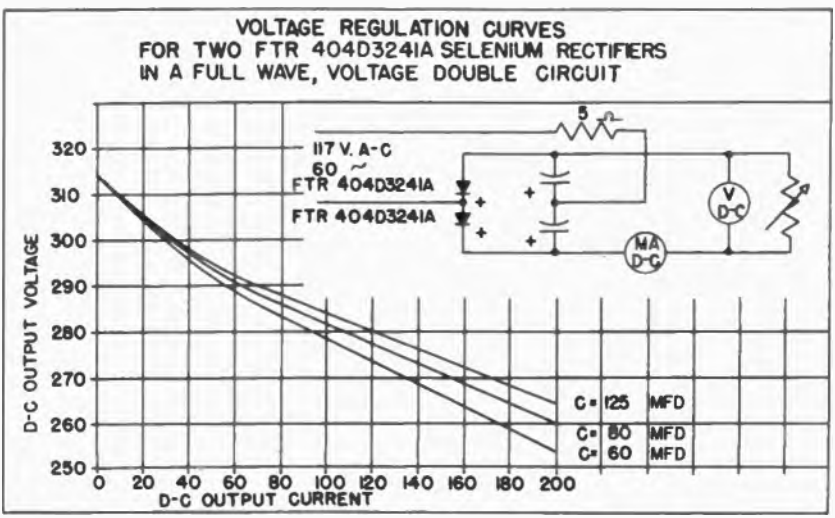
Max. Input RMS Voltage	160
Max. Peak Inverse Voltage	440
Max. Peak Current (Ma)	2000
Max. RMS Current (Ma)	550
Max. D-C Current Output (Ma)	200
Approx. Rectifier Voltage Drop	9
Minimum Series Resistance (Ohms)	5
Max. Plate Operating Temperature	85°C

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A 7/16	D 1-17/32	G ..1/16±1/64	J 5/32
B 1-17/32	E 17/64	H 1-11/16	K ..... .177
C 5/32	F 1/32	I 3/32x3/16	

CIRCUIT APPLICATION

The FTR 404D3241A miniature selenium rectifier was developed for use in 200 ma vibrator power supplies. The characteristic curves for this rectifier employed in a full-wave doubler circuit with a 117 volt input are shown below. As indicated in the description of the 402D3239A rectifier, the 117 volt and sine wave input will, in many cases, not be obtained from the vibrator transformer secondary—in which case the designer must approximate the output to be expected.



Federal MINIATURE SELENIUM RECTIFIERS

25 VOLT, BRIDGE TYPE

FTR TYPE
402D3550
150 MA

FTR TYPE
403D3551
300 MA

FTR TYPE
404D3552
600 MA

CHARACTERISTICS

TYPE	Max. Peak Current (MA)	Max. RMS Current (MA)	Max. D-C Current Output
402D3550	1800	270	150
403D3551	2400	540	300
404D3552	4000	1080	600

The following characteristics apply for all 25 Volt Bridge Type. Rectifiers:

Max. Rms Input Voltage	25
Max. Peak Inverse Voltage	35
Approx. Rectifier Voltage Drop	2
Max. Operating Temperature	85° C

Federal 25 VOLT, BRIDGE TYPE SELENIUM RECTIFIER

DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

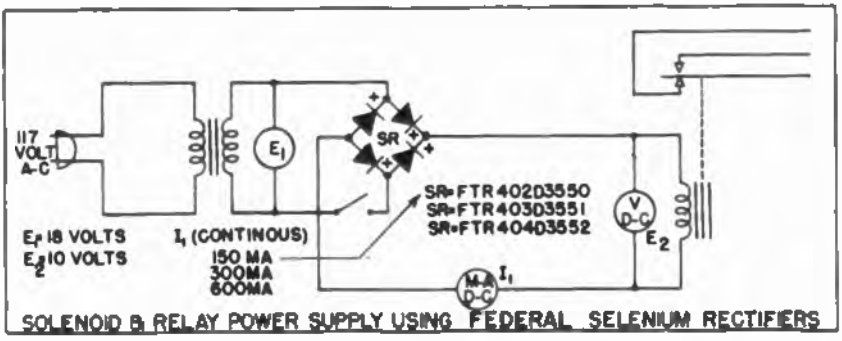
TYPE	A	B	D	I
402D3550	19/64	1	1	5/64
403D3551	23/64	1 13/64	1 9/32	5/64
404D3552	7/16	1 17/64	1 17/32	3/32

All Types Have the Following Dimensions:

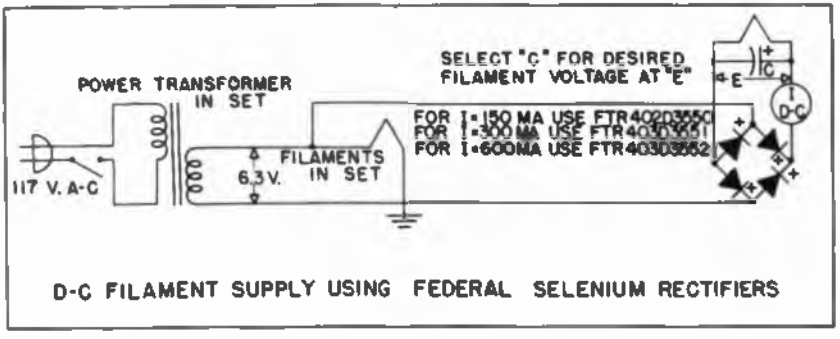
H ..... 3/4 J ..... 5/32 (No Locking Lug)

CIRCUIT APPLICATION

Federal's 25 volt, bridge type miniature selenium rectifiers provide an economical and efficient method of supplying d-c power in applications where low voltages—up to 25 volts RMS input—and comparatively high current—up to 600 Ma d-c are required. Two typical supplies are shown below. It should be noted that all four rectifier arms are contained within each bridge rectifier—each selenium rectifier plate comprising one arm. In applications where intermittent rather than continuous operation is required—a higher value of maximum d-c current can be used providing that the plate operating temperature does not exceed 85°C.



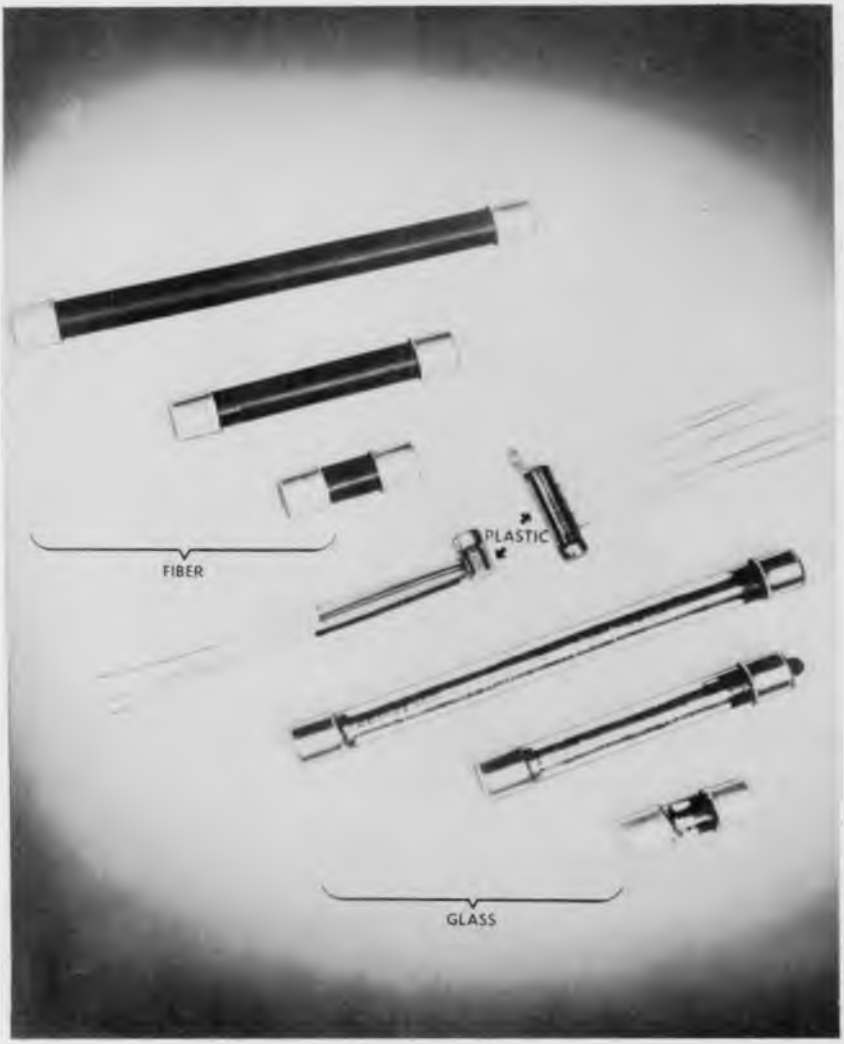
SOLENOID & RELAY POWER SUPPLY USING FEDERAL SELENIUM RECTIFIERS



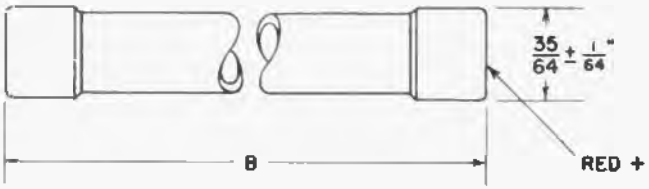
D-C FILAMENT SUPPLY USING FEDERAL SELENIUM RECTIFIERS

Federal HIGH VOLTAGE SELENIUM RECTIFIERS

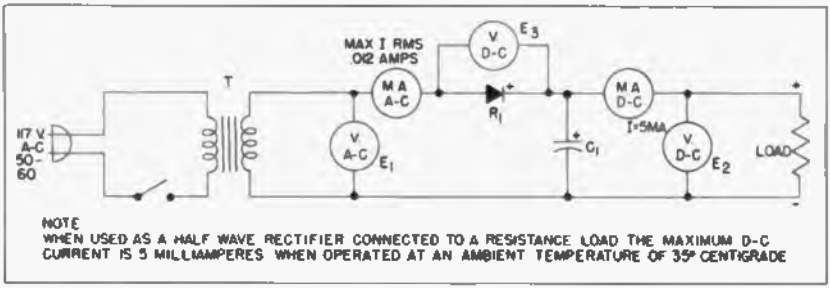
250 – 5000 VOLTS, 5 AND 10 MA



Federal HIGH VOLTAGE SELENIUM RECTIFIERS



CHARACTERISTICS AND DIMENSIONS



FTR CODE NUMBER	DC OUTPUT VOLTS E_2	C_1 MFD	B	MAXIMUM PEAK INVERSE E_3 VOLTAGE	AC INPUT VOLTS E_1	MAX. EFF. INVERSE VOLTS E_3
1230101	1400	.12	$4\frac{23}{32}" \pm \frac{1}{16}"$	4000	1400	2860
1230107	1050	.15	$4\frac{9}{32}" \pm \frac{1}{16}"$	3000	1050	2130
1230126	700	.23	$3\frac{9}{32}" \pm \frac{1}{16}"$	2000	700	1430
1230182	350	.46	$1\frac{23}{32}" \pm \frac{1}{16}"$	1000	350	730

CIRCUIT APPLICATIONS

Federal's high voltage, enclosed selenium rectifiers—with voltage ratings from 250 volts to 5000 volts and current ratings of 5 ma for half-wave circuits and 10 ma for full-wave and bridge rectifiers—have found wide application in photo-flash power supplies, cathode ray oscilloscopes, television circuits, d-c power supplies, high voltage testing equipment, bias supplies, and many other high voltage, low current circuits. As illustrated in the photograph, these rectifiers are available in a fiber enclosure; in a hermetically sealed glass enclosure for operation in high temperatures and humidity; and in plastic enclosures for application in full-wave, bridge, or doubler circuits with voltage rating of 26 to 500 volts RMS.

Federal MINIATURE SELENIUM RECTIFIER

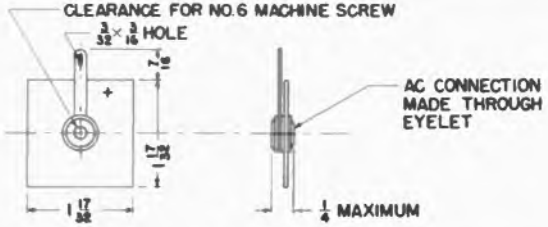
TYPE 4D2814AS

BATTERY CHARGER

CHARACTERISTICS

In half-wave applications with resistive load—
Max. RMS Input Voltage..... 18
Max. D-C Current (Ma).....450
In half-wave applications with capacitive load—
Max. RMS Input Voltage..... 9
Max D-C Current (Ma).....450
In half-wave battery charging applications—

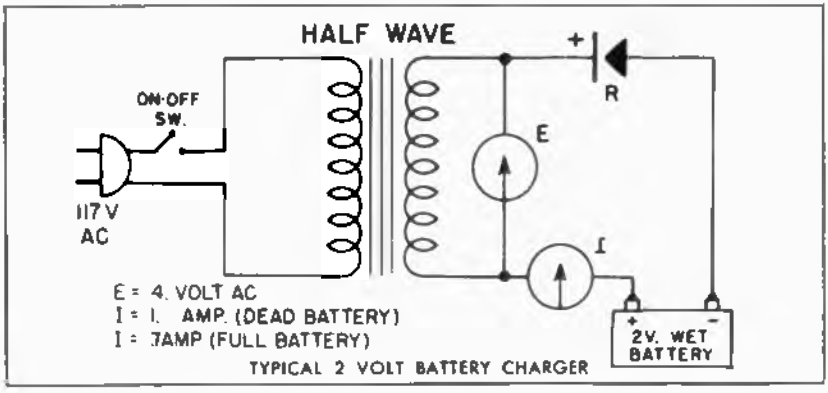
No. Cells	*RMS Input Voltage*	*Charging Current (amp) Fully Charged*	*Dead*
1	4	.7	1.0
3	8	.7	1.0



DIMENSIONAL DIAGRAM

CIRCUIT APPLICATION

The FTR 4D2814AS miniature selenium rectifier was developed primarily for use in 2 and 6 volt battery chargers such as are used in self-charging portables. The schematic diagram of a typical charger using this rectifier is shown below. The 4D2814AS can also be used in bias and filament supplies described for the FTR 402D3151 rectifier.



TYPICAL 2 VOLT BATTERY CHARGER

Federal MINIATURE SELENIUM RECTIFIER

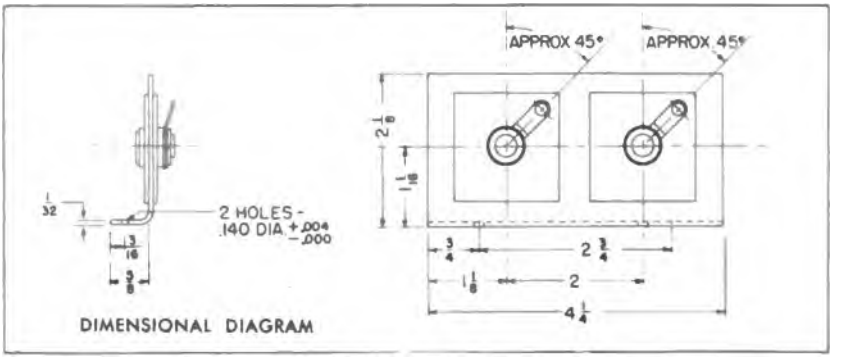
TYPE 104D2943S

BATTERY CHARGER

CHARACTERISTICS

In full wave applications with resistive load—
Max. RMS Input Voltage..... 26
Max. D-C Current (Ma).....2000
In full wave applications with capacitive load—
Max. RMS Input Voltage..... 26
Max. D-C Current 1600
In full wave battery charging applications—

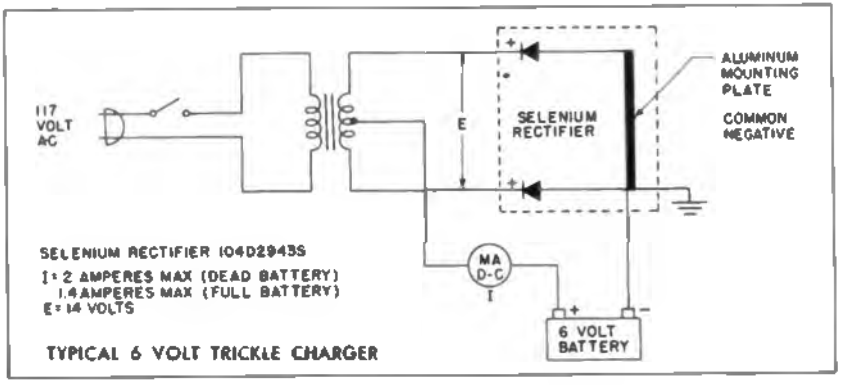
No. of Cells	RMS Input Voltage	Charging Current (amp) Fully Charged	Dead
3	15	1.4	2.0



DIMENSIONAL DIAGRAM

CIRCUIT APPLICATION

The FTR 104D2943S miniature selenium rectifier was developed for use in trickle battery charging equipment for recharging 6 volt batteries. A typical recharger circuit is shown below. This circuit can also be used for d-c filament supplies.



TYPICAL 6 VOLT TRICKLE CHARGER

Federal MINIATURE SELENIUM RECTIFIER

TYPE 402D3151

75 MA, 20 V

CHARACTERISTICS

Max. RMS Input Voltage	20
Max. Peak Inverse Voltage	55
Max. Peak Current (Ma)	900
Max. RMS Current (Ma)	220
Approx. Rectifier Voltage Drop	1
Max. D-C Current	75 ma
Minimum Series Resistance	22
Maximum Plate Operating Temperature	85°C

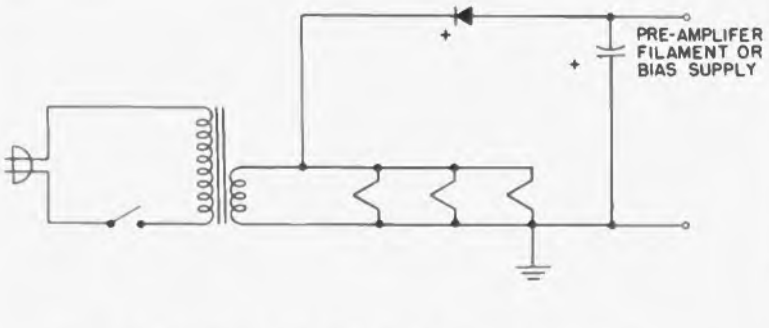
DIMENSIONS IN INCHES *(See dimensional diagram p. 7)*

A	19/64	D	1	G	*	J	5/32
B	1	E	*	H	3/8	K	*
C	*	F	*	I	5/64x5/32		

*(No Locking Lug)

CIRCUIT APPLICATION

The FTR 402D3151 type of selenium rectifier was developed for application in bias supplies where relatively low voltage is required. When only one rectifier is utilized, the maximum voltage and current output of such a bias supply would be 20 volts, at 75 milliamperes. However it is possible to increase these maximum ratings by adding rectifiers in series for greater voltages, or in parallel for higher current outputs. For example, in designing an audio amplifier it is particularly advantageous to utilize d-c for the pre-amplifier filament. This can be done by use of a half-wave rectifier circuit in series with that filament as shown in the schematic below. If the filament requires 150 ma, then two of the type 402D3151 rectifiers would be used in parallel—if 300 ma is necessary then four in parallel would be employed. It should be noted that the value for the minimum series resistance given above applies only to a single rectifier in the circuit.



BIAS OR FILAMENT SUPPLY USING FILAMENT SECONDARY

Applications

The field of application of Federal miniature selenium rectifiers continues to broaden at a rapid rate. The small size and weight, and the low cost of this rectifier, plus its favorable electrical characteristics of long life, instantaneous rectification, and high surge current rating, have resulted in the design of more economical and improved radio and electronic equipment. Federal, in maintaining a policy of full cooperation with the engineer, has kept pace with the requirements of the industry through the development of new types of miniature selenium rectifiers.

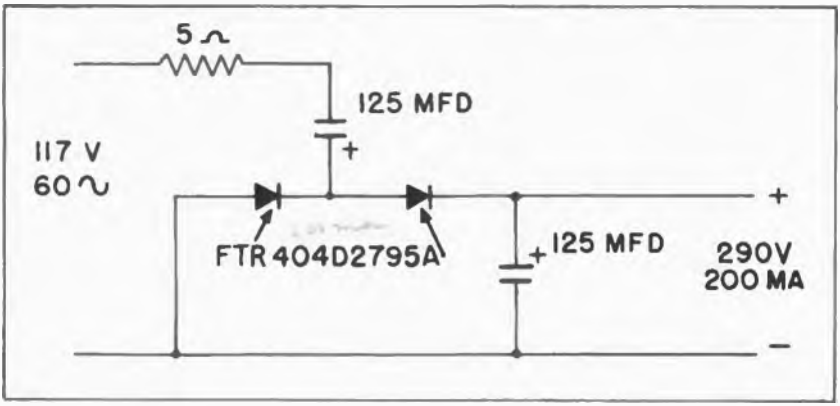
The Federal miniature selenium rectifier can be employed wherever conversion from a-c to d-c is either necessary or desirable. It has already been used with great advantage in a wide variety of applications including: Three-way portables where instantaneous starting is obtained in the a-c/d-c position; television where large savings in cost, size, and weight have been achieved; highly efficient mobile supplies resulting in a reduction in battery current drain, small d-c power supplies for fans, relays, magnetic chucks, and similar devices.

In particular the Federal miniature selenium rectifier has tremendous design potentialities in fields where conversion from a-c to d-c, although desirable, has heretofore been impractical. For example, virtually all electric shavers used a-c to drive their motors, though a d-c supply would provide a much smoother, more comfortable shave. A-C is employed, since the converter unit, when tubes were utilized, was far too large, bulky, and expensive. However, as a result of the introduction of the miniature rectifier, an economical, small converter unit has been developed.

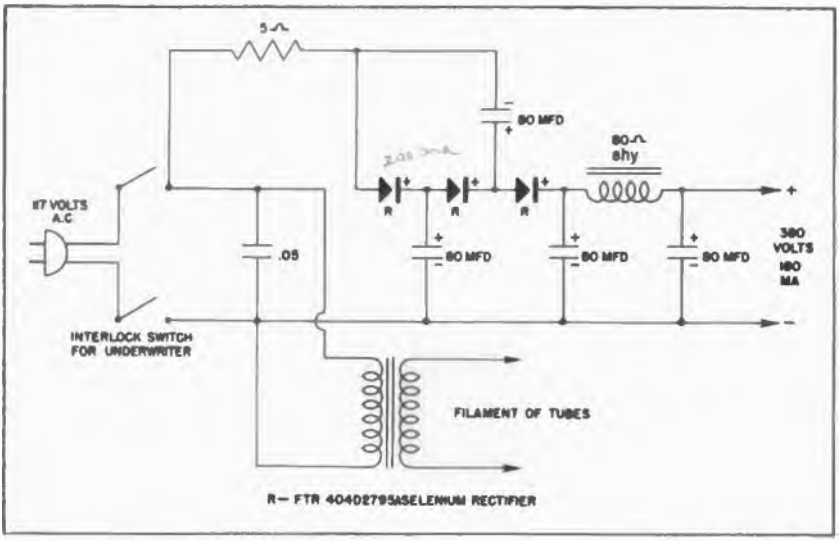
The many circuit suggestions shown in the succeeding pages by no means cover all the possible rectifier applications or designs. They are offered to supply ideas and guidance for the engineer, who can modify any of the circuits to suit his individual requirements. Federal, with a corps of specialized personnel, will gladly assist the designer in perfecting any circuit utilizing these rectifiers.

TELEVISION

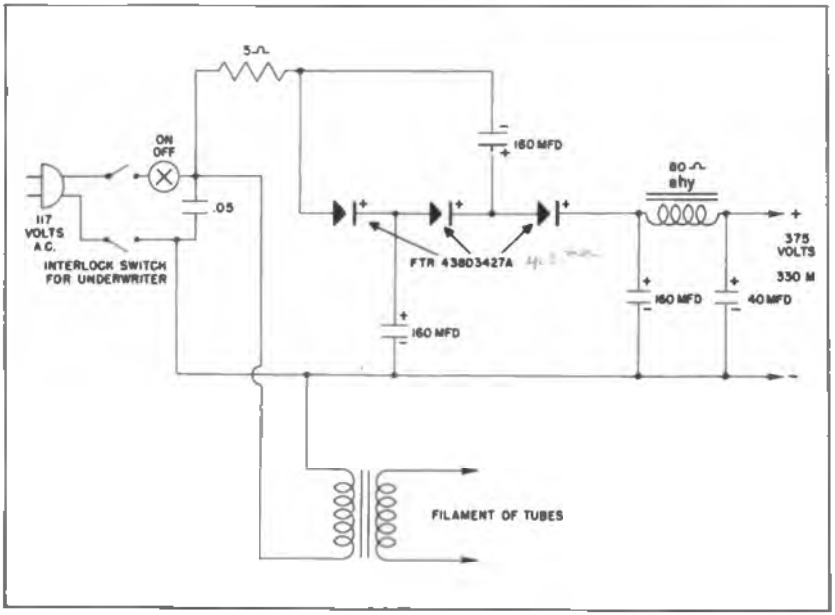
Federal's miniature selenium rectifiers, by eliminating the need for the power transformer and rectifier tubes, have been a major factor in the development of low cost, lighter television receivers. In addition to their use in the smaller type sets, these rectifiers, due to their efficiency and flexibility, offer many design advantages in larger units where special circuits can be incorporated to improve design at very little addition in cost. On succeeding pages, Federal presents a number of circuit suggestions designed to meet the individual requirements of any type or size of television receiver.



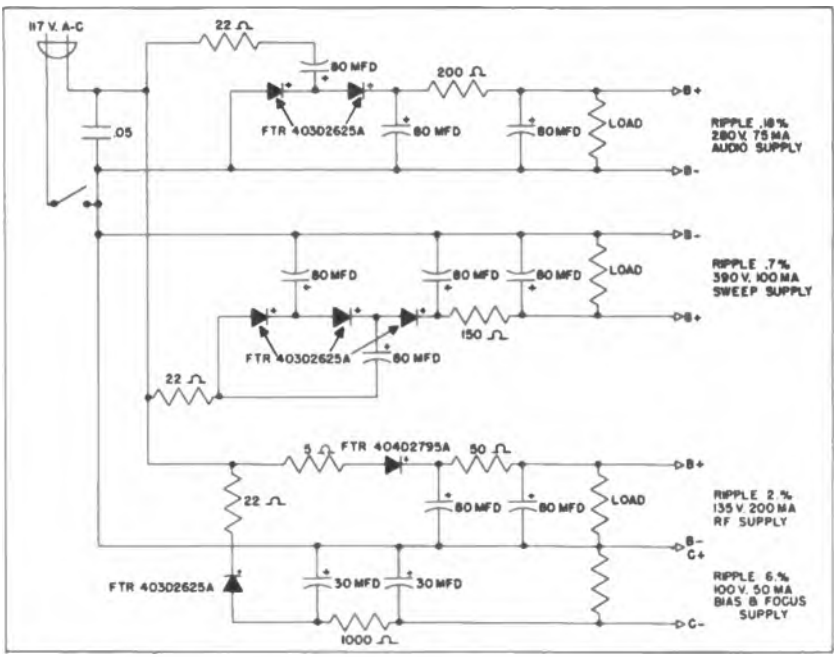
7" Television Power Supply using Voltage-Doubler Circuits.



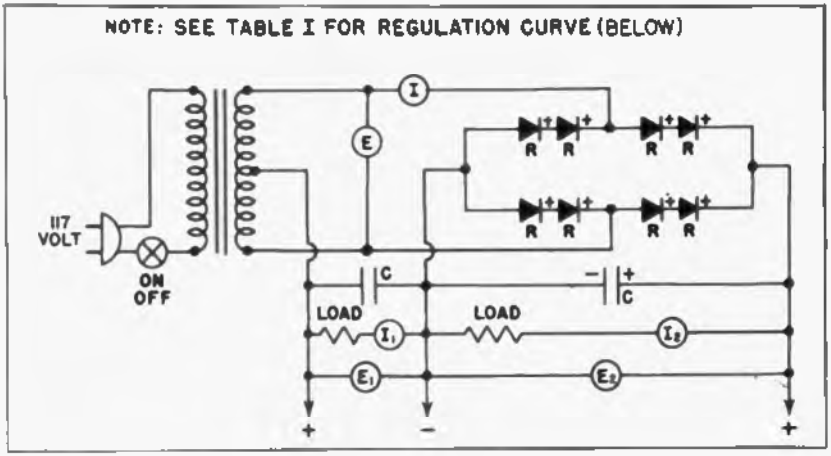
68 Watt Television Power Supply using Voltage-Tripler Circuit.



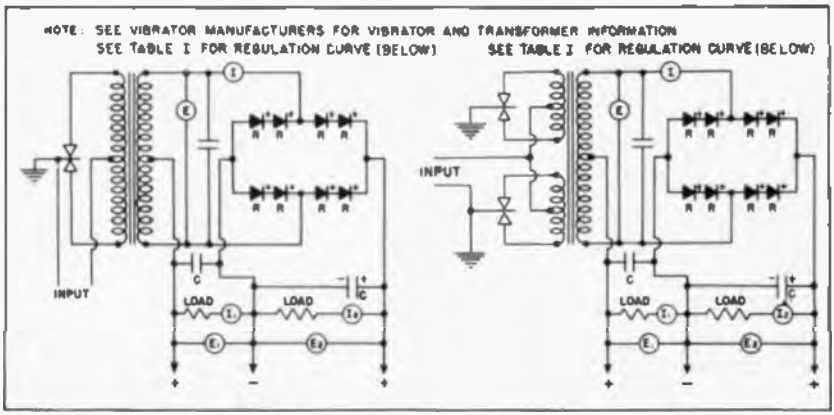
122 Watt Television Power Supply using Voltage-Tripler Circuit.



Multiple Power for High Quality Television Receivers.



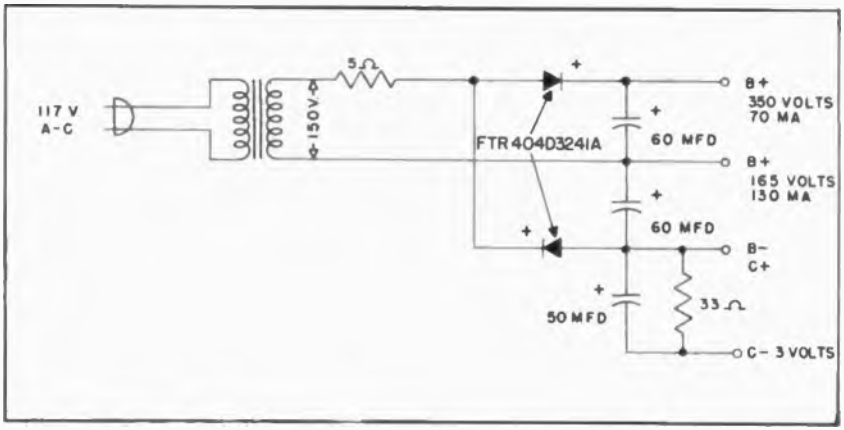
Full Wave Bridge Rectifier Circuit.



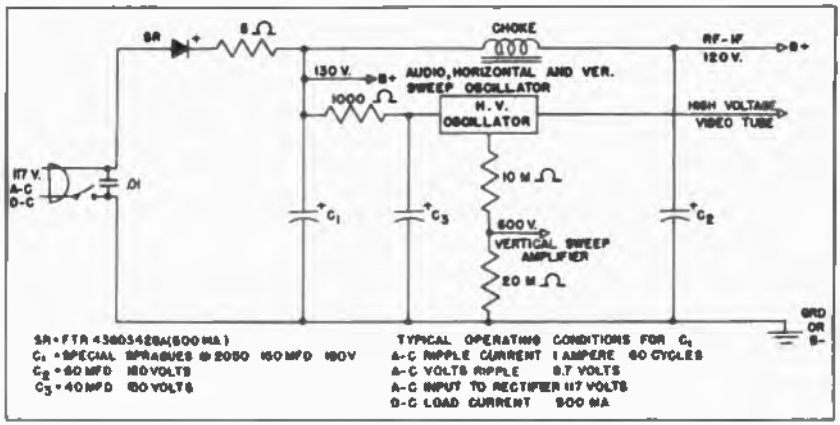
Vibrator Power Supplies for use in Mobile Television Receivers.

INPUT A. C.		OUTPUT D. C.				RIPPLE VOLTS		CAPACITANCE
E	I (Amps.)	E_1	I_1 (Ma.)	E_2	I_2 (Ma.)	E_1	E_2	μfd.
323	.540	200	100	400	200	4.5	9.2	40
323	.43	203	75	402	150	3.4	7.1	
323	.30	205	50	410	100	2.35	4.8	
323	.16	210	25	416	50	1.22	2.5	
323	.0055	219	0	469	0	.37	.22	
323	.54	200	100	400	200	3.0	6.2	60
323	.43	204	75	402	150	2.2	4.9	
323	.30	206	50	410	100	1.55	3.25	
323	.16	210	25	416	50	.83	1.7	
323	.0055	219	0	469	0	.27	.15	
323	.54	200	100	400	200	2.2	4.7	80
323	.43	204	75	401	150	1.7	3.6	
323	.43	206	50	410	100	1.13	2.4	
323	.16	210	25	416	50	.64	1.25	
323	.0055	219	0	469	0	.20	.11	

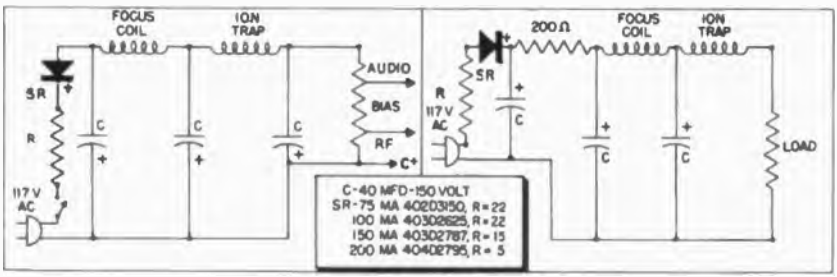
Table 1. Voltage Regulation Characteristics of Vibrator Power Supplies using Federal No. 404D2795A Miniature Selenium Rectifiers.



B+ and Bias Supply for Television Receivers.



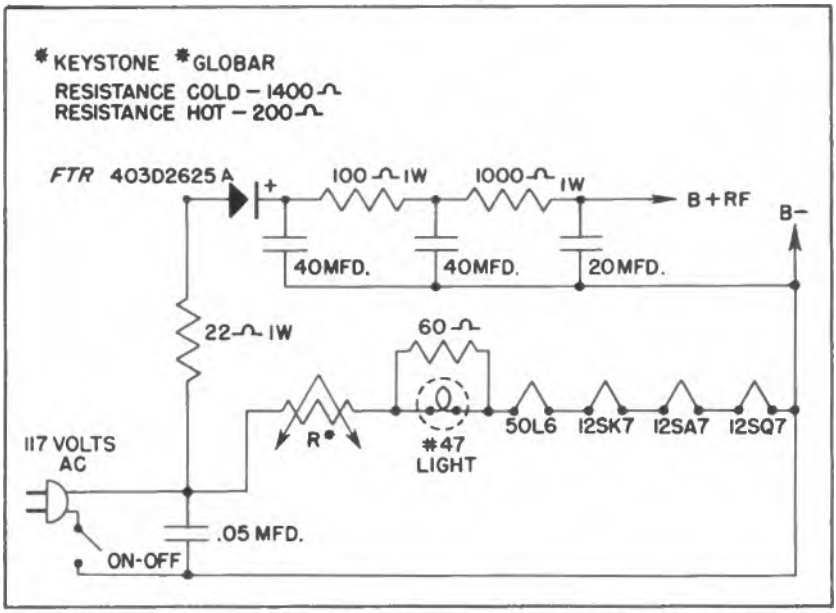
AC-DC Television Power Supply.



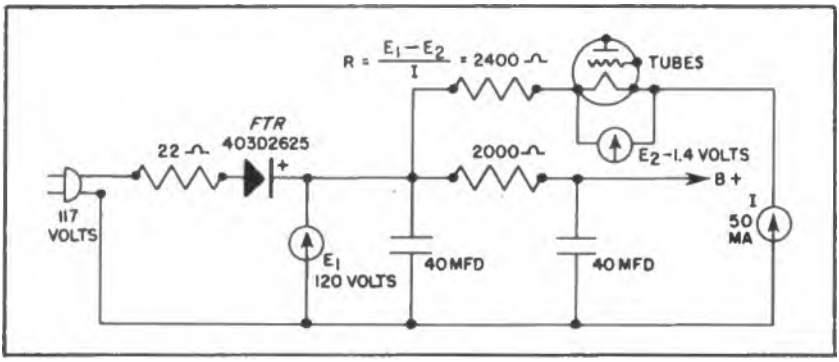
Focus and Bias Power Supply for Television Receivers.

HOME RECEIVERS

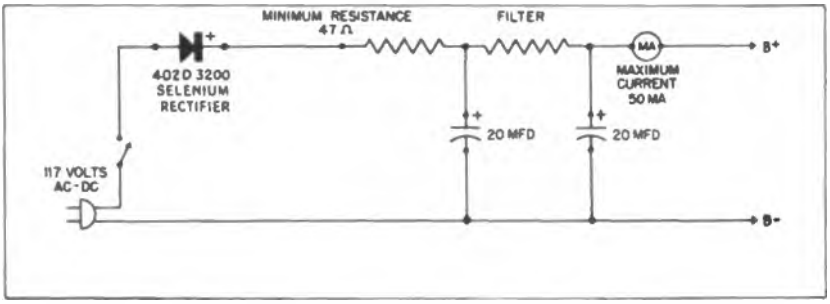
Federal miniature selenium rectifiers provide the radio industry with something NEW to increase sales and reduce costs. Use of these rectifiers with the negative temperature coefficient resistor, which maintains filament current at a constant level, reduces tube and pilot light failures to a minimum, while lowering the price and increasing the output of the set. Furthermore, at a very little increase in cost, it is possible to separate bias supplies, eliminate filament hum, and achieve many other improvements in design. Schematic diagrams for some of these circuit improvements are shown on succeeding pages.



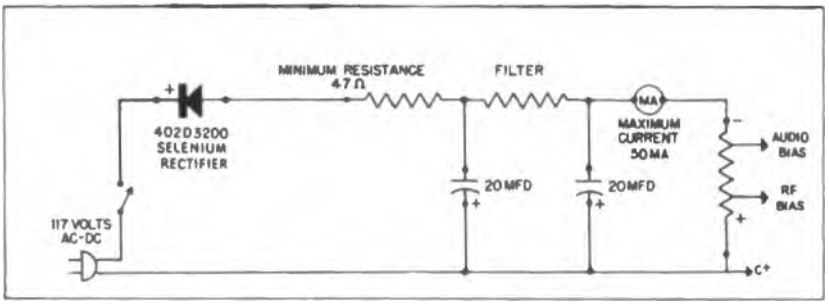
Typical AC-DC Power Supply using Negative Temperature Coefficient Resistor to Give Long Life to Pilot Lights and Tubes, using Federal's Selenium Rectifier B Supply.



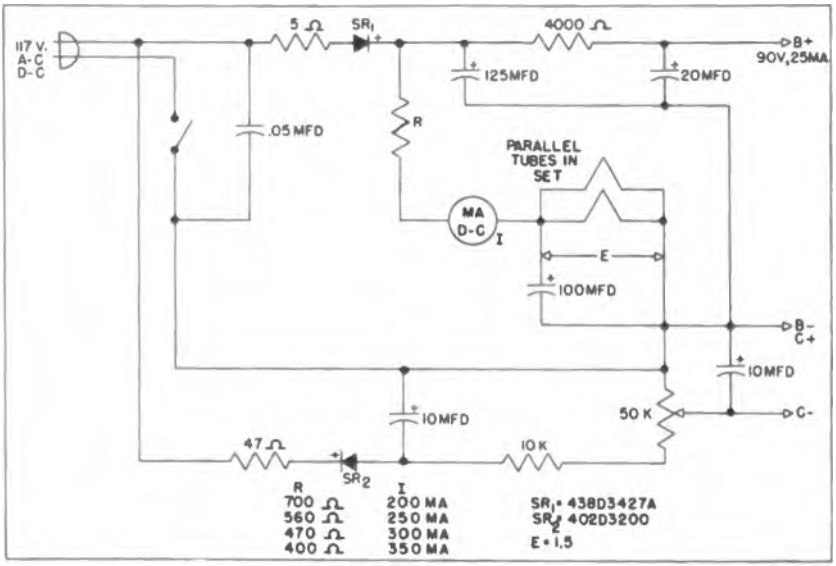
Typical 3-Way Portable Power Supply.



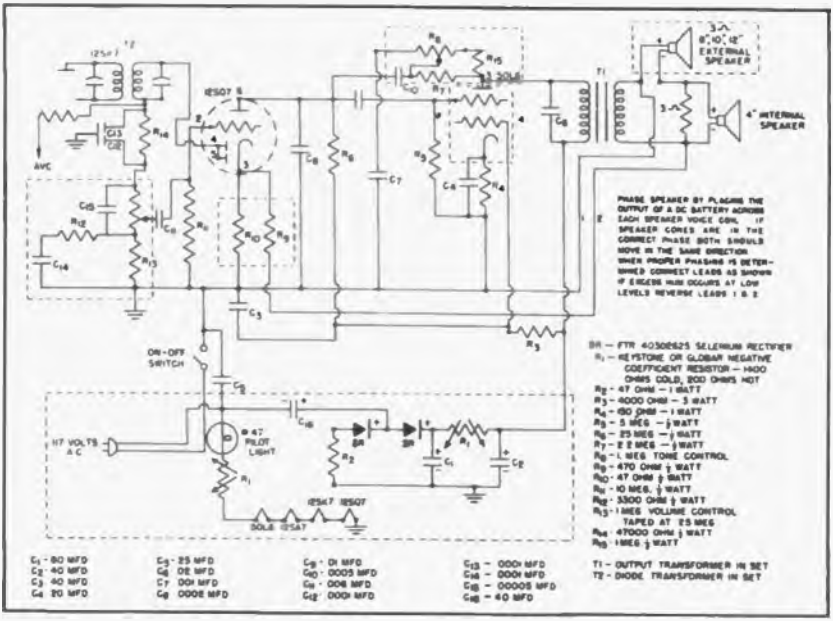
50 ma, B+ Power Supply using Federal's Miniature Selenium Rectifier.



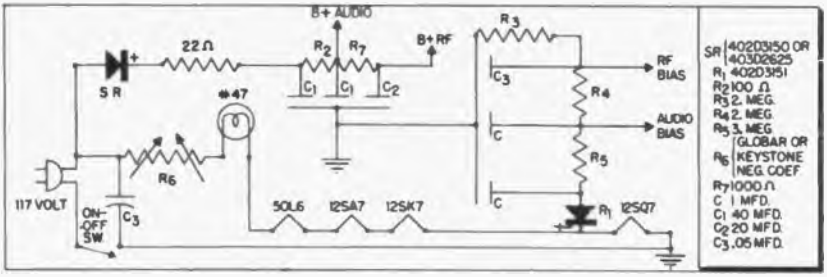
50 ma, Bias Power Supply using Federal's Miniature Selenium Rectifier.



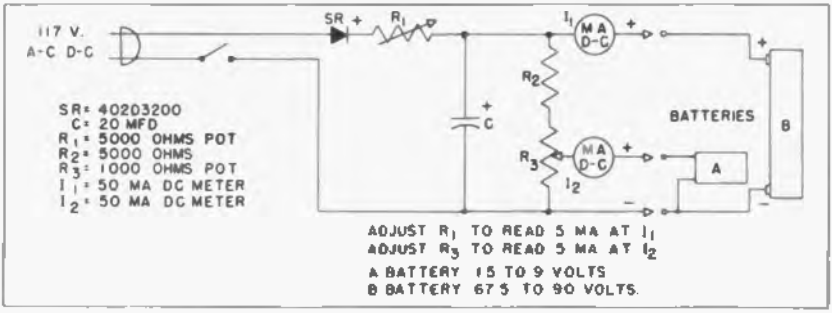
D-C Power Supply for B+, Bias, and Filaments.



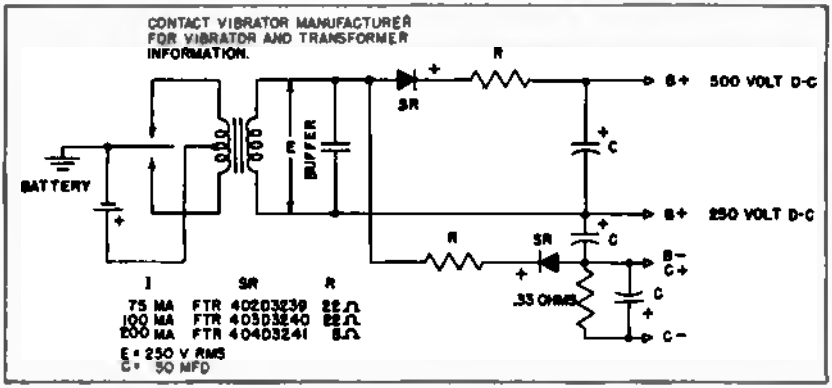
Power Supply for 5 Tube A-C/D-C Sets.



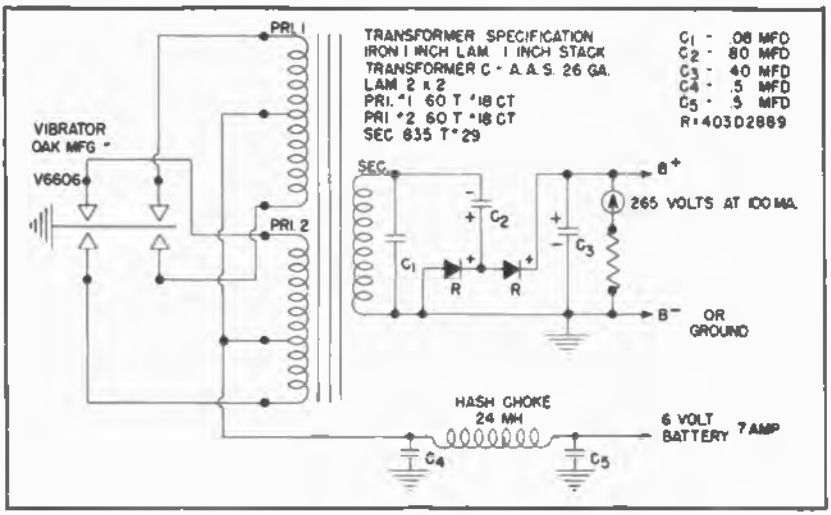
Bias and B+ Power Supply Providing Higher Audio Output and Improved Performance.



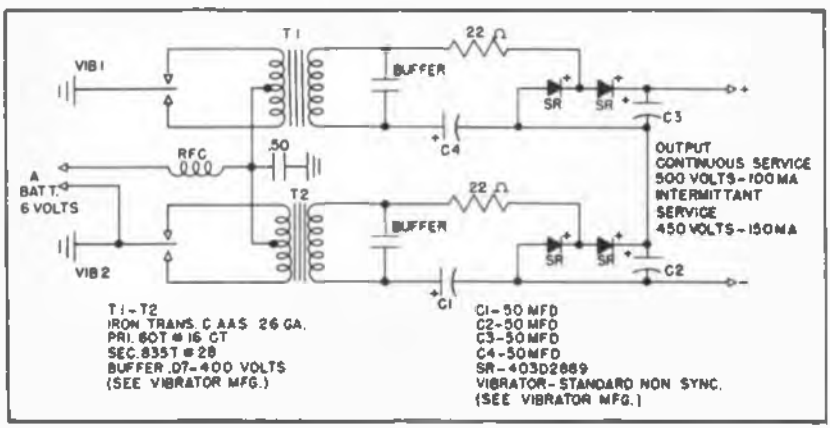
Battery Recharger for Portables.



Typical Full Wave, Doubler Vibrator Power Supply.

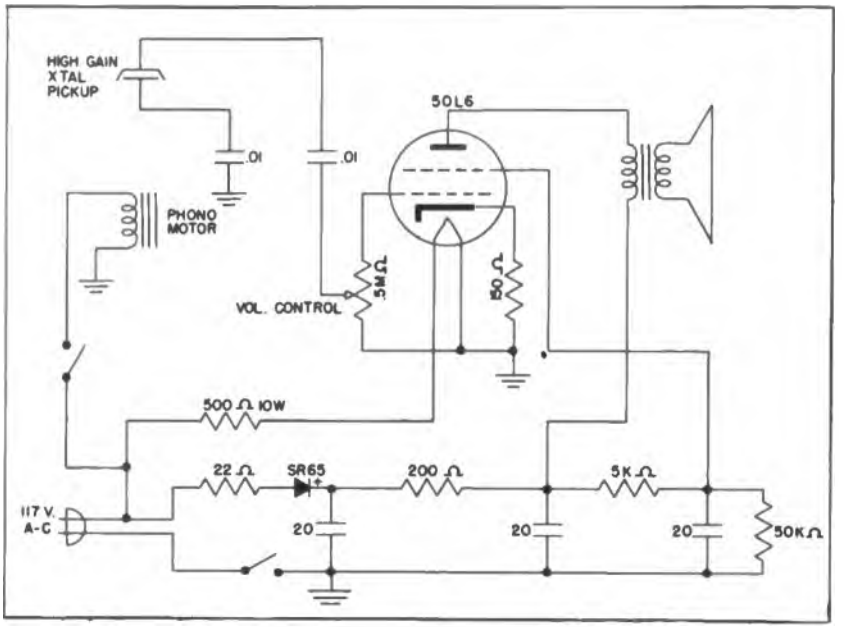


Mobile Power Supply with Transformer Specifications

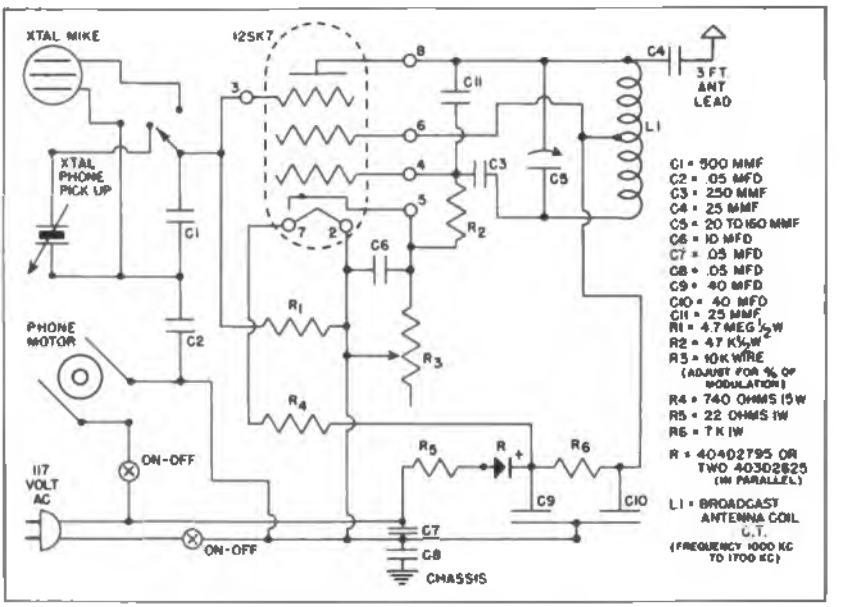


B+ and Bias Mobile Power Supply.

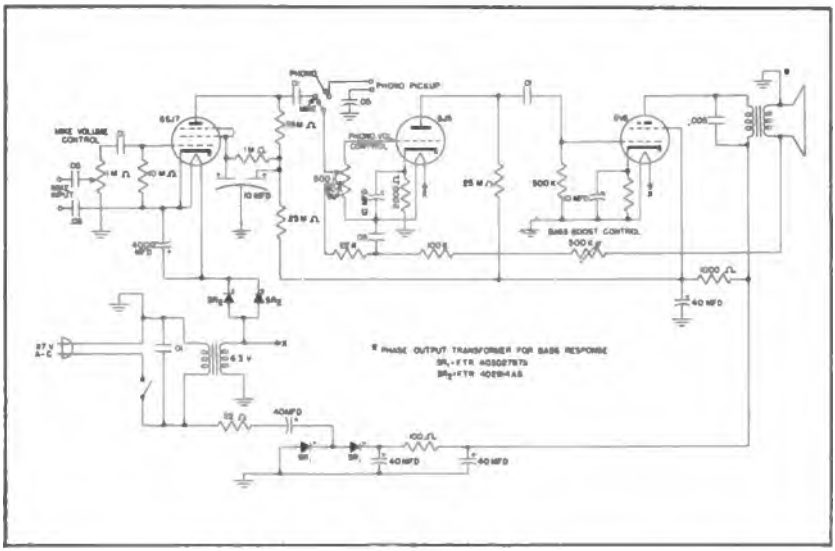
PHONOGRAPH



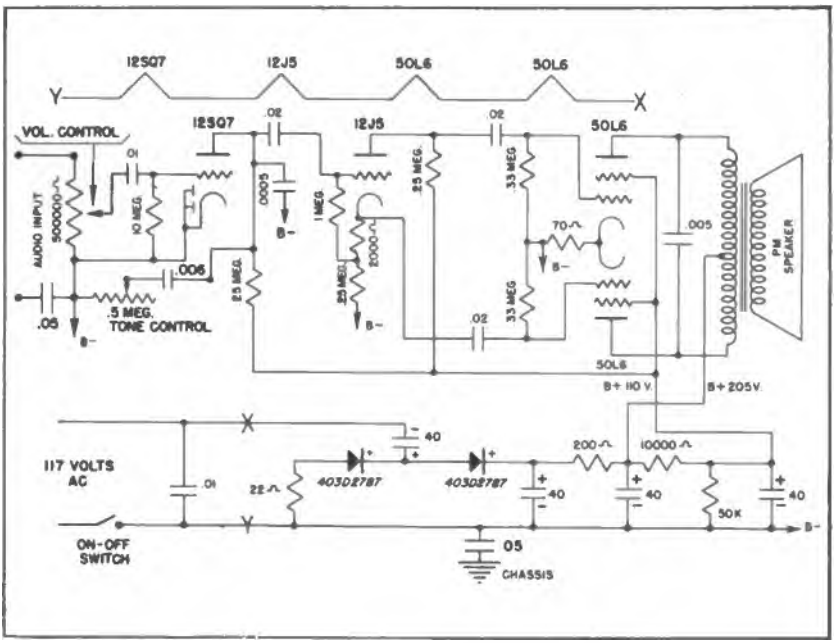
Typical Phonograph Amplifier



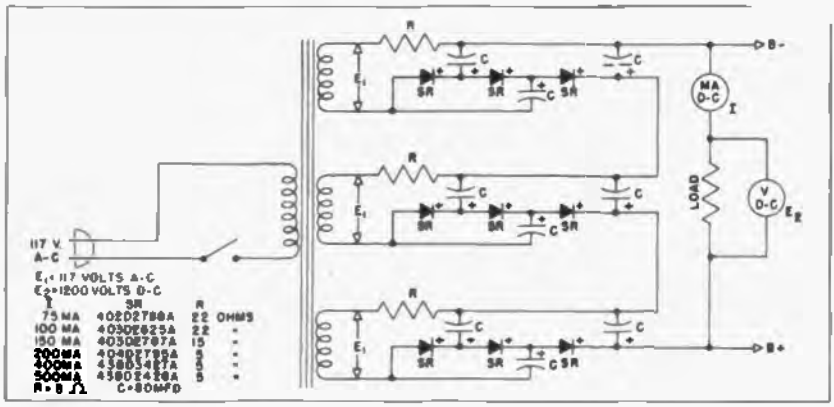
Phonograph Oscillator.



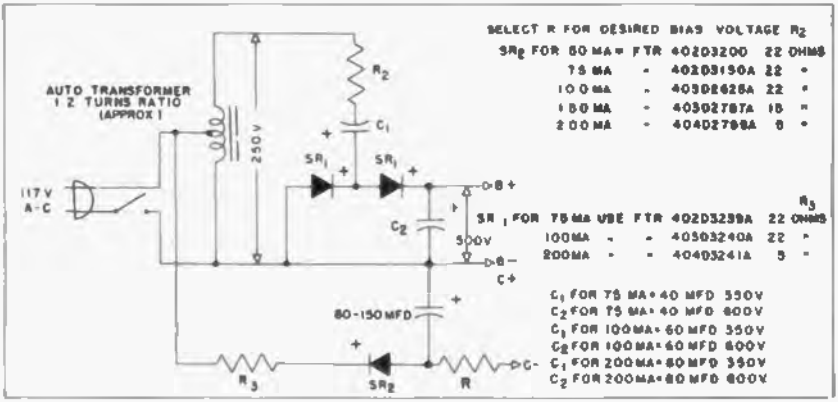
Audio Amplifier.



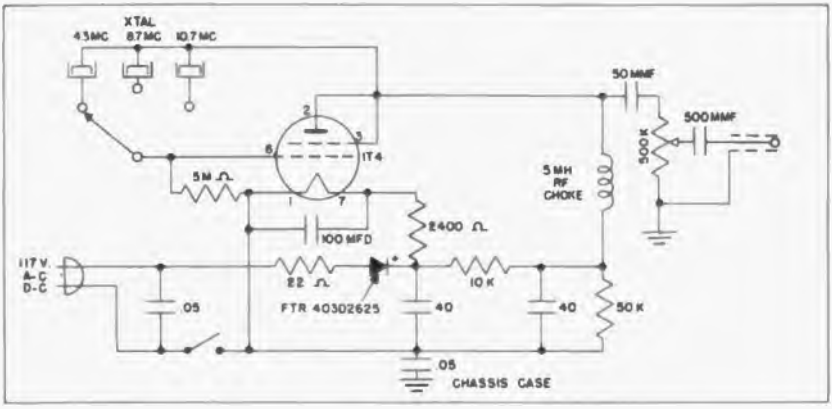
8 Watt Push-Pull Audio Amplifier.



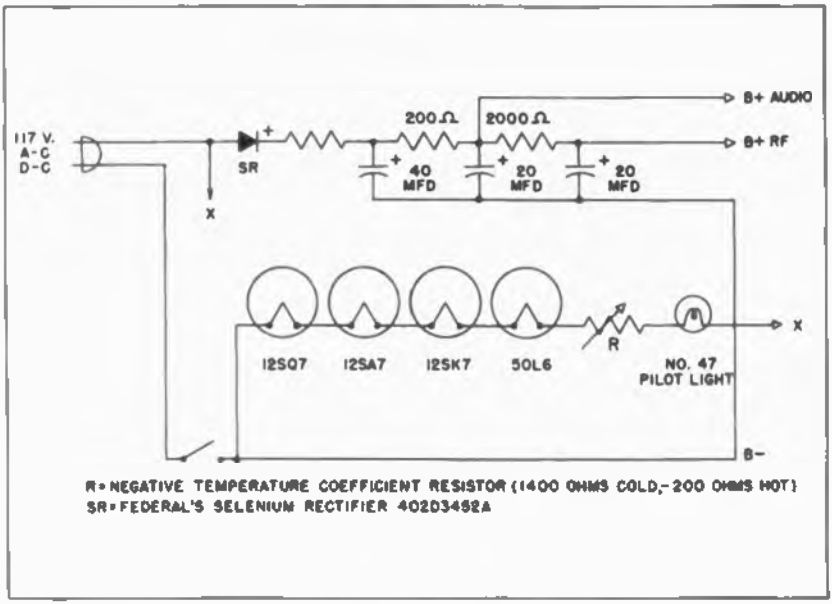
High Voltage Power Supply for up to 500W Amateur Transmitters.



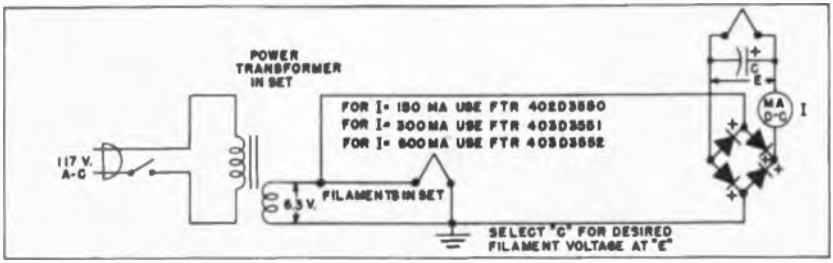
500 Volt B+ Power Supply for Amateur Transmitter.



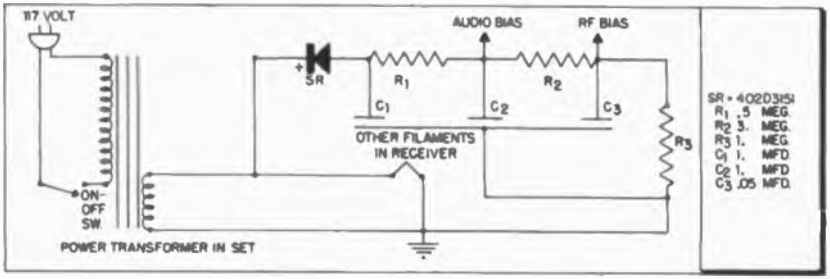
Test Oscillator



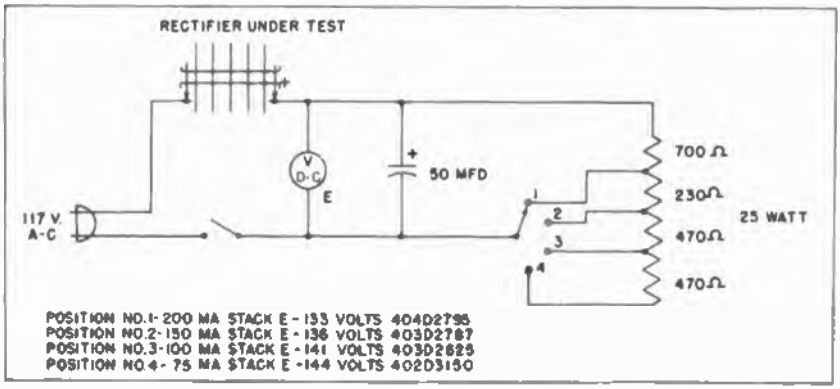
Radio Phonograph Power Supply.



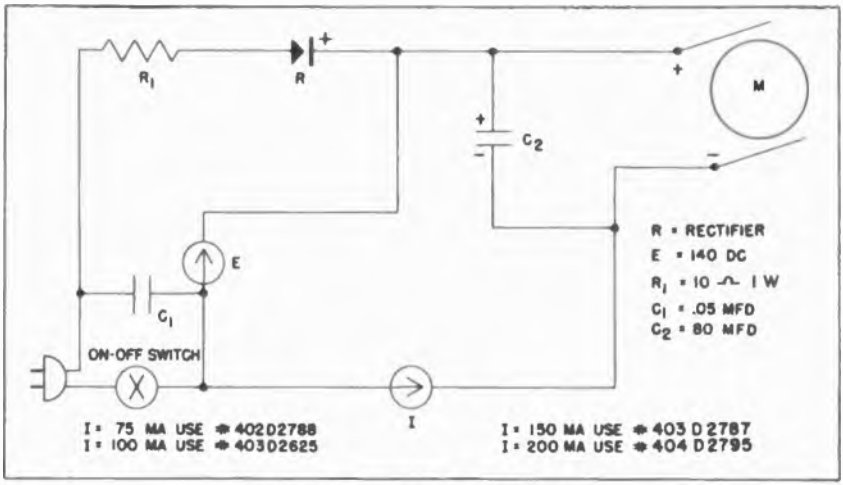
D-C Filament Supply.



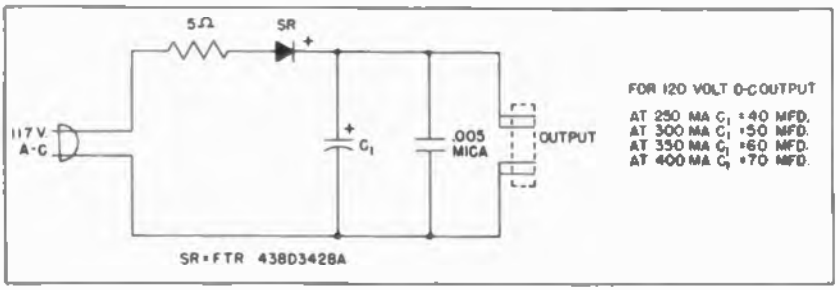
RF and Audio Bias Supply Utilizing Filament Voltage Source and Federal's Miniature Selenium Rectifiers.



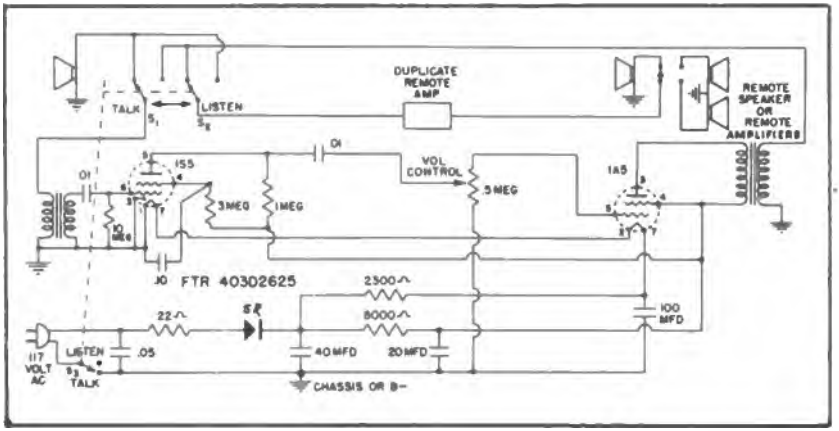
Circuit for Testing Selenium Rectifiers.



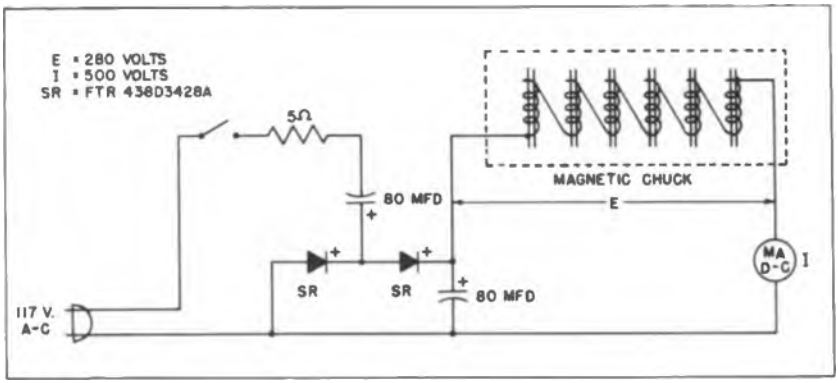
Power Supply for D-C Motor.



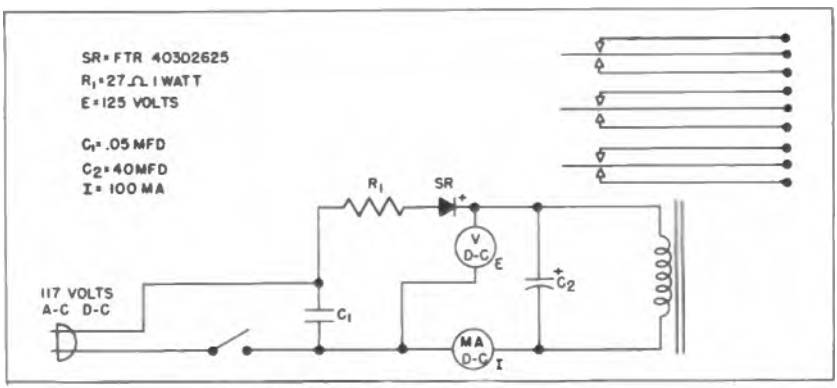
D-C Power Supply for Powering Electric Fans, Relays, and Similar Devices.



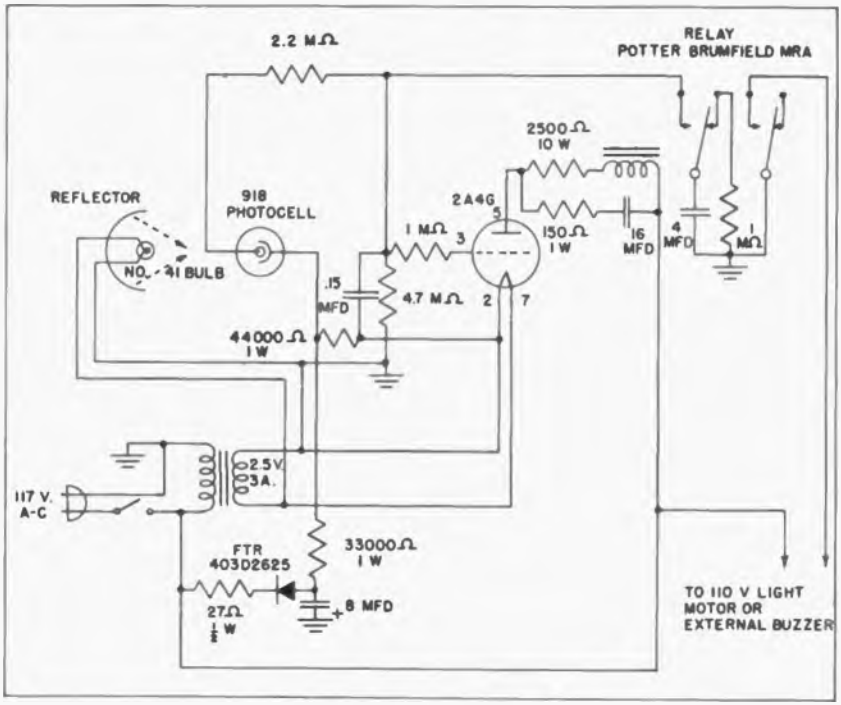
Intercommunications System



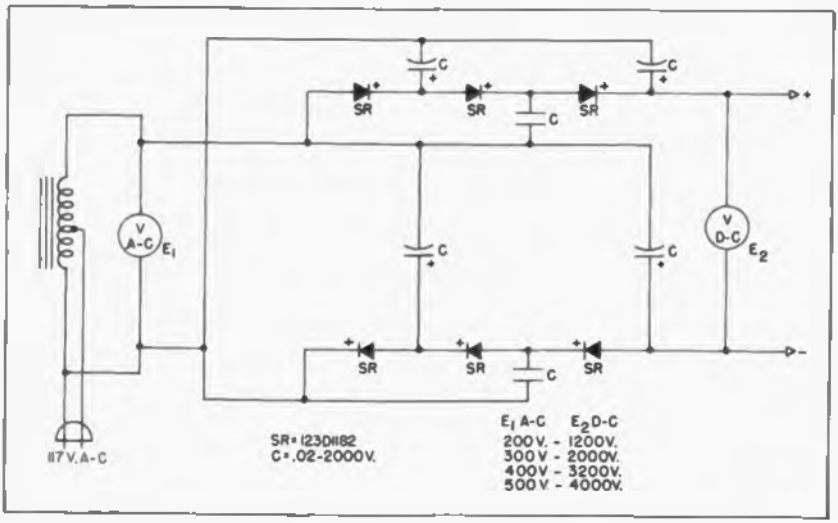
D-C Power Supply for Powering Magnetic Chucks.



D-C Power Supply for Actuating Relays.



Typical Photocell Circuit



4000 Volt D-C Power Supply using Federal's High Voltage Selenium Rectifiers.

Federal Manufactures A Complete Line of "Packaged" Standard Selenium Rectifiers

You can now obtain standard selenium rectifiers in "packaged" form at your nearest distributor or dealer. The packaged list shown below is but a fraction of Federal designs available for meeting any a-c to d-c power conversion need.

NOTE: Ratings for 35° C. Ambient; Resistive or Inductive Loads; All Designs Shown are for Single Phase Full Wave Rectification.

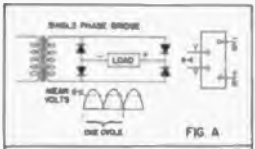


FIG. A

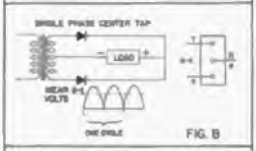


FIG. B

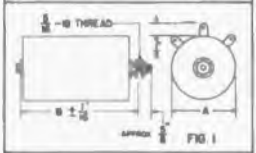


FIG. 1

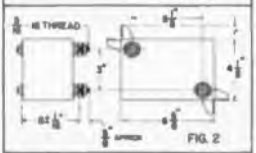


FIG. 2

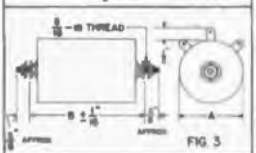


FIG. 3

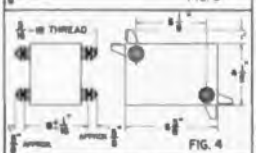


FIG. 4

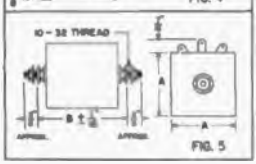


FIG. 5

D.C. OUTPUT VOLTS	D.C. OUTPUT AMPS	RECTIFIER STACK CODE NUMBER	*APPROX. A.C. INPUT VOLTS NEW	*APPROX. A.C. INPUT VOLTS MAX.	CIRCUIT AND STACK CONN. DIAGRAM	RECTIFIER STACK DIMENSIONS A	RECTIFIER STACK DIMENSIONS B ± 1/16"	RECTIFIER STACK DIMENSIONS FIG.	CATALOG NUMBER
6	2	6C1ABLX1	8	9	'B'	3⅛"	1 9/16"	1	2001
	4	7C1ABLX1	8.2	9		4⅜"	1 9/16"	1	2002
	6	233C1ABLX1	8.5	11		4⅜"	1¾"	1	2003
	8	28C1ALX1	8.2	9		6⅝"x4½"	1½"	2	2004
	12	234C1ALX1	8.5	11		6⅝"x4½"	1 15/16"	2	2005
6	2	681ABLX1	9	18	'A'	3⅛"	2 1/16"	1	2006
	4	781ABLX1	9.4	18		4⅜"	2 1/16"	1	2007
	6	3381ABLX1	10	18		4⅜"	2 1/16"	1	2008
	8	2881ALX1	9.4	18		6⅝"x4½"	2 1/16"	2	2009
	12	3481ALX1	10	16		6⅝"x4½"	2 1/16"	2	2010
12	2	681ABLX1	16	18	'A'	3⅛"	2 1/16"	1	2011
	4	781ABLX1	16.3	18		4⅜"	2 1/16"	1	2012
	6	2381ABLX1	16.8	22		4⅜"	2 1/16"	1	2013
	8	2881ALX1	16.3	18		6⅝"x4½"	2 1/16"	2	2014
	12	2381ALX1	16.8	22		6⅝"x4½"	2 1/16"	2	2015
24	2	682ALX1	32	36	'A'	3⅛"	3 1/16"	3	2016
	4	782ALX1	32.6	36		4⅜"	3 1/16"	3	2017
	6	2382ALX1	33.6	44		4⅜"	5"	3	2018
	8	2882ALX1	32.6	36		6⅝"x4½"	3⅝"	4	2019
	12	2382ALX1	33.6	44		6⅝"x4½"	5"	4	2020
32	2	2068 2ALX1	41	44	'A'	3⅛"	3 1/16"	3	2021
	4	2078 2ALX1	41.5	44		4⅜"	3 1/16"	3	2022
	6	1338 2ALX1	42.5	52		4⅜"	5"	3	2023
	8	2288 2ALX1	41.5	44		6⅝"x4½"	3⅝"	4	2024
	12	1348 2ALX1	42.5	52		6⅝"x4½"	5"	4	2025
36	2	1068 2ALX1	45	52	'A'	3⅛"	3 1/16"	3	2026
	4	1078 2ALX1	45.5	52		4⅜"	3 1/16"	3	2027
	6	1338 2ALX1	46.7	52		4⅜"	5"	3	2028
	8	1288 2ALX1	45.5	52		6⅝"x4½"	3⅝"	4	2029
	12	1348 2ALX1	46.7	52		6⅝"x4½"	5"	4	2030
48	2	2068 3ALX1	61.5	66	'A'	3⅛"	4½"	3	2031
	4	2078 3ALX1	62	66		4⅜"	4½"	3	2032
	6	1338 3ALX1	63.5	78		4⅜"	6¾"	3	2033
	8	2288 3ALX1	62	66		6⅝"x4½"	4 13/16"	4	2034
	12	1348 3ALX1	63.5	78		6⅝"x4½"	7 1/16"	4	2035
120	.5	1048 6SALX1	148	156	'A'	1 13/32" sq.	4⅞"	5	2036
	1.	1058 6ALX1	148	156		2⅝"	7⅝"	3	2037
	2.	1068 6ALX1	149	156		3⅛"	7⅝"	3	2038
	4	1078 6ALX1	151	156		4⅜"	7⅝"	3	2039
	6	1338 7ALX1	157	182		4⅜"	14⅛"	3	2040

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Federal's Modern Manufacturing Plant and Research Laboratories with 300-foot Microwave Tower . Nutley – Clifton, N. J.