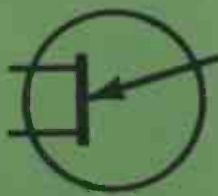




TRANSISTOR AF and RF CIRCUITS

by Allan Lytel



Schematics and descriptions
of over 100 transistorized
circuits for r-f and audio
applications.



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PREFACE

TRANSISTOR AF AND RF CIRCUITS

by

Allan Lytel



HOWARD W. SAMS & CO., INC.
THE BOBBS-MERRILL COMPANY, INC.
Indianapolis • New York

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TRANSISTOR AF AND RF CIRCUITS

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PREFACE

The use of semiconductors in electronic circuits has, and still is, growing at a rapid rate. Experimenters and hobbyists are continuously looking for transistor circuits to construct.

This book is a compilation of many r-f and audio circuits using transistors. In each of the five sections of the book, you will find schematics, parts lists, and discussions of operation of many of the circuits. In addition, an introductory section provides general information on the construction of the circuits and includes a table of parts manufacturers.

Acknowledgment must be given to the following manufacturers who supplied much of the data from which this book was prepared: Amperex Electronic Corp.; CBS Electronic Division, CBS, Inc.; Delco Radio Div.; Fairchild Semiconductor Corp.; General Electric Co.; General Motors Corp.; Motorola Semiconductor Products; Nucleonic Products Co., Inc.; Pacific Semiconductor, Inc.; Radio Corporation of America; and Texas Instruments, Inc.

ALLAN LYTEL

January, 1965

PREFACE

The use of transistors in electronic circuits has now become a fact of life. It is a fact that has revolutionized the electronics industry and has opened up new horizons for the designer. This book is a practical guide to the use of transistors in electronic circuits. It is written for the student, the hobbyist, and the professional designer. It covers the basic theory of transistors and their use in a wide variety of electronic circuits. The book is divided into two parts. The first part covers the basic theory of transistors and their use in a wide variety of electronic circuits. The second part covers the design of electronic circuits using transistors. The book is written in a clear and concise style and is easy to read. It is a valuable reference for anyone interested in electronics.

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40-Watt Marine Transmitter—A-M Tuner—150-MC F-M Transmitter—F-M Wireless Transmitter—27-MC Citizens Band Transmitter—F-M Tuner—1-Watt 27-MC Transmitter—Ultralow-Powered Transmitters—76-MC 2-Watt Transmitter—240-MC 0.5-Watt Transmitter—5-Watt Citizens Band Transmitter—20-Watt Marine Transmitter—1-Watt Citizens Band Transmitter—Citizens Band Transceiver—76-MC 10-Watt Transmitter—27-MC Transmitter—Superregenerative 130-MC Receiver—27-MC Remote-Control Transmitter—Superregenerative 27-MC Receiver

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INTRODUCTION

This book is designed primarily for the electronics experimenter; it covers radio receivers and audio amplifiers. In general, the power supplies are not included, since various types can be used and these are covered in another book.

All of the circuits discussed have been built and tested; some use noncommercial or nonstandard parts. Where this is the case, the part has been described as completely as possible so that it can be made or obtained by the builder. Because the field of transistors is growing rapidly and because new devices as well as new and different designations for old devices are appearing constantly, it is possible for you to substitute parts and still have a working unit.

Usually, the resistors, capacitors, and inductors that are used as a part of the circuit should be as close as possible to the given values. For example, wattage ratings given for resistors, are for conditions of normal ventilation. There are some deviations, of course, that can be made, such as using larger or smaller capacitors than specified in a filter circuit. But, if an electrolytic capacitor has a higher voltage than specified, it may not properly "form" at the circuit working voltage. In most cases it is good practice to at least build the circuit as it was originally built and tested before an experimentation or parts substitution is made.

These circuits have been contributed to the book by semiconductor manufacturers, and in some cases the semiconductors carry a "house number," which is an unregistered number used for a developmental transistor. In every case these transistors are available, either under the number as given in the book, or perhaps under a registered number where the manufacturer has gone into large-scale commercial production.

Lead dress and care in construction is critical, particularly in the high frequency, or front, end of these receivers. The construction of many of these circuits requires a considerable amount of experience on the part of the experimenter. This is necessarily true for both receivers and transmitters, but it is not quite as necessary for audio amplifiers, since the lead dress and placing of parts is not usually as critical as it is in radio-frequency circuits.

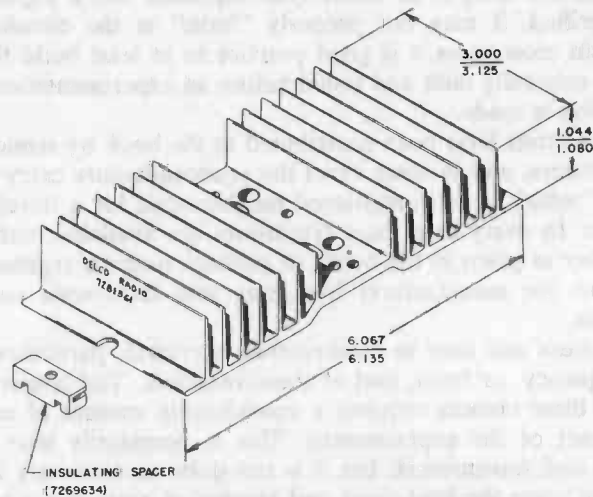
Because circuit layouts will in most cases vary with the requirements, no specific mechanical details are normally given for the parts layouts. Where these details are given, it is because they are particularly important to the circuit being discussed. Circuit performance depends on the quality of the components selected as well as the care used in the layout and construction of the circuit. To obtain the best signal reproduction from receivers and amplifiers, quality speakers, transformers, chokes, and transducers (microphones and phonograph pickups) must be used.

Parts for the receiver circuits may be obtained by specifying the required characteristics of the desired components. When ordering r-f coils, the circuit location (antenna or interstage), tuning range, and tuning capacitance should be given. For i-f coils or transformers, the intermediate frequency, circuit location (first if, second if, etc.), and possibly the transistor used with the coil should be specified. For oscillator coils, the receiver tuning range, intermediate frequency, type of converter transistor, and type of winding (tapped or transformer-coupled) should be known and included in the data given to the supplier.

Table 1 gives a list of the manufacturers who make the indicated components.

POWER TRANSISTORS

Power transistors require special considerations; they are very rugged devices and can undergo considerable rough treatment, al-



Courtesy Delco Radio Div., General Motors Corp.

Fig. A. Delco 7281361 heat sink.

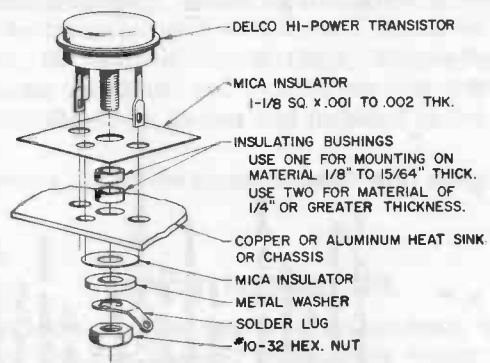
Table 1. Component Manufacturers

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Tuner assemblies	x						x							x				
Transformer cores		x			x	x		x		x						x		
Transformers—i-f, r-f, and r-f chokes			x			x					x			x		x		
Transformers—audio and power				x					x	x								x
1. Automatic Electric Sales Corp. 400 N. Wolf Road Northlake, Ill.																		
2. Arnold Magnetics Corp. 6050 West Jefferson Blvd. Los Angeles, Calif.																		
3. Better Coil and Transformer Corp. Goodland, Ind.																		
4. Columbus Process Co., Inc. Columbus, Ind.																		
5. Indiana General Corp. Crows Mill Road Keasby, N. J.																		
6. General Instrument Co. Automatic Manufacturing Division 65 Gouverneur Street Newark, N. J.																		
7. P. R. Mallory and Co., Inc. 3029 East Washington St. Indianapolis, Ind.																		
8. Magnetic Metals Co. Hayes Avenue at 21st Street Camden, N. J.																		
9. Microtran Co., Inc. 145 East Mineola Avenue Valley Stream, N. Y.																		
10. Mid-West Coil and Transformer Co. 1642 N. Halstead Chicago, Ill.																		
11. J. W. Miller Co. 5917 South Main Street Los Angeles, Calif.																		
12. Stancor Electronics, Inc. 3501 West Addison Street Chicago, Ill.																		
13. Triad Transformer Corp. 4055 Redwood Avenue Venice, Calif.																		
14. TRW Electronic Components, Div. Thompson-Ramo-Woodridge, Inc. Davis and Copewood Streets Camden, N. J. 08103																		
15. Thordarson Weissner, Inc. 7th and Bellmont Mt. Carmel, Ill.																		
16. United Transformer Corp. 150 Varick Street New York, N. Y.																		
17. Workman TV Products, Inc. Box 5397 Sarasota, Florida																		
18. Merit Coil & Transformer Corp. 2040 Sherman Street Hollywood, Florida																		

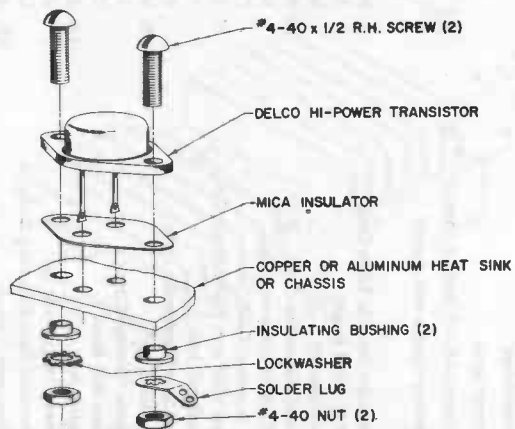
though unnecessary mechanical shock is to be avoided. It is important to avoid extreme shock or excessive bending or twisting of the power-transistor leads when they are being used. When operated within their normal ratings, power transistors provide a long and useful life. But, even small excessive voltage or excessive power demands may possibly destroy the transistor instantaneously.

When you are building or experimenting with new circuits, it is important to take certain precautions. Before applying power to a circuit, the polarity of the power-supply voltage should be checked and then rechecked. A voltage of incorrect polarity applied to a circuit can damage the transistors as well as any electrolytic capacitors

DELCO TRANSISTOR MOUNTING KIT NO. 7274633



DELCO TRANSISTOR MOUNTING KIT NO. 7274775



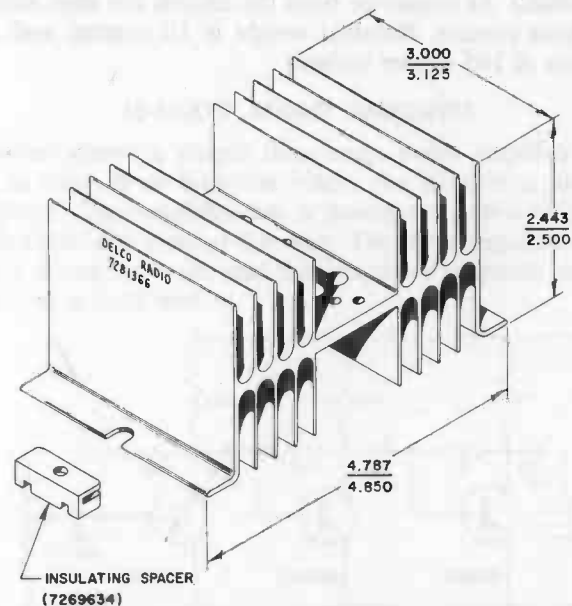
Courtesy Delco Radio Div., General Motors Corp.

Fig. B. Mounting transistors on heat sink.

that are used in the circuit. After a new circuit is built and is being tested, the voltage should be applied in easy stages, beginning with a value below normal. Check the basic wiring to see if the circuit operation is correct. It is important to be very careful of high-voltage surges at all times. If the 12-volt electronic power supply that you are using is unregulated, it is possible to load this power supply with a storage battery in order to stabilize the voltage. If the circuit appears to be operating properly, the collector current in the power transistor stages should be measured, and the bias adjusted if necessary.

Temperature extremes can be damaging to a transistor. Power transistors should usually be mounted on a heat sink or radiator. Where the collector is above ground potential, the sink should be insulated from the chassis; if possible, bolt the transistor to the chassis with insulated bolts and use a washer between the transistor and chassis.

Excessive heat is an enemy of power transistors. Since heat increases the collector cutoff current thus reducing the power output, further heat is then developed; it is possible that thermal runaway may result. A circuit can be stabilized by using a thermistor or temperature-sensitive resistor in the base circuit so that an increase in



Courtesy Delco Radio Div., General Motors Corp.

Fig. C. Delco 7281366 heat sink.

temperature decreases the base-to-emitter voltage and stabilizes the collector cutoff current.

Transistor heat sinks are necessary in many power-transistor applications. Fig. A shows the Delco 7281361 heat sink made of extruded aluminum. This has a nominal weight of 8 ounces and a surface area of about 110 square inches. The mounting of two different types of transistors in this heat sink is shown in Fig. B. The use of these mounting kits allows the insulated mounting of transistors to this heat sink.

The effectiveness of a particular heat sink depends on the contact interface between the transistor and the heat-sink surface. It is necessary that the most intimate contact be made for heat transfer, and the effectiveness of this contact depends on the meeting of the surfaces and the pressure holding them together. The use of a grease or oil is useful in minimizing the effect of any surface irregularity where the two surfaces meet. A suggested type is silicone oil, type 200 (Dow Corning Corp., Midland, Michigan).

A different type of heat sink (Delco type 7281366) is shown in Fig. C. This type of heat sink has an insulated spacer which is used to insulate the entire heat sink from the chassis. The transistor can be mounted directly to the heat sink rather than using a mica insulator which insulates the transistor from the chassis but does not act as an effective heat contact. Nominal weight is 10 ounces, and there is a surface area of 165 square inches.

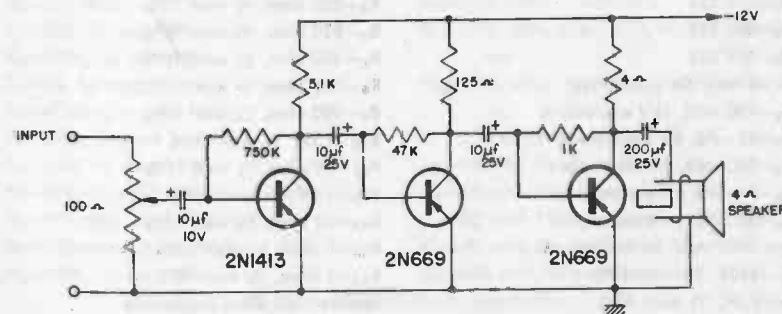


Section 1

AUDIO-FREQUENCY AMPLIFIERS

1/2-WATT AUDIO AMPLIFIER

This circuit shows a simple three-stage audio amplifier of a type that can be used in an intercom where the speaker is also used as a microphone. The amplifier has a maximum power output of 0.5 watt, with a 5% distortion at 0.4 watt. The drive requirement for this circuit is 5 mv at 0.4 watt, and the frequency response is from 140 cycles to 2 kc at 0.25 watt.



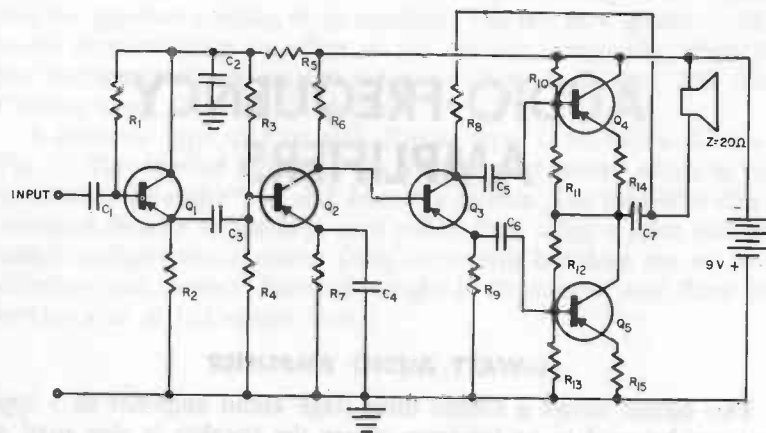
Courtesy Delco Radio Div., General Motors Corp.

1/2-watt amplifier.

1/2-WATT AUDIO-FREQUENCY AMPLIFIER

The amplifier uses five transistors and a 9-volt source to produce 0.5 watt of audio power. No transformers are used; the frequency response is essentially flat from 95 cycles to 16 kc, and the power gain at 1 kc is 86 db.

There is a 45-ma standby current with zero signal, and for maximum power output an input signal of 1.6 mv is required with a distortion of 10% at 1 kc; the input current needed from the battery to provide maximum power output is 90 ma. There is 2% distortion at 1 kc with an output of 50 mw; the circuit input impedance is 24K.



- | | |
|---|---------------------------------------|
| Q ₁ —SFT 337 | R ₃ —5.6K, 1/2 watt 10% |
| Q ₂ —SFT 353 | R ₄ —1K, 1/2 watt 10% |
| Q ₃ —SFT 325 | R ₅ —820 ohm, 1/2 watt 10% |
| Q ₄ —SFT 325 | R ₆ —820 ohm, 1/2 watt 10% |
| Q ₅ —SFT 325 | R ₇ —100 ohm, 1/2 watt 10% |
| C ₁ —5 mfd, 6V electrolytic | R ₈ —100 ohm, 1/2 watt 10% |
| C ₂ —100 mfd, 12V electrolytic | R ₉ —100 ohm, 1/2 watt 10% |
| C ₃ —25 mfd, 6V electrolytic | R ₁₀ —1.5K, 1/2 watt 10% |
| C ₄ —500 mfd, 3V electrolytic | R ₁₁ —82 ohm, 1/2 watt 10% |
| C ₅ —50 mfd, 6V electrolytic | R ₁₂ —1.5K, 1/2 watt 10% |
| C ₆ —50 mfd, 6V electrolytic | R ₁₃ —82 ohm, 1/2 watt 10% |
| C ₇ —1000 mfd, 6V electrolytic | R ₁₄ —1 ohm, 1/2 watt 10% |
| R ₁ —560K, 1/2 watt 10% | R ₁₅ —1 ohm, 1/2 watt 10% |
| R ₂ —2.2K, 1/2 watt 10% | Speaker—20 ohms impedance |

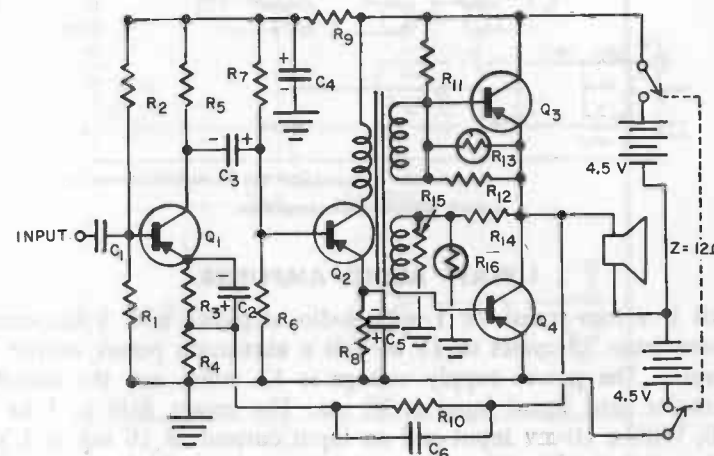
Courtesy Nucleonic Products Co.

1/2 watt audio-frequency amplifier.

3/4-WATT AUDIO AMPLIFIER

This four-transistor amplifier provides a 0.75-watt output and uses a 9-volt source which is split into two 4.5-volt sources as shown. The frequency response is from 100 cycles to 8 kc, with a maximum power gain of 77 db at 1 kc.

The standby current with no signal input is 17 ma, and the input current to provide maximum power output at 1 kc is 120 ma; there is a 10% distortion at this maximum power output. The input impedance to this amplifier is 5K.



- | | |
|---------------------------------------|---|
| Q ₁ —SFT 353 | R ₁₁ —1.5K, 1/2 watt 10% |
| Q ₂ —SFT 353 | R ₁₂ —120 ohm, 1/2 watt 5% |
| Q ₃ —SFT 325 | R ₁₄ —1.5K, 1/2 watt 10% |
| Q ₄ —SFT 325 | R ₁₅ —120 ohm, 1/2 watt 5% |
| R ₁ —22K, 1/2 watt 10% | R ₁₃ —130 ohm, Type A/T, —20% thermistor |
| R ₂ —120K, 1/2 watt 10% | R ₁₆ —130 ohm, Type A/T, —20% thermistor |
| R ₃ —1K, 1/2 watt 10% | C ₁ —2 mfd, 6V electrolytic |
| R ₄ —47 ohm, 1/2 watt 10% | C ₂ —25 mfd, 6V electrolytic |
| R ₅ —6.8K, 1/2 watt 10% | C ₃ —10 mfd, 6V electrolytic |
| R ₆ —6.8K, 1/2 watt 10% | C ₄ —50 mfd, 12V electrolytic |
| R ₇ —10K, 1/2 watt 10% | C ₅ —50 mfd, 6V electrolytic |
| R ₈ —470 ohm, 1/2 watt 10% | C ₆ —500 mfd, ceramic capacitor |
| R ₉ —150 ohm, 1/2 watt 10% | |
| R ₁₀ —39K, 1/2 watt 10% | |

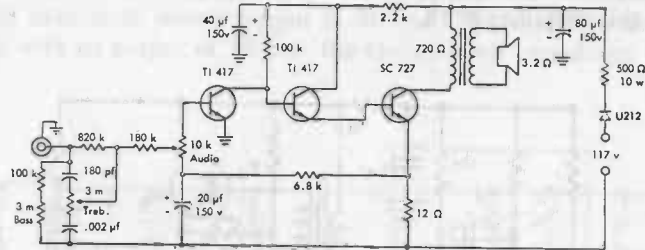
T1—Type MH2089 driver transformer

Courtesy Nucleonic Products Co.

3/4-watt audio amplifier.

1-WATT PHONOGRAPH AMPLIFIER

This circuit shows a complete 1-watt phonograph amplifier using two type TI417 transistors, and one type SC727 power transistor. A single diode is used to provide half-wave rectification, and the rectified voltage is applied to all three transistors. A bass and treble control, as well as a volume control, are used in the circuit. The output transformer should have a 720-ohm primary to match the voice-coil impedance of the speaker.



Courtesy Texas Instruments Inc.

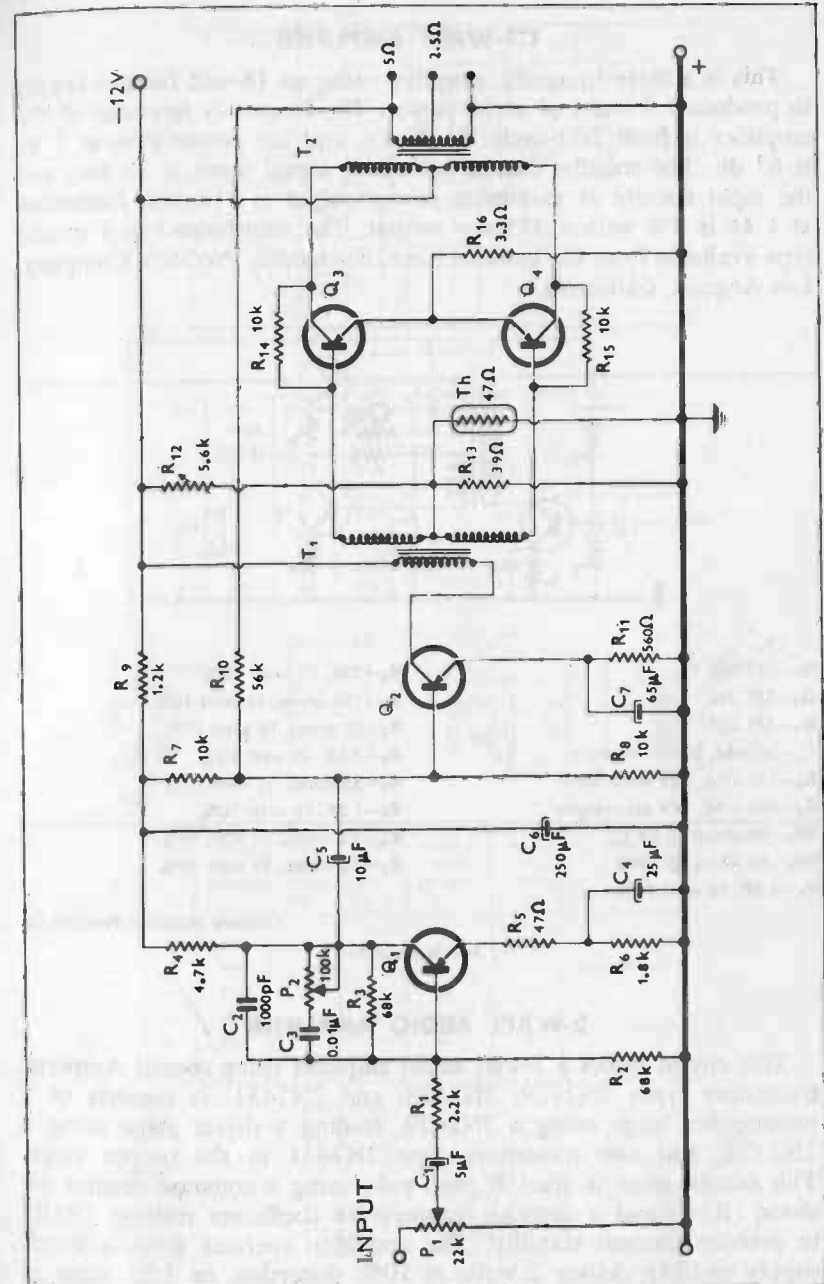
1-watt phonograph amplifier.

1-WATT AUDIO AMPLIFIER

This is a four-transistor 1-watt audio amplifier with a frequency response from 75 cycles to 15 kc and a maximum power output of 1.4 watts. The power supply voltage is 12 volts, and the standby current for zero signal input is 20 ma. The power gain at 1 kc is 78 db. With a 10-mv input and an input current of 16 ma at 1 kc, the distortion is 4% with maximum power output. There is 2% distortion at 1 kc with a power output of 250 mw. The transformers are available from Nucleonics Products Co., Los Angeles, California.

Q ₁ —SFT 337	R ₂ —68K, ½ watt 10%
Q ₂ —SFT 353	R ₃ —68K, ½ watt 10%
Q ₃ —SFT 325	R ₄ —4.7K, ½ watt 10%
Q ₄ —SFT 325	R ₅ —47 ohms, ½ watt 10%
C ₁ —5 mfd, 9V electrolytic	R ₆ —1.8K, ½ watt 10%
C ₂ —1000 pf, 12V ceramic	R ₇ —10K, ½ watt 10%
C ₃ —10,000 pf, 12V ceramic	R ₈ —10K, ½ watt 10%
C ₄ —25 mfd, 6V electrolytic	R ₉ —1.2K, ½ watt 10%
C ₅ —10 mfd, 9V electrolytic	R ₁₀ —56K, ½ watt 10%
C ₆ —250 mfd, 12V electrolytic	R ₁₁ —560 ohms, ½ watt 10%
C ₇ —65 mfd, 6V electrolytic	R ₁₂ *—5.6K, ½ watt 10%
P ₁ —22K, ¼ watt linear	R ₁₃ —39 ohms, ½ watt 10%
P ₂ —100K, ¼ watt logarithmic	R ₁₄ —10K, ½ watt 10%
TH ₁ —47 ohms @ 25°C α = -3.6%/°C	R ₁₅ —10K, ½ watt 10%
R ₁ —2.2K, ½ watt 10%	R ₁₆ —3.3 ohms, ½ watt 10%

*R₁₂ is adjusted to obtain the indicated value for open base voltage.

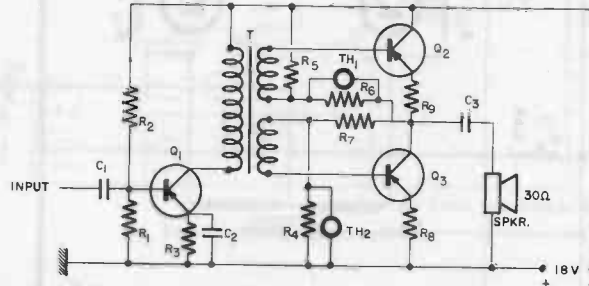


Courtesy Nucleonic Products Co.

1-watt audio amplifier.

1.3-WATT AMPLIFIER

This is a three-transistor amplifier using an 18-volt battery supply to produce 1.3 watts of audio power. The frequency response of the amplifier is from 200 cycles to 20 kc, and the power gain at 1 kc is 67 db. The standby current with zero signal input is 15 ma, and the input current at maximum power output is 110 ma. Distortion at 1 kc is 3% with a 375-mw output. The transformer is a special type available from the manufacturer, Nucleonics Products Company, Los Angeles, California.



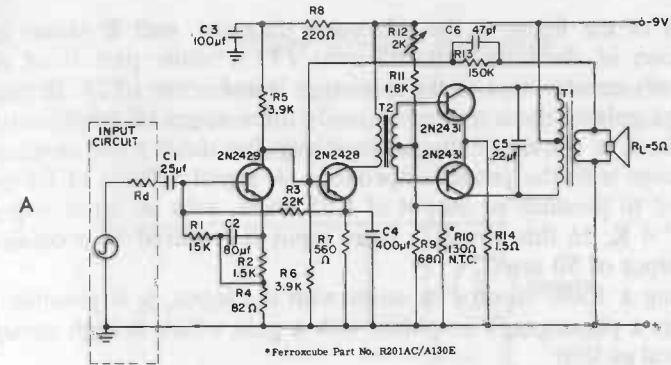
- Q₁—SFT 353
- Q₂—SFT 325
- Q₃—SFT 325
- C₁—50 mfd, 50V electrolytic
- C₂—100 mfd, 50V electrolytic
- C₃—300 mfd, 12V electrolytic
- TH₁—50 ohms @ 25°C
- TH₂—50 ohms @ 25°C
- R₁—1.5K, 1/2 watt 10%
- R₂—22K, 1/2 watt 10%
- R₃—180 ohms, 1/2 watt 10%
- R₄—33 ohms, 1/2 watt 10%
- R₅—1.2K, 1/2 watt 10%
- R₆—33 ohms, 1/2 watt 10%
- R₇—1.2K, 1/2 watt 10%
- R₈—2.2 ohms, 1/2 watt 10%
- R₉—2.2 ohms, 1/2 watt 10%

Courtesy Nucleonic Products Co.

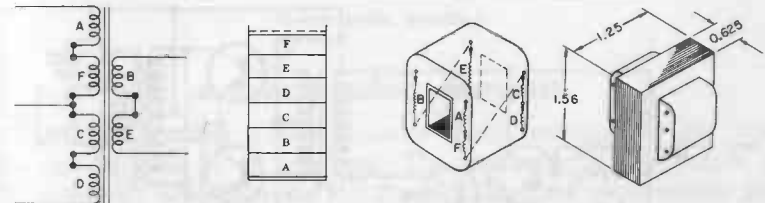
1.3-watt amplifier.

2-WATT AUDIO AMPLIFIER

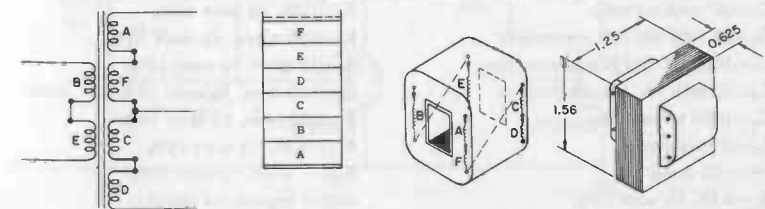
This circuit shows a 2-watt audio amplifier using special Amperex transistors types 2N2429, 2N2428, and 2N2431. It consists of a preamplifier stage using a 2N2429, feeding a driver stage using a 2N2428, and two transistors type 2N2431 in the output stage. This output stage is class B push-pull, using a common emitter resistor (R14) and a negative temperature coefficient resistor (R10) to provide thermal stability. The amplifier operates from a 9-volt supply and can deliver 2 watts at 10% distortion, or 1.55 watts at 4% distortion. Frequency response for this amplifier is flat within 3 db from 60 cycles to 19 kc.



Coil	Turns of Copper Enamel	Gauge of Wire SWG	Width of coil (in.)	Number of turns per layer	Number of layers	Resistance (ohms)
A	82	28	0.75	41	2	A+F = C+D = 1.9 ohms
B	52	24	0.75	26	2	
C	82	28	0.75	41	2	B+E = 0.5 ohms
D	82	28	0.75	41	2	
E	52	24	0.75	26	2	
F	82	28	0.75	41	2	



Coil	Turns of Copper Enamel	Gauge of Wire SWG	Width of coil (in.)	Number of turns per layer	Number of layers	Resistance ohms
A	284	14	0.75	71	6	A+F = C+D = 25 ohms
B	656	16	0.75	82	8	
C	284	14	0.75	71	4	B+E = 82 ohms
D	284	14	0.75	71	4	
E	656	16	0.75	82	8	
F	284	14	0.75	71	4	



Courtesy Amperex Electronic Corp.

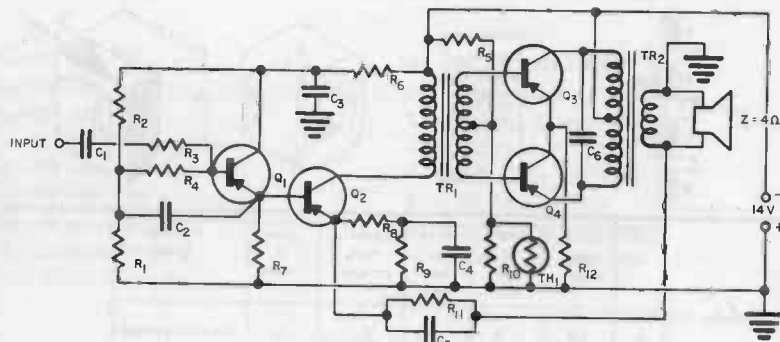
2-watt audio amplifier.

Part A of the figure is the schematic diagram, part B shows the construction of the output transformer (T1), while part C of the figure shows construction of the interstage transformer (T2). Because of the high gain of these transistors, only three stages of amplification are required to provide enough sensitivity for driving the amplifier from a tuner with the proper impedance. A signal voltage of 6.6 mv is required to produce an output of 1.55 watts, with an input impedance of 7.6 K. In this circuit 1.2-mv input is required to produce a power output of 50 mw.

By using a 330K resistor in series with the input, it is possible to use this as a phonograph amplifier with a gain which is high enough for a crystal pickup.

1.7-WATT AMPLIFIER

This is a four-transistor 1.7-watt amplifier with a frequency response from 100 cps to 10 kc and a maximum power output of 1.7 watts with 10% distortion. The power supply voltage is 14 volts, and the power gain of 79 db is obtained at 1 kc. Input impedance is 24K.



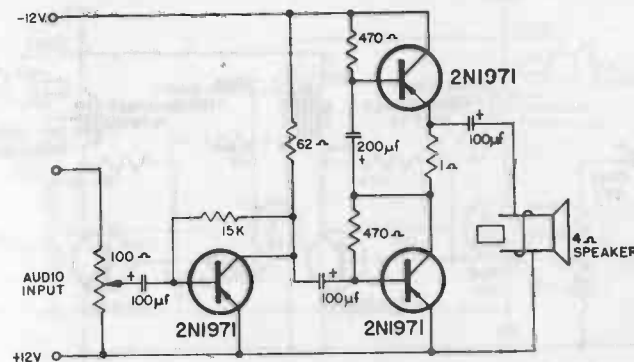
- | | |
|---|--|
| Q ₁ —SFT 337 | R ₂ —4.7K, 1/2 watt 10% |
| Q ₂ —SFT 353 | R ₃ —100K, 1/2 watt 10% |
| Q ₃ —SFT 325 | R ₄ —4.7K, 1/2 watt 10% |
| Q ₄ —SFT 325 | R ₅ —1.8K, 1/2 watt 10% |
| C ₁ —.47 mfd ceramic | R ₆ —1.5K, 1/2 watt 10% |
| C ₂ —25 mfd 10/12V electrolytic | R ₇ —560 ohms, 1/2 watt 10% |
| C ₃ —100 mfd 10/12V electrolytic | R ₈ —10 ohm, 1/2 watt 10% |
| C ₄ —50 mfd 10/12V electrolytic | R ₉ —680 ohm, 1/2 watt 10% |
| C ₅ —1000 pf ceramic | R ₁₀ —33 ohm, 1/2 watt 10% |
| C ₆ —.1 mfd paper | R ₁₁ —3.9K, 1/2 watt 10% |
| TH ₁ —50 ohms | R ₁₂ —1 ohm, 1/2 watt 10% |
| R ₁ —4.7K, 1/2 watt 10% | 4-ohm impedance speaker |

Courtesy Nucleonic Products Co.

7-watt amplifier.

2-WATT AUDIO AMPLIFIER

This circuit shows three transistors used in a 2-watt audio amplifier that has 1% distortion at 1 watt. The drive requirements are 6 mv at 2.0 watts. The frequency response is from 90 cps to 6 kc at 1.0 watt.

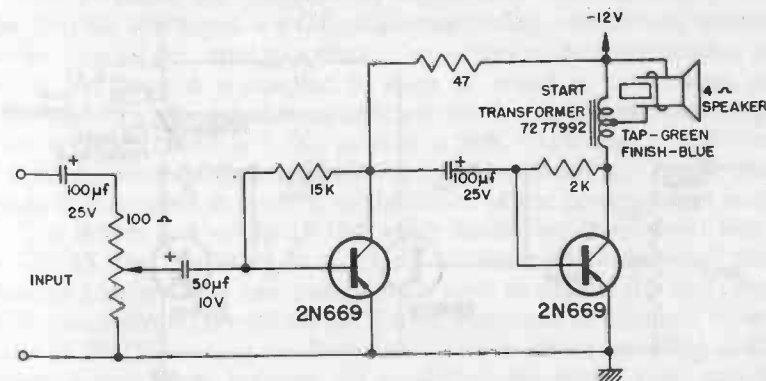


Courtesy Delco Radio Div., General Motors Corp.

2-watt audio amplifier.

2.5-WATT AUDIO AMPLIFIER

This circuit shows a two-transistor audio amplifier of the type that can be used as an intercom. The maximum power output is 2.5 watts with 4% distortion at 1.0 watt. The drive requirements are 3 mv at 1.0 watt, and the frequency response is from 120 cycles to 4 kc at 1.0 watt.

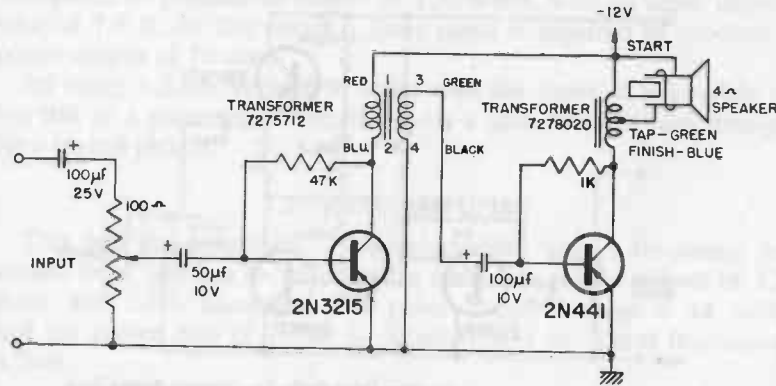


Courtesy Delco Radio Div., General Motors Corp.

2.5-watt audio amplifier.

2.5-WATT AUDIO AMPLIFIER

This circuit shows a transformer-coupled two-transistor audio amplifier with 2.5 watts of audio output and 6% distortion at 1.0 watt. The drive requirements are 8 mv at 1.0 watt, and the frequency response is from 40 cps to 14 kc at 1.0 watt.

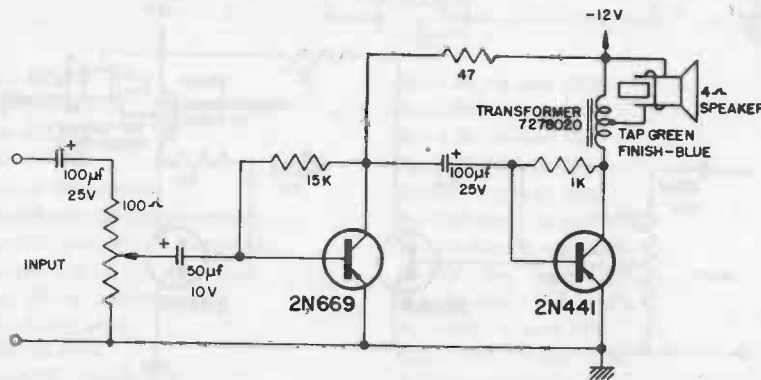


Courtesy Delco Radio Div., General Motors Corp.

2.5-watt audio amplifier.

2.5-WATT AUDIO AMPLIFIER

This circuit shows a two-transistor resistance-coupled audio amplifier with 2.5 watts of audio output and 6% distortion at 1.0 watt. The drive requirements are 6 mv at 1.0 watt. The frequency response is from 100 cycles to 3.5 kc at 1.0 watt.

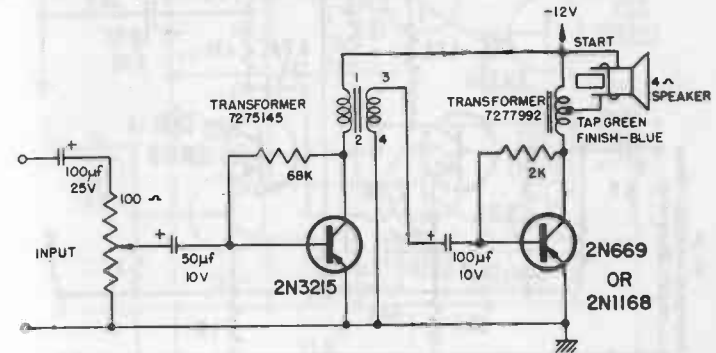


Courtesy Delco Radio Div., General Motors Corp.

2.5-watt audio amplifier.

2.5-WATT AUDIO AMPLIFIER

This circuit shows a two-transistor transformer-coupled audio amplifier that is suitable for intercom. The output is 2.5 watts, and there is a 5% harmonic distortion at 0.5 watt. The drive requirements are 5 mv at 0.5 watt; the frequency response is from 60 cycles to 5 kc.



Courtesy Delco Radio Div., General Motors Corp.

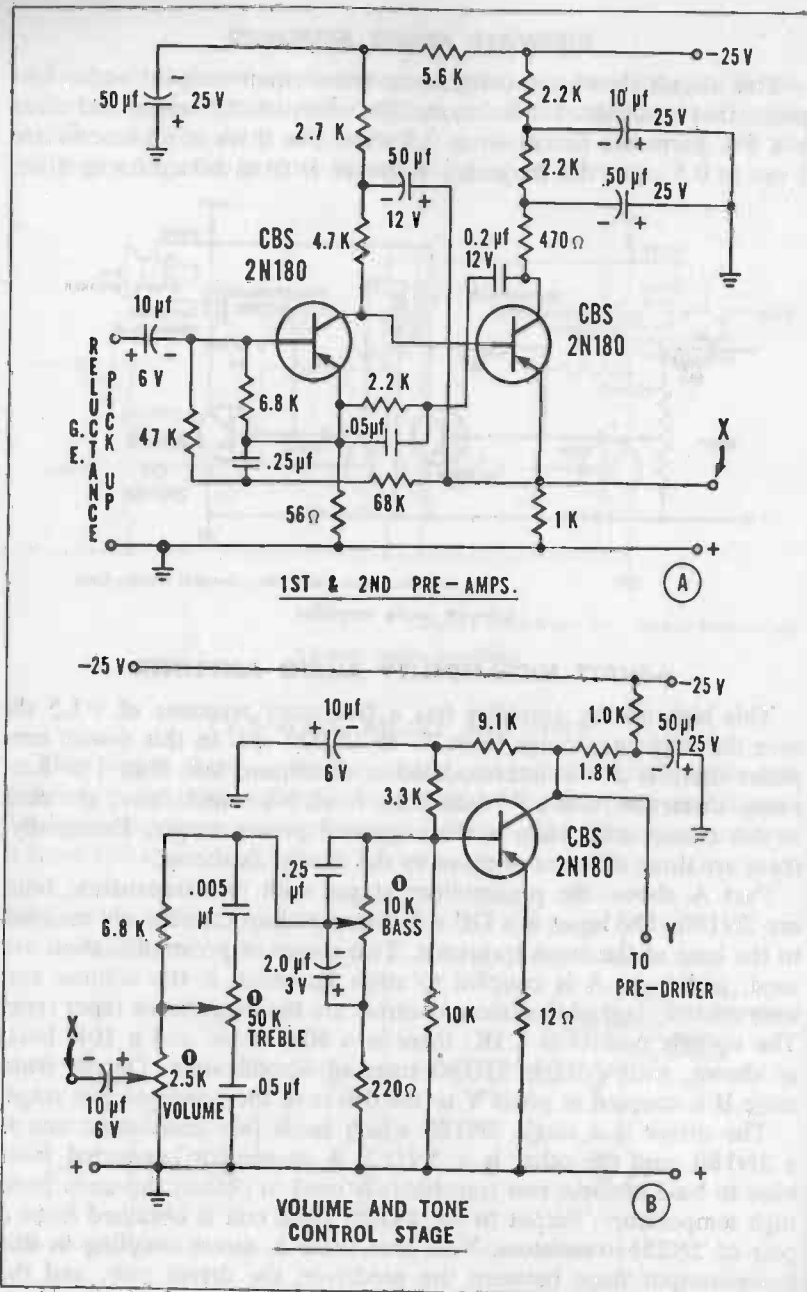
2.5-watt audio amplifier.

6-WATT HIGH-FIDELITY AUDIO AMPLIFIER

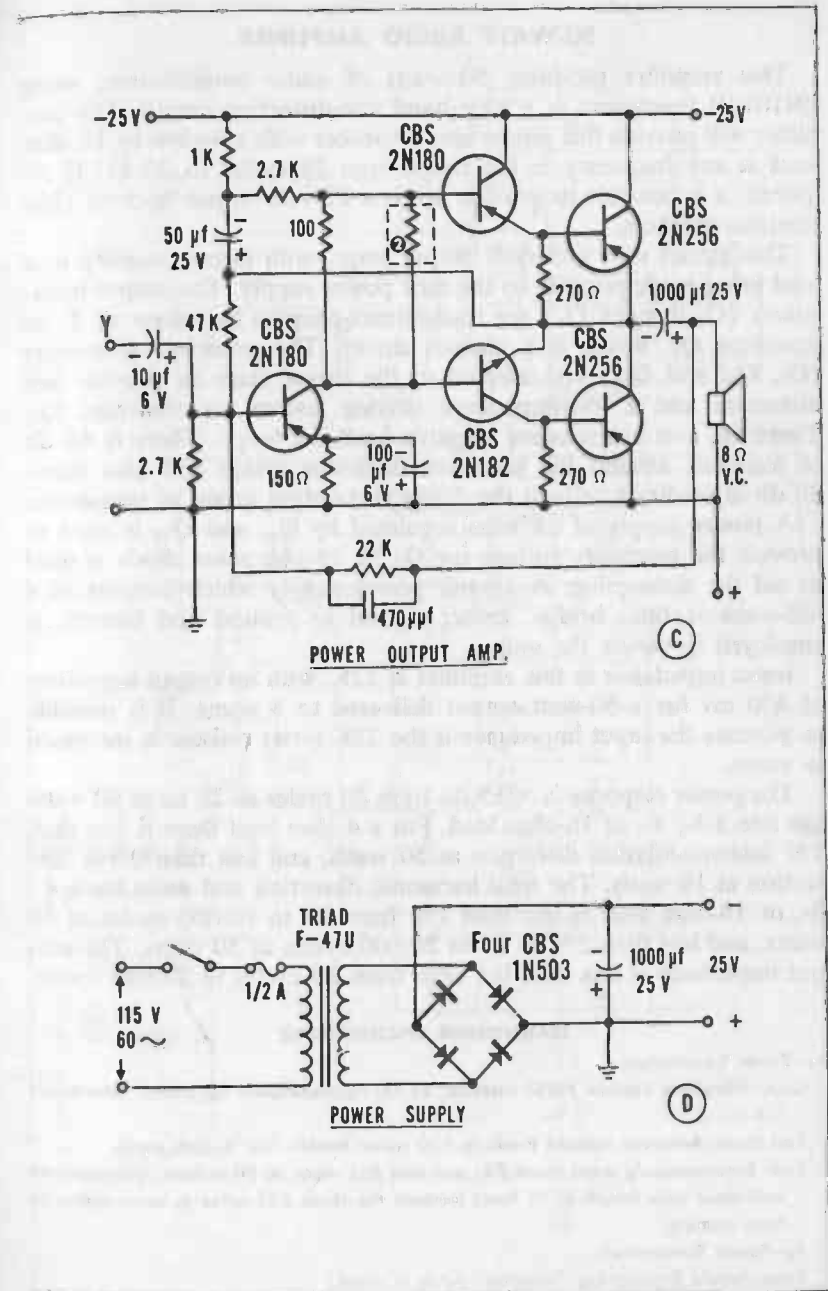
This high-fidelity amplifier has a frequency response of ± 1.5 db over the frequency range from 30 to 15,000 cps. In this 6-watt amplifier there is 2.5% intermodulation distortion, less than 1% harmonic distortion, and a -74-db noise level. No transformers are used in this circuit other than in the suggested power supply. Essentially, there are three different portions to the circuit, as shown.

Part A shows the preamplifier stages with two transistors; both are 2N180. The input is a GE reluctance pickup capacitively coupled to the base of the input transistor. Two stages of preamplification are used, and stage A is coupled to stage B, which is the volume and tone control stage. All of these controls are the logarithmic taper type. The volume control is 2.5K; there is a 50K treble and a 10K bass, as shown, with a single 2N180 stage of amplification. Output from stage B is coupled at point Y to the driver of the power-output stage.

The driver is a single 2N180 which feeds two transistors; one is a 2N180, and the other is a 2N182. A thermistor connected from base to base of these two transistors is used to protect the units from high temperature; output to the 8-ohm voice coil is obtained from a pair of 2N256 transistors. Note that there is direct coupling in this power-output stage between the predriver, the driver pair, and the power output stages. A suggested power supply is shown to provide the required 25 volts dc.



6-watt high-fidelity



audio amplifier.

Courtesy CBS Electronic Div., CBS Inc.

50-WATT AUDIO AMPLIFIER

This amplifier produces 50 watts of audio amplification, using 2N1073B transistors in a wide-band low-distortion circuit. The amplifier will provide this power into a speaker with a 4-ohm to 16-ohm load at any frequency in the range from 20 cycles to 20 kc. If required, it is possible to provide up to a 25-volt output to drive electrostatic speakers.

This circuit uses a class-B output stage, with direct coupling to a load being made possible by the dual power supply. The output transistors (Q_1 through Q_6) are transformer-coupled by means of T_1 to transistor Q_7 , which is a class-A driver. The predriver transistors (Q_8 , Q_9 , and Q_{10}) are coupled to the driver stage to provide low distortion and a low-impedance driving source for transistor Q_7 . There are two independent negative feedback loops. There is 66 db of feedback around the predriver transistor group and also about 20 db of feedback around the driver and output group of transistors.

A power supply of 24 volts regulated by Q_{11} and Q_{12} is used to provide the necessary voltage for Q_7 . A 16-volt zener diode is used to aid the decoupling. A 46-volt power supply which consists of a full-wave rectifier bridge, center tapped to ground and filtered, is employed to power the unit.

Input impedance to this amplifier is 22K, with an output sensitivity of 400 mv for a 50-watt output delivered to 8 ohms. It is possible to increase the input impedance if the 22K series resistor is increased in value.

The power response is ± 0.5 db from 20 cycles to 20 kc at 50 watts out into a 4-, 8-, or 16-ohm load. For a 4-ohm load there is less than 1% intermodulation distortion at 50 watts, and less than 0.5% distortion at 10 watts. The total harmonic distortion and noise for a 4-, 8-, or 16-ohm load is less than 1% from 20 to 10,000 cycles at 50 watts, and less than 2% at 20 to 20,000 cycles at 50 watts. The output impedance is less than 0.5 ohm from 20 cycles to 20,000 cycles.

TRANSFORMER SPECIFICATIONS

T_1 —Driver Transformer:

Core: Allegheny Ludlum #4750 material, EI 75. Approximately $\frac{3}{4}$ pound, interleaved 1 X 1.

Coil Form: American Molded Products E-33 nylon bobbin (for $\frac{3}{4}$ -inch stack).

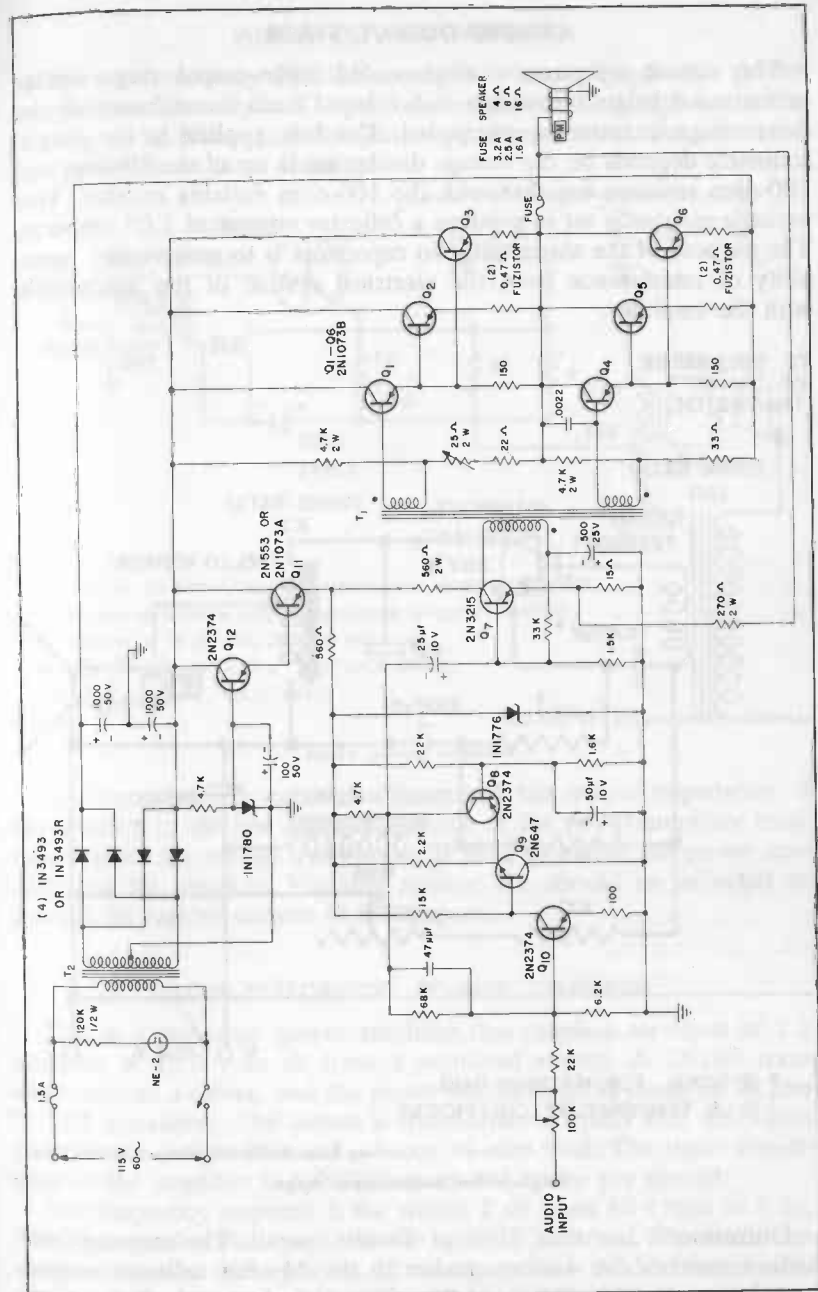
Coil: Simultaneously wind three #30 and two #26 wires to fill bobbin. (Approximate individual wire length is 50 feet.) Connect the three #30 wires in series-aiding to form primary.

T_2 —Power Transformer:

Core: Arnold Engineering "Silectron" AA-6. (C-cores.)

Coil Form: .040-inch-thick kraft paper. 1" X 1 $\frac{1}{4}$ " X 1 $\frac{17}{32}$ " long.

Coil: Primary—378 turns #22. Secondary—2 each 113 turns #21 (bifilar).

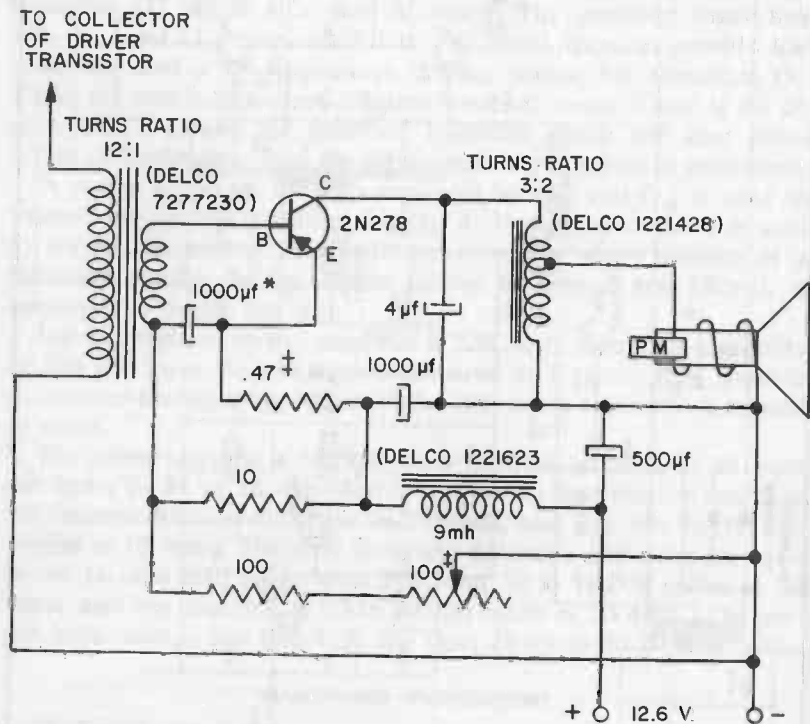


Courtesy Delco Radio Div., General Motors Corp.

50-watt audio amplifier.

AUDIO-OUTPUT STAGE

This circuit represents a single-ended audio-output stage similar to that used in an automobile radio. Input from the collector of the driver stage is transformer-coupled. The bias applied to the output transistor depends on the voltage divider made up of the 10-ohm and 100-ohm resistors together with the 100-ohm variable resistor. This variable resistor is set to produce a collector current of 1.05 amperes. The purpose of the choke and two capacitors is to remove any possibility of interference from the electrical system of the automobile with the amplifier.



* OPTIONAL FOR MAXIMUM GAIN
‡ PLUS TEMPERATURE COEFFICIENT

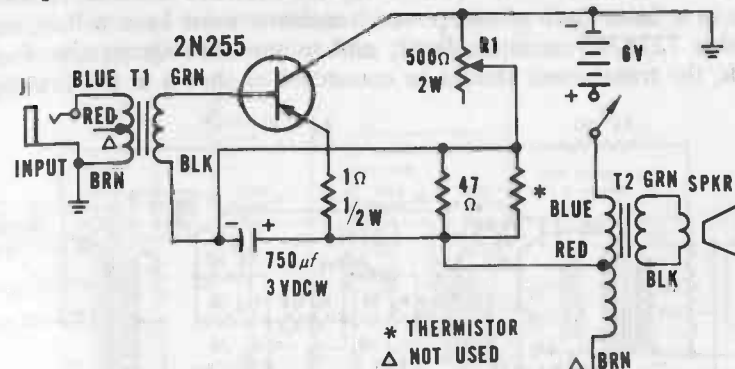
Courtesy Delco Radio Div., General Motors Corp.

Single-ended audio-output stage.

Distortion is less than 10% at 4-watts output. The output transformer matches the 4-ohm speaker to the 11-ohm collector output impedance. It is necessary that a heat sink be used; Delco type 7270725 and type 7281366 are suggested.

AUDIO POWER AMPLIFIER

This is a single-stage (2N255), transformer-coupled, class-A power amplifier used for audio. This unit is designed to be plugged into the portable radio phone jack for increasing the power output of a personal portable radio to 1 watt.



T₁—500-ohm to 8-ohm transistor transformer (Argonne AR-164)
T₂—48-ohm to 3.2-ohm output transformer (Argonne AR-503)
PM speaker, 6" X 8" dia., 3.2-ohm voice coil
Heat-sink chassis—4" X 3 1/8" X 1" (ICA 29082)
*40-ohm thermistor, VECO 14X2

Courtesy CBS Electronic Div., CBS Inc.

Audio power amplifier.

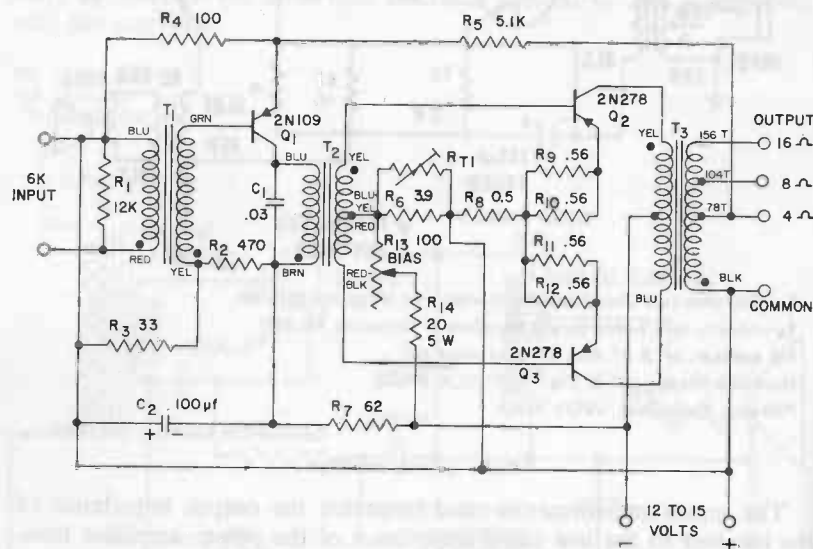
The input transformer is used to match the output impedance of the receiver to the low input impedance of the power-amplifier transistor, while the output transformer is used to match the power amplifier to the speaker. Variable resistor R1 should be adjusted to provide an emitter current of 0.5 ampere.

LOW-DISTORTION POWER AMPLIFIER

This is a two-stage power amplifier that requires an input of 2.1 amperes at 12.6 volts dc from a regulated supply. A 2N109 transistor acts as a driver, and the power output stage is made up of two 2N278 transistors. The circuit is transformer-coupled with an output transformer designed for a 4-, 8-, or 16-ohm load. The input impedance of the amplifier is 6,000 ohms at 400 cycles per second.

The frequency response is flat within 2 db from 60 cycles to 8 kc. Maximum undistorted output at 400 cycles is 7.5 watts. The maximum power output at 400 cycles is 12 watts, and the total harmonic distortion at 2 watts output at 400 cycles is 0.8%. The power gain is 51.2 db at 8 watts output.

The driver stage has a collector current of 5.5 ma and a 9-volt nominal difference between the collector and emitter. The driver is transformer-coupled to the bases of the 2N278 power transistors, each of which operates at 1.05 amperes of collector current in class A push-pull. The thermistor (R_{T1}) provides a negative temperature compensation to limit base current. A 0.5-ohm resistor rated at 10 watts acts as a fuse. Each of the power transistors must have a heat sink (Delco 7278788 or equivalent), and to prevent regenerative feedback, the transformer should be connected as shown in the drawing.



- C_1 —0.03 mfd, paper capacitor
- C_2 —100 mfd, 50V electrolytic capacitor
- R_{13} —100 ohm, 4 watt potentiometer
- Q_1 —RCA 2N109 transistor
- Q_2, Q_3 —Delco Radio 2N278 (matched pair transistors)
- R_1 —12K, 1/2 watt carbon resistor
- R_2 —470 ohm, 1/2 watt carbon resistor
- R_3 —33 ohm, 1/2 watt carbon resistor
- R_4 —100 ohm, 1/2 watt carbon resistor
- R_5 —5.1K, 1/2 watt carbon resistor
- R_6 —3 ohm, 1 watt carbon resistor
- R_7 —62 ohm, 1 watt carbon resistor
- R_8 —0.5 ohm, 10 watt fuse resistor (See text)
- R_9, R_{10}, R_{11} —0.56 ohm, 1 watt carbon

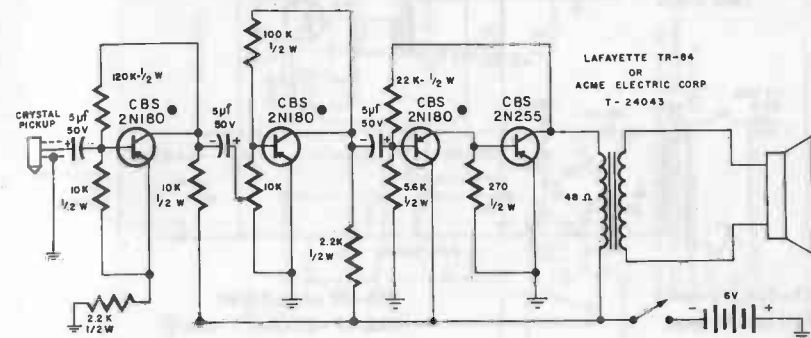
- R_{14} —20 ohm, 5 watt wirewound resistor
- T_1 —Input transformer (See winding data) 7269336
- T_2 —Driver transformer (See winding data) 7269339
- T_3 —Output transformer (See winding data) (May be modified 7270327)
- R_{T1} —G.E. thermistor WA754 or equivalent, 30 ohms at 25°C
- Delco radio heat sink 7278788 or equivalent (2 required)
- Delco radio insulating spacer 7269634 (4 required, two used for electrically insulating each heat sink from the chassis)

Courtesy Delco Radio Div., General Motors Corp.

Low-distortion power amplifier.

PHONOGRAPH AMPLIFIER

This is a lightweight, inexpensive phonograph amplifier using three 2N180 transistors and one 2N255 as the power output. Other transistors may be substituted, as shown in the schematic. This unit will provide about 1/2 watt of audio power output from a standard crystal pickup, and the current drain is about 500 ma. If desired, a simple power supply can be substituted for the 6-volt battery.



NOTE 1:

The circuit has been designed so that transistors having lower Betas, such as types 2N107, GT222, and CK722, may be substituted for the 2N180 units.

Courtesy CBS Electronic Div., CBS Inc.

Phonograph amplifier.

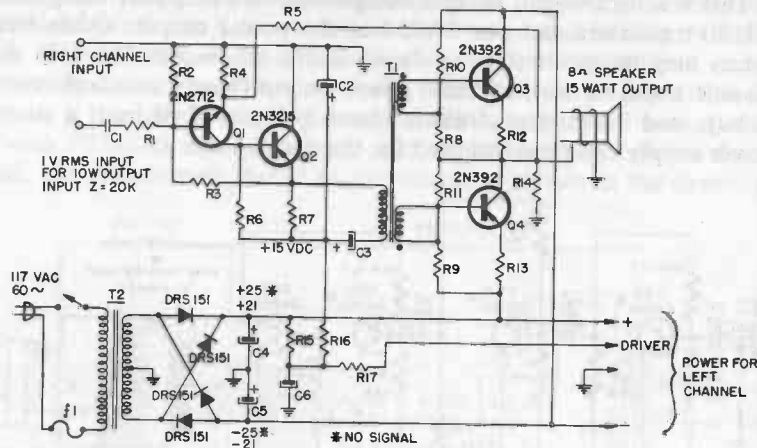
15-WATT STEREO AMPLIFIER

This circuit is designed as a stereo amplifier without elaborate circuit devices. The frequency response is reasonably flat from 40 cycles to 15 kc, and 15 watts of power can be obtained from about 80 cycles to beyond 10 kc. Five watts of output can be obtained up to about 20 kc, while more power output can be obtained in the low frequency end by increasing the value of the power-supply filters.

Four transistors are shown; the transistors in the driver stage are direct-coupled. Resistor R3 is used to provide both a-c and d-c feedback. The a-c feedback will lower distortion and the d-c feedback allows a wide variation in the gain of the transistors.

R3 is used for temperature compensation. The collector-to-emitter voltage of Q2 should be about 8 volts d-c, and if it is not, resistor R3 should be adjusted. There is no direct current in the input transformer; thus, its size is kept small and the low frequency response is increased. Note that the input transformer is a special type, used to reduce the phase shift and high frequencies, and to allow effective

feedback without creating oscillations. The output from this unit is at least 15 watts, into an 8-ohm speaker.



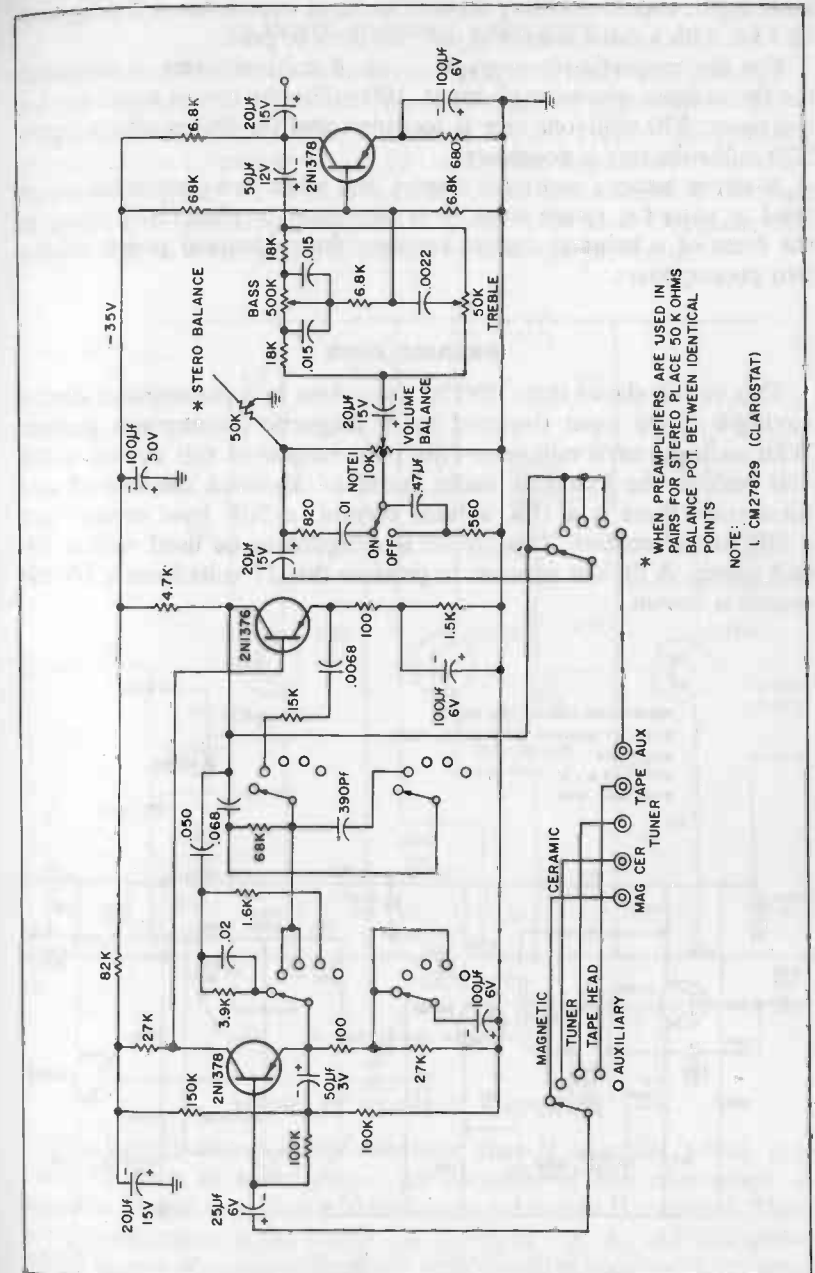
- R1—10K, 1/2 watt
 R2—33K, 1/2 watt
 R3—Select for Q2
 Vce = 8Vdc
 (100K is typical)
 R4—75 ohm, 1/2 watt
 R5—1.5K, 1/2 watt
 R6—2.7K, 1/2 watt
 R7—82 ohm, 2 watt
 R8, 9—3.3 ohm, 1/2 watt
 R10, 11—750 ohm, 1 watt
 R12, 13—.47 or .5 ohm, 1/2 watt
 R14—100 ohm, 1 watt
 T1—Core: EI-21, Radio Grade VI, 1/2" stack, EI laminations
 Coil Form: Use nylon bobbin for EI-21.
 Winding Data: Simultaneously wind 2 #32 wires and 2 #28 wires to fill the nylon bobbin (approximately 250 turns). Interleave the EI laminations in the bobbin. Connect the 2 #32 wires in series-aiding to form the primary.
 T2—Core: EI-12, M-19 Grade, 1" stack, EI laminations
 Winding Data: Pri: 660 T #26 AWG
 Sec: 2 windings 120 T each #21 AWG. Bifilar wind the secondary windings.

Courtesy Delco Radio Div., General Motors Corp.

15-watt stereo amplifier.

MULTI-INPUT PREAMPLIFIER

This circuit shows a three-transistor multi-input preamplifier designed for a magnetic pickup, a ceramic pickup, a tuner input, a tape



* WHEN PREAMPLIFIERS ARE USED IN PAIRS FOR STEREO PLACE 50 K OHMS BALANCE POT. BETWEEN IDENTICAL POINTS

NOTE:
 L CM27829 (CLAROSTAT)

Courtesy Texas Instruments Inc.

Multi-input preamplifier.

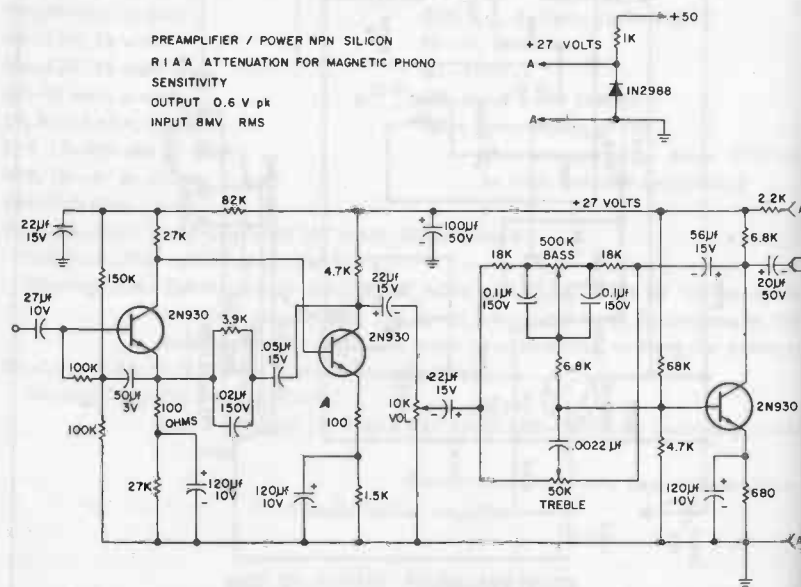
head input, and an auxiliary input. The input impedance is 2 megohms at 1 kc, with a rated output of 0.5 volt peak to peak.

For the magnetic-phonograph input, 8 millivolts rms is required; for the ceramic-phonograph input, 100 millivolts rms is required; for the tuner, 130 millivolts rms is required; and for the auxiliary input, 500 millivolts rms is necessary.

A stereo balance control is shown, and when two preamplifiers are used in pairs for stereo work, it is necessary to place 50K ohms in the form of a balance control between these identical points of the two preamplifiers.

PREAMPLIFIER

This circuit shows three 2N930 transistors in a preamplifier circuit having a single input designed for a magnetic phonograph pickup. With an input of 8 millivolts (rms) the output of this circuit is 0.6 volt peak to the following audio amplifier. Between the second and third stage there is a 10K volume control, a 50K bass control and a 50K treble control. This circuit is designed to be used with a 27-volt source. A divider network to produce this 27 volts from a 50-volt source is shown.

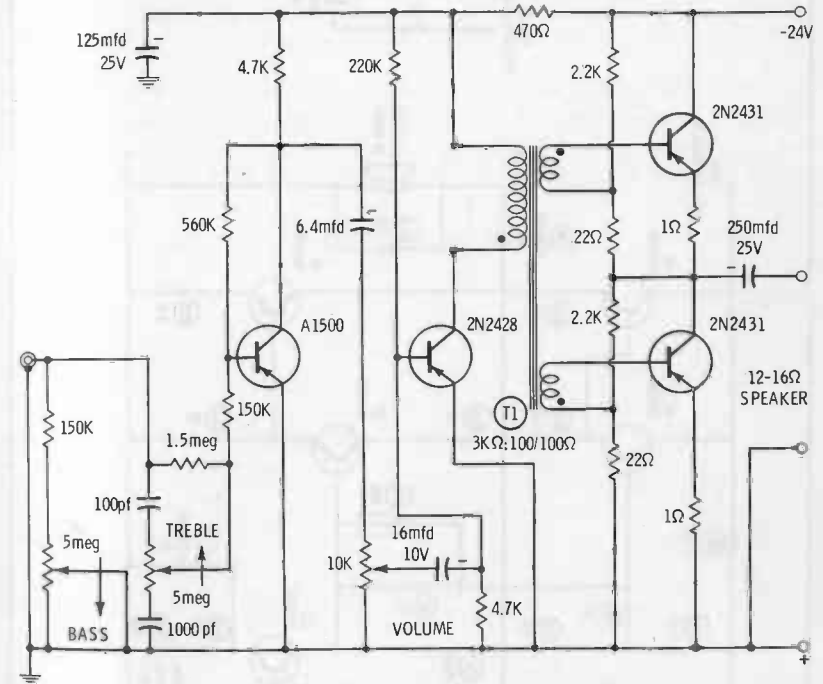


Courtesy Texas Instruments Inc.

Preamplifier circuit.

5-WATT PHONO AMPLIFIER

This circuit shows a phonograph amplifier that can produce a 5-watt output with a 0.6-volt input. Transistor types are A-1500, 2N2428, and 2N2431. With a negative 24-volt supply, the amplifier directly drives a speaker with a 12- to 16-ohm impedance. The inter-stage transformer (T1) is a special driver-transformer (American Transformer Company No. 202D2 or H & H Coil Company No. 39AJ5). Both a treble and a volume control are provided.

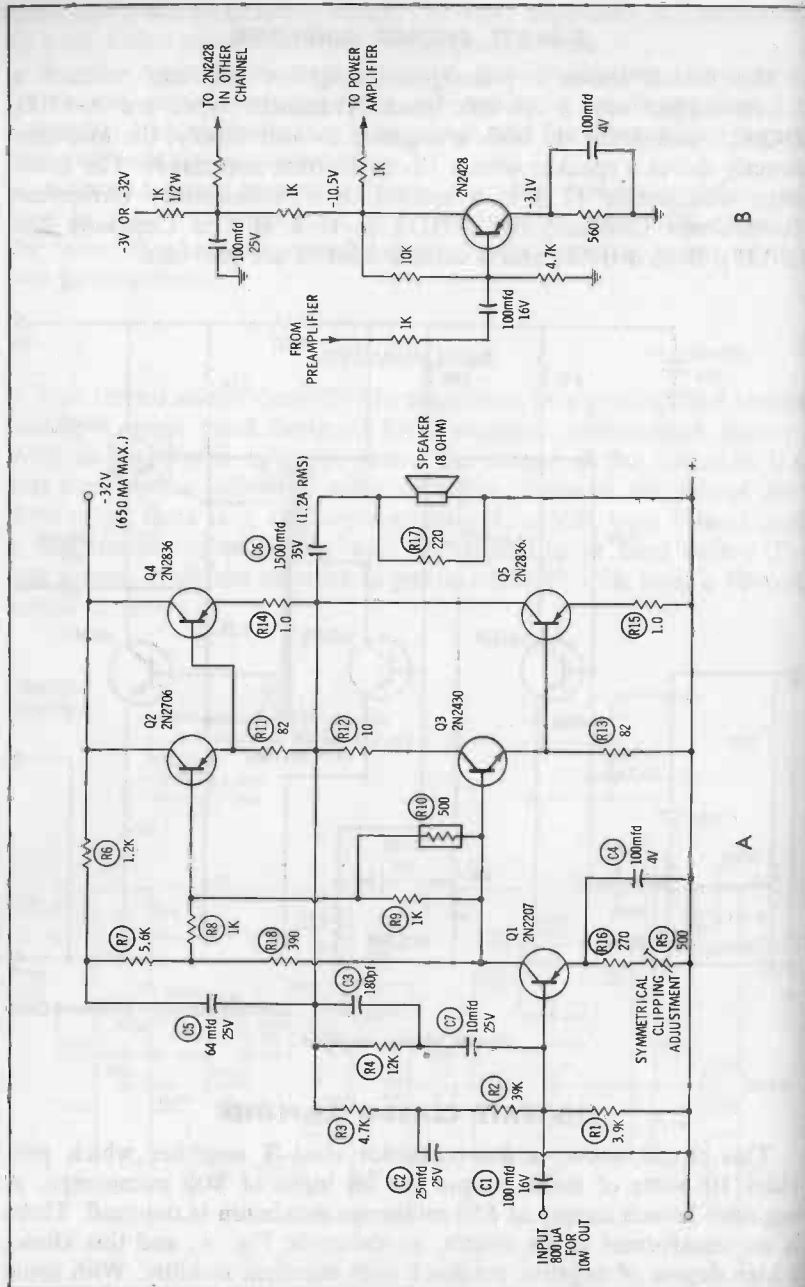


Courtesy Amperex Electronic Corp.

5-watt phono amplifier.

10-WATT CLASS-B AMPLIFIER

This circuit shows a five-transistor class-B amplifier which provides 10 watts of audio output for an input of 800 microamps. A negative 32-volt supply at 650 milliamps maximum is required. There is no transformer in the circuit, as shown in Fig. A, and this allows a high degree of negative feedback with excellent stability. With some preamplifiers where insufficient input is obtained, an additional pre-amplifier, as shown in Fig. B, can be used.



Courtesy Amperex Electronic Corp.

10-watt Class-B amplifier.

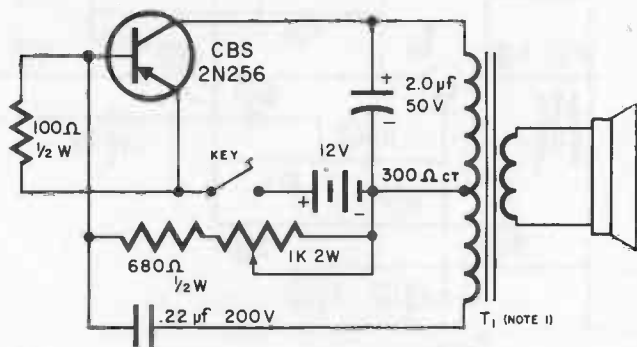
This circuit, as shown, has a low level of distortion. If this low level of distortion is not required, the components used for feedback (resistor R-4 and capacitor C-3) can be changed to increase the gain. It is possible that with an increase in gain, the amplifier might not require the preamplifier, depending on the driving source.

Section 2

OSCILLATORS, CONVERTERS, MIXERS

CODE-PRACTICE OSCILLATOR

A single transistor is used in this audio-oscillator circuit, which can be used for code practice by inserting a key in series with a 12-volt source as shown.



NOTE 1:

T₁—ARGONNE AR-121, NEW ENGLAND TYPE 399,
OR TRIAD TY-57X

Courtesy CBS Electronic Div., CBS Inc.

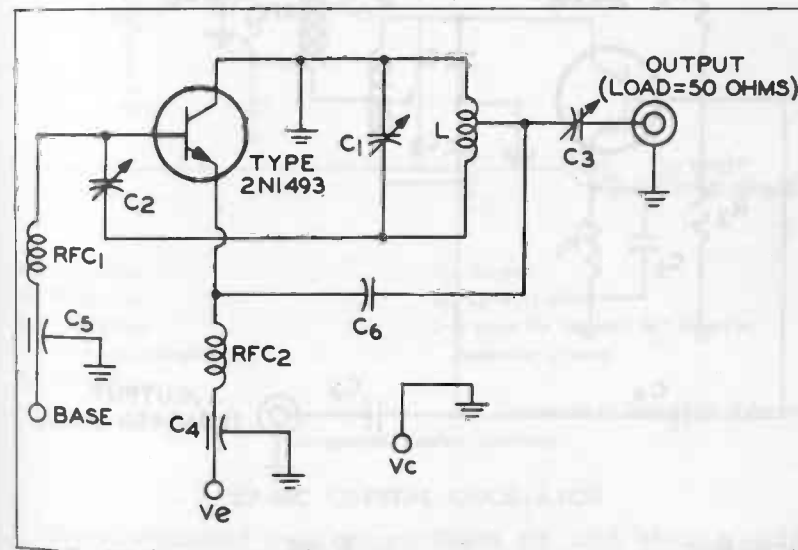
Audio-oscillator circuit.

The output from the circuit is about 300 mw, which is sufficient to drive a small speaker; the variable resistor, as shown, is a tone control that can be adjusted for operator convenience. It is possible to add an L-pad in series with the speaker voice-coil lead to provide a volume control if desired.

70-MC POWER OSCILLATOR

A power oscillator suitable for use with transistor type 2N1491, 2N1492, or 2N1493 is shown. These transistors can operate with a collector-to-base voltage of 30 volts, 60 volts, or 100 volts, respectively.

By using a 2N1493 in the circuit shown, about 0.6 watt may be obtained, using a collector voltage of 50 volts and a collector current of 25 ma. In operation, the transistor case is clamped to a copper chassis to provide a low thermal resistance path to the chassis, and insulating mica is not required since the collector is connected to the chassis. The output load for this circuit is 50 ohms.



C₁—5-50 mmf, variable

C₂, C₃—7-100 mmf, variable

C₄, C₅—feedthrough capacitor, 1500 mmf

C₆—0.01 mfd

L—3½ turns No. 14 wire, ¾" diameter,
tapped at 2 turns

RFC₁, RFC₂—radio-frequency choke, 10 μh

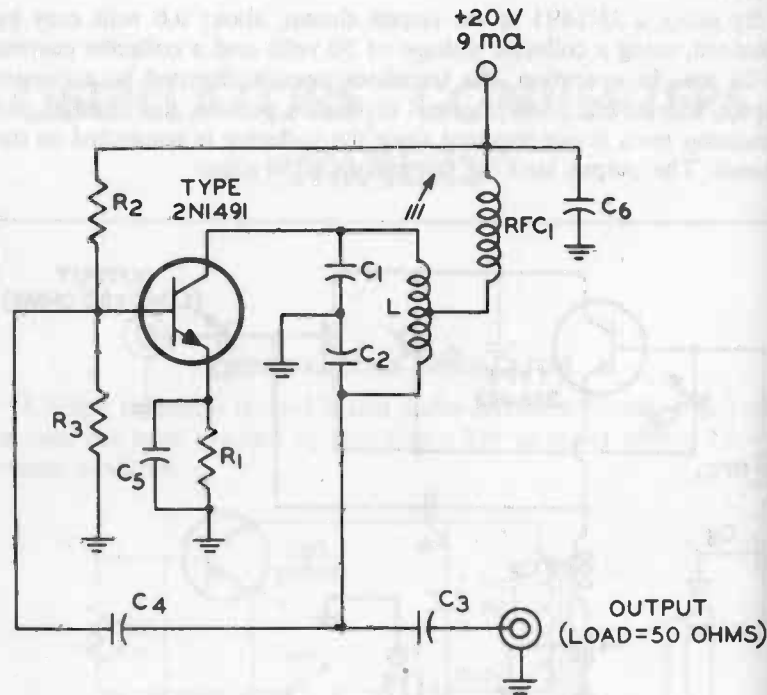
Courtesy Radio Corporation of America

70-megacycle power oscillator.

70-MC COLPITTS OSCILLATOR

A low-power oscillator operating at 70 megacycles and using transistor type 2N1491 is shown. Applications for circuits such as this include local oscillators or variable-frequency oscillators as used in transmitters. In these application the output power is not required to be very high, and power output in the range from 25 to 50 milliwatts is normally enough.

The circuit as shown has a typical power output of 35 milliwatts and a maximum power output of about 50 milliwatts. It is possible to use types 2N1492 or 2N1493 if a higher power output is required.



- | | |
|------------------|----------------------|
| R_1 —200 ohms | C_2 —30 mmf |
| R_2 —9100 ohms | C_3 —22 mmf |
| R_3 —1500 ohms | C_4 —18 mmf |
| C_1 —20 mmf | C_5, C_6 —0.01 mfd |
- L —5 turns No. 20 wire close wound on CTC LS5 form, tapped at 3 turns (white dot core)
 RFC_1 —radio-frequency choke, $10\mu h$

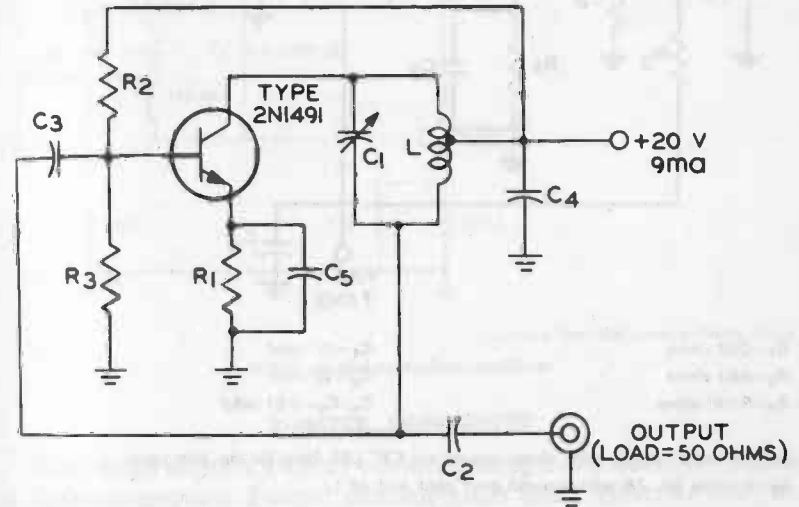
70-megacycle Colpitts oscillator.

Courtesy Radio Corporation of America

70-MC HARTLEY OSCILLATOR

A Hartley oscillator of the type that can be used for local oscillators or variable-frequency oscillators in transmitters is shown using a type 2N1491 transistor. With a 20-volt supply and a current of 9 ma, this circuit will provide an output of about 35 milliwatts, with a maximum power output of about 50 milliwatts.

If a higher output is required, a type 2N1492 or 2N1493 may be used. For the 2N1491, maximum collector-to-base voltage is 30 volts; for type 2N1492 it is 60 volts; and for 2N1493 it is 100 volts.



- | | |
|---------------------------|---|
| R_1 —200 ohms | C_3 —15 mmf |
| R_2 —9100 ohms | C_4, C_5 —0.01 mfd |
| R_3 —1500 ohms | L —3 turns No. 18 wire, $\frac{3}{4}$ " diameter, tapped at 2 turns |
| C_1 —4-24 mmf, variable | |
| C_2 —12 mmf | |

Courtesy Radio Corporation of America

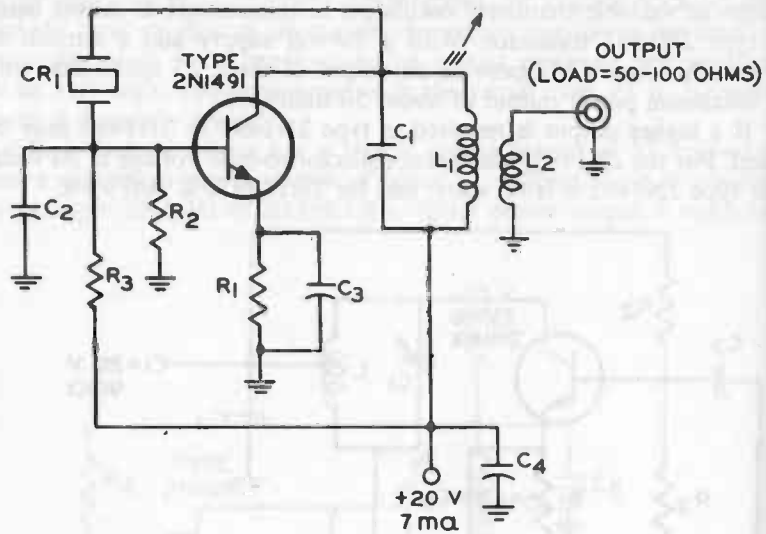
70-megacycle Hartley oscillator.

27-MC CRYSTAL OSCILLATOR

Crystal-controlled transistor oscillators are used where a stable signal source is required, as in a fixed-tuned transmitter or receiver, or in a signal generator.

The circuit shows a type 2N1491 transistor in a crystal-controlled circuit with a 20-volt supply. This circuit can use overtone crystals in the approximate frequency range from 25 to 30 mc. As indicated, using a 2N1491 with a load resistance in the 50- to 100-ohm range the power output will be about four milliwatts. Normally, for this

application this is a sufficient power output; types 2N1492 or 2N1493 may be substituted if a greater power output is required.



R₁—200 ohms
R₂—680 ohms
R₃—9100 ohms

C₁—22 mmf
C₂—20 mmf
C₃, C₄—0.01 mfd

CR₁—27 mc crystal

L₁—15 turns No. 22 wire close wound on CTC LS5 form (white dot core)
L₂—2 turns No. 18 wire wound over cold end of L₁

Courtesy Radio Corporation of America

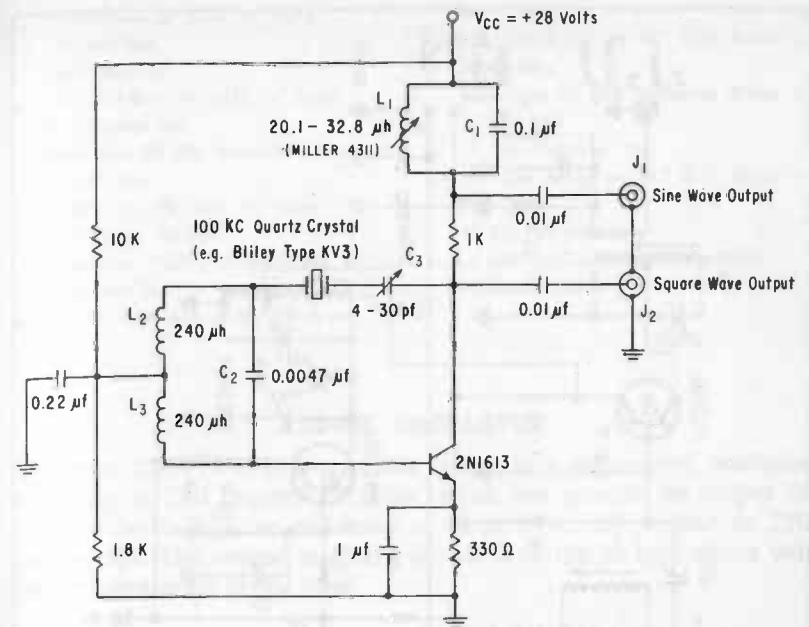
27-megacycle crystal oscillator.

100-KC CRYSTAL-CONTROLLED OSCILLATOR

This circuit shows a 100-kc crystal-controlled oscillator using a 2N1613 transistor. Both a square-wave and a sine-wave output are produced with excellent frequency stability.

This circuit is similar to a Hartley oscillator where positive feedback is obtained from collector to base using phase reversal in the tapped tank circuit of L₂, L₃, and C₂. The oscillator frequency depends upon the resonant frequency of the series L-C network in the feedback loop. This network includes capacitor C₃ and the quartz crystal operating in a parallel mode.

Capacitor C₃ is made variable to act as a fine frequency control adjustment. There is a square-wave output from jack J₂ since the collector is driven from cutoff to saturation, and a sine-wave output is available at jack J₁ across the tank circuit made up of L₁ and C₁.



Courtesy Fairchild Semiconductor Corp.

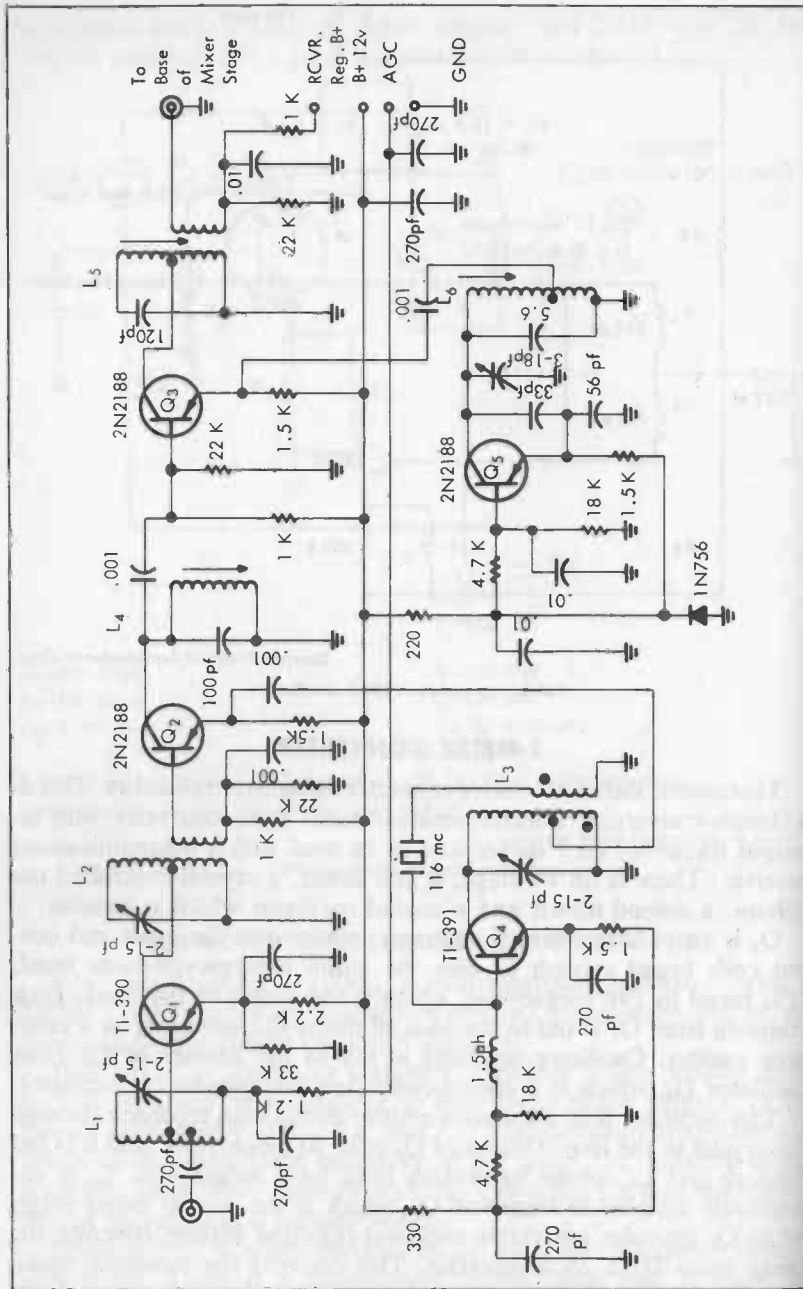
100-kc crystal-controlled oscillator.

2-METER CONVERTER

This circuit shows a 2-meter converter using five transistors. This is a double-conversion 2-meter amateur radio band converter with an output frequency on 7 megacycles to be used with a communications receiver. There is an r-f stage, a first mixer, a crystal-controlled oscillator, a second mixer, and a second oscillator which is tunable.

Q₁ is an r-f stage using a common emitter with the input and output coils broad enough to pass the entire 4-megacycle-wide band. It is tuned to 146 megacycles, which is the center of the band. Link coupling from Q₁ is fed to the base of mixer Q₂, operating as a common emitter. Oscillator injection is fed to the emitter of Q₂ from oscillator Q₄, which is a crystal-controlled first-conversion oscillator.

This oscillator is in a common-emitter circuit with feedback through the crystal to the base. Output of Q₂ is at 30 megacycles, and it is fed through coil L₄, whose bandwidth must be 4 megacycles. L₄ is capacitively coupled to transistor Q₃, which is the second mixer stage, while Q₅ provides a variable oscillator-injection voltage covering the range from 21 to 25 megacycles. This converts the incoming signal to 7 megacycles. Output of the converter is designed to operate into the base of the first mixer of a communications receiver.



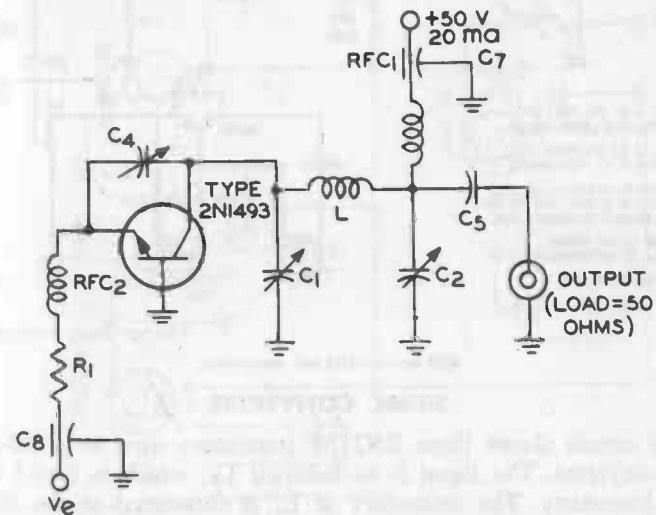
Courtesy Texas Instruments Inc.

2-meter converter.

- L₁—5T #18 Buss 3/8" O.D. 1/2" Long
1T Input Tap
1 1/2T Base Tap
- L₂—4 1/2T #18 Buss 3/8" O.D. 1/2" Long
2T Collector Tap
Secondary 2T #25 Solderze Bifilar at Cold End
- L₃—4T #18 Buss 3/8" O.D. 1/2" Long
1/4T Tap for Injection
Secondary 1 1/2T #25 Solderze Bifilar at Cold End
- L₄—8T #21 Solderze on 1/4" Form ~
- White Slug
- L₅—28T 10/44 Litz on 1/4" O.D. Form ~
White Slug
- Secondary 3T #28 Solderze Bifilar at Cold End
15 Turn Collector Tap
- L₆—16T #24 S.P.U. on 1/4" O.D. Form ~
Red Slug
2T Tap for Injection
- L₄, L₅, and L₆—Cambridge Thermionic #PLS62C4L/20063

250-MC OSCILLATOR

A type 2N1493 is shown in this circuit as a self-excited oscillator operating at 250 megacycles. This circuit can provide an output of 150 milliwatts with an efficiency of from 15 to 20 percent at 250 megacycles. The output matching circuit is of the pi type which will reduce harmonics in the load.



- C₁—3-15 mmf
- C₂—4-50 mmf
- C₄—0.6-5.5 mmf
- C₅—0.002 mfd
- C₇, C₈—feedthrough capacitor, 1000 mmf

- R₁—400 ohms
- RFC₁, RFC₂—radio-frequency choke, 0.82 μh
- L—1 turn No. 14 wire, 1-inch diameter

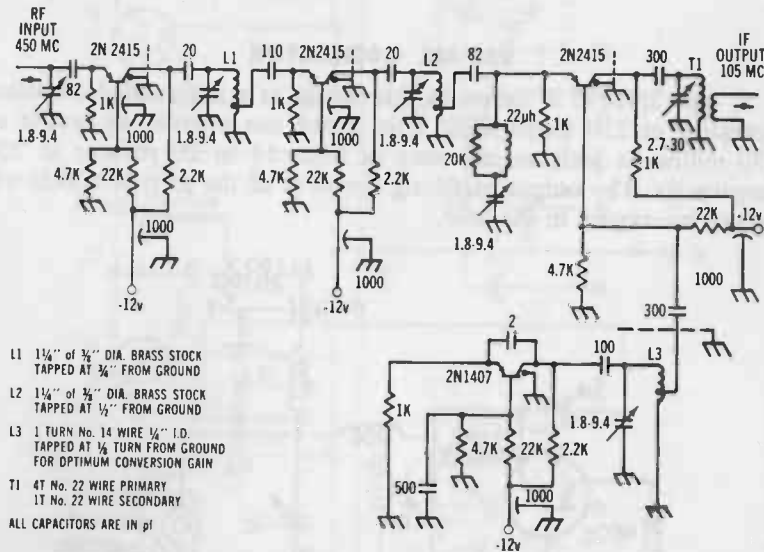
Courtesy Radio Corporation of America

250-megacycle oscillator.

450 MC-TO-105 MC CONVERTER

This is a converter designed to convert a 450-mc radio-frequency input signal to an i-f output of 105 mc. The circuit includes a two-stage amplifier, a 450-megacycle to 105-megacycle mixer stage and a 345-megacycle local oscillator.

There is a two-stage r-f amplifier using 2N2415 transistors with a power gain of 20 db, a noise figure of 4.5 db, and a bandwidth of 10 megacycles. The third stage is a 2N2415 mixer with a conversion gain of about 12 db; this circuit is fed from the 2N1407 local oscillator, as shown. The noise figure of this circuit overall is 5.0 db, and there is a gain from input to output of 32 db.



- L1 1 1/4" of 3/8" DIA. BRASS STOCK TAPPED AT 3/4" FROM GROUND
 - L2 1 1/4" of 3/8" DIA. BRASS STOCK TAPPED AT 1/2" FROM GROUND
 - L3 1 TURN No. 14 WIRE 1/2" I.D. TAPPED AT 1/2 TURN FROM GROUND FOR OPTIMUM CONVERSION GAIN
 - T1 4T No. 22 WIRE PRIMARY 1T No. 22 WIRE SECONDARY
- ALL CAPACITORS ARE IN pf

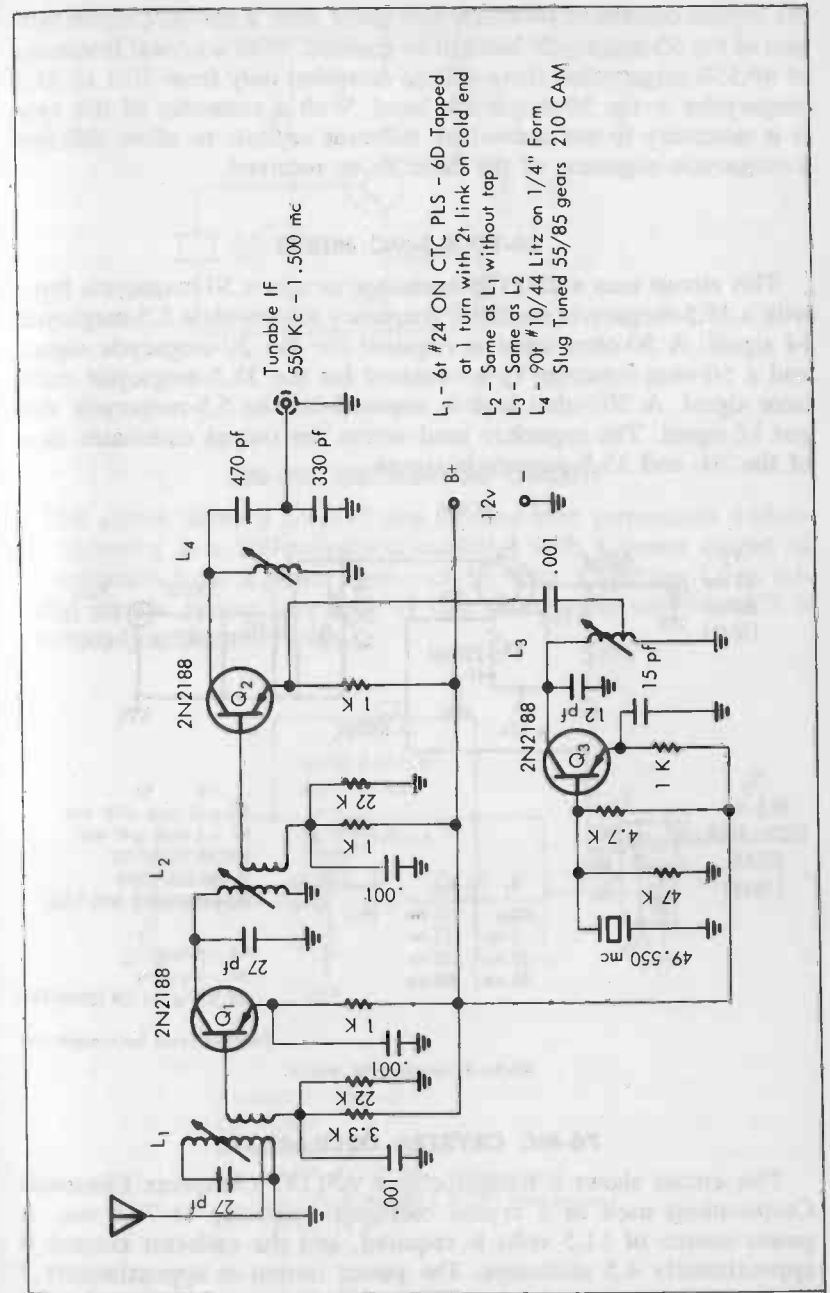
Courtesy Texas Instruments Inc.

450 mc-to-105 mc converter.

50-MC CONVERTER

This circuit shows three 2N2188 transistors used in a 50-megacycle converter. The input is to inductor L_1 , which is tuned to the signal frequency. The secondary of L_1 is connected to the base of the common-emitter r-f amplifier (Q_1), and the output of this stage is coupled to the base of the common-emitter mixer stage (Q_2).

The oscillator is crystal controlled in a common-base circuit; it provides an injection signal to the emitter of Q_2 . The output of Q_2 is developed across inductor L_4 . Because the oscillator is crystal controlled, the broadcast receiver working with this converter must be tunable. Since the entire broadcast band is only one megacycle wide,



Tunable IF
550 Kc - 1,500 mc

- L1 - 6t #24 ON CTC PLS - 6D Topped at 1 turn with 2t link on cold end
- L2 - Same as L1 without tap
- L3 - Same as L2
- L4 - 90t #10/44 Litz on 1/4" Form Slug Tuned 55/85 gears 210 CAM

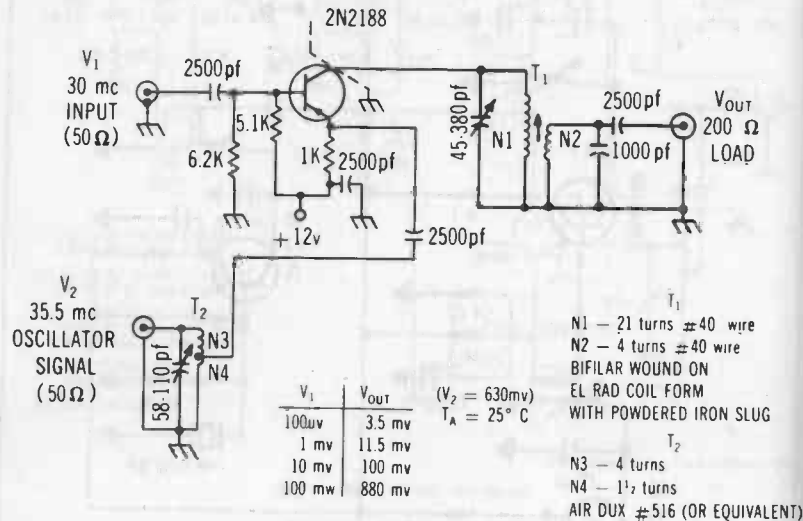
Courtesy Texas Instruments Inc.

50-mc converter.

the crystal-controlled oscillator will allow only a one-megacycle portion of the 50-megacycle band to be covered. With a crystal frequency of 49.550 megacycles, there will be reception only from 50.1 to 51.1 megacycles in the 50-megacycle band. With a converter of this type it is necessary to use individual, different crystals to allow different 1-megacycle segments of the band to be received.

30-TO-5.5-MC MIXER

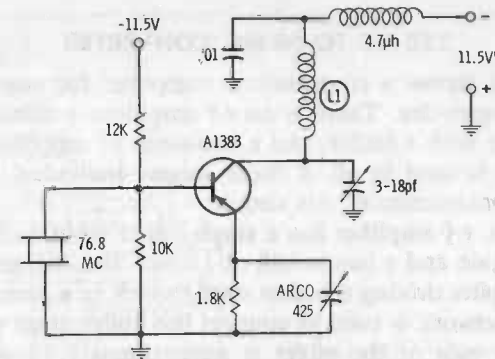
This circuit uses a 2N2188 transistor to mix a 30-megacycle input with a 35.5-megacycle oscillator frequency to provide a 5.5-megacycle i-f signal. A 50-ohm input is required for the 30-megacycle signal, and a 50-ohm input to T_2 is required for the 35.5-megacycle oscillator signal. A 200-ohm load is required for the 5.5-megacycle output i-f signal. The capacitor used across the output eliminates most of the 30- and 35.5-megacycle signals.



30-to-5.5-megacycle mixer.

76-MC CRYSTAL OSCILLATOR

This circuit shows a transistor type A-1383 (Amperex Electronic Corporation) used in a crystal oscillator operating at 76.8 mc. A power source of 11.5 volts is required, and the collector current is approximately 4.5 milliamps. The power output is approximately 2 milliwatts at the operating frequency of the crystal. Coil L_1 is 8 turns of No. 18 wire wound on a 1/4-inch-diameter coil form.

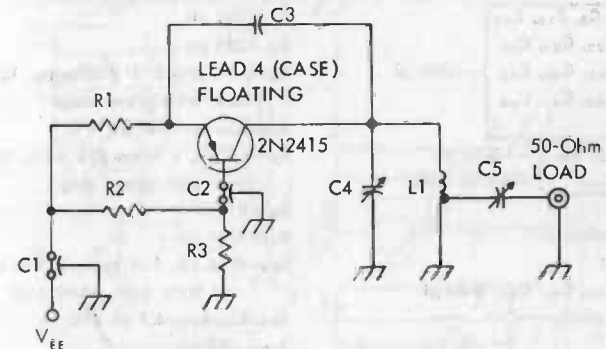


Courtesy Amperex Electronic Corp.

76-mc crystal oscillator.

500-MC OSCILLATOR CIRCUIT

This circuit shows a 2N2415 pnp diffused-base germanium transistor operating as a 500-megacycle oscillator with a power output of 10 milliwatts from a power source of 15 volts. Capacitor C_4 is adjusted for the proper frequency of operation, while capacitor C_5 is used to adjust the power input.



- C1 and C2: 1000 pf
- C3: 1.0 pf
- C4 and C5: 1.8 - 13 pf
- L_1 : 1 1/4" of 3/8" dia. silver-plated brass stock tapped 1 3/16" from ground.
- R1: 510 Ω , 1/2 W
- R2: 470 Ω , 1/2 W
- R3: 2.7 k Ω , 1/2 W

Courtesy Texas Instruments Inc.

500-mc oscillator circuit.

250 MC-TO-60 MC CONVERTER

This circuit shows a six-transistor converter for conversion from 250 to 60 megacycles. There is an r-f amplifier, a mixer, a separate local oscillator with a buffer, and a two-stage i-f amplifier. Transistor type 2N2865 is used in all of these stages. Individual chassis were used in the construction of this circuit.

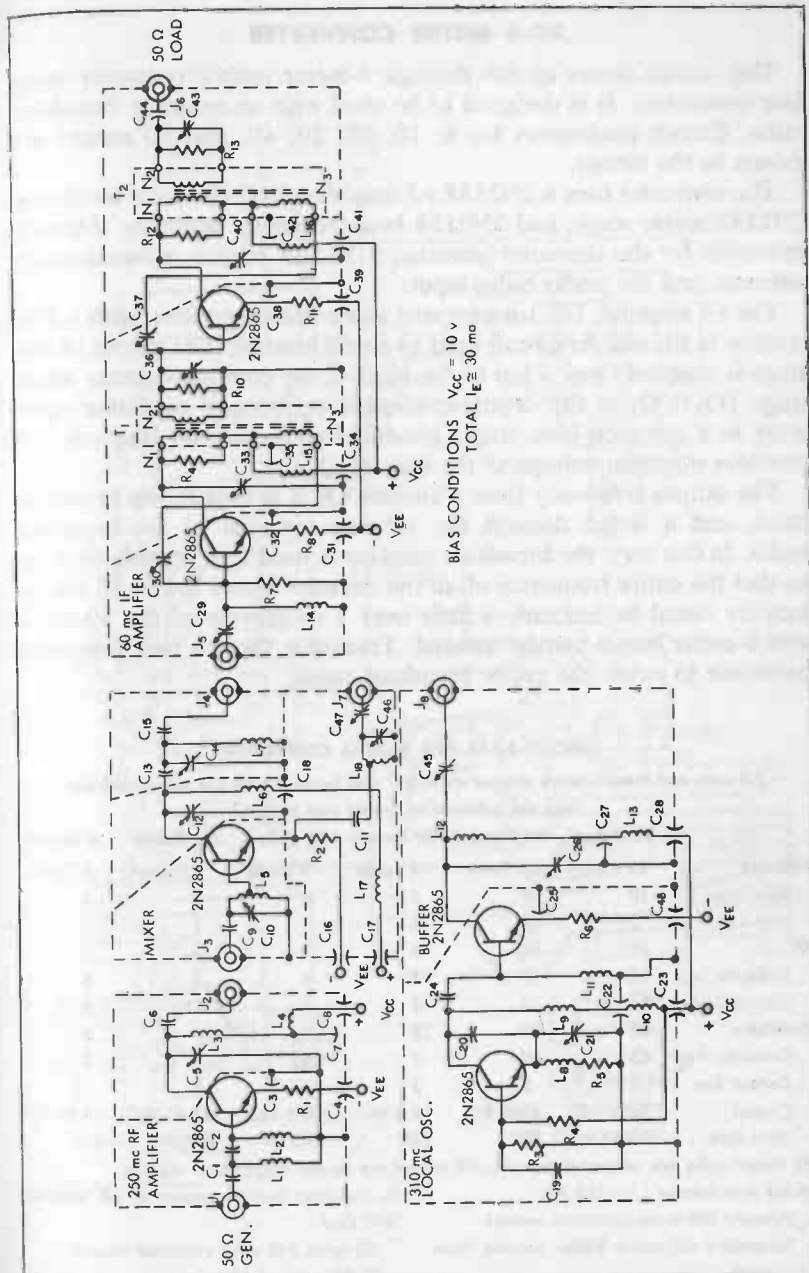
The 250-mc r-f amplifier has a single-tuned input and output with about 12-db gain and a bandwidth of 13 mc. The 310-mc local oscillator is a Colpitts driving a buffer stage, which is a common emitter. A matching network is used to connect the buffer stage to the mixer.

Conversion gain of the mixer is approximately 11 db. A single-tuned network is used to match the 50-ohm cable to the base, while a double-tuned network at the output is used to provide a transformation to the 50-ohm cable driving the succeeding stage.

There are two neutralized, double-tuned stages in the 60-megacycle i-f amplifier with about 40-db power gain and a bandwidth of 10 mc. The overall power gain of this converter is 69 db with a 5-mc bandwidth and a 7-db noise figure. The sensitivity is 3.5 microvolts, and image rejection is greater than 40 db.

- C₁—300 pf
- C₂—35 pf
- C₃, C₄, C₇, C₈, C₁₆, C₁₇
- C₁₈, C₁₉, C₂₂, C₂₃, C₂₅
- C₂₇, C₂₈, C₃₁, C₃₂, C₃₄
- C₃₅, C₃₈, C₃₉, C₄₁, C₄₂
- C₄₄, C₄₈
- C₅, C₃₀, C₄₅, C₄₇ —1.8-13 pf
- C₃₃, C₄₀, C₃₇ —Air variable
- C₆—2.5 pf
- C₁₀—8-50 trimmer
- C₁₁—500 pf
- C₁₂, C₁₄, C₂₀, C₂₁, C₂₉—6-80 pf
- C₉, C₁₃—4 pf
- C₁₅—18 pf
- C₂₄—1 pf
- C₂₆, C₄₆—2.7-30 pf
- C₃₆, C₄₃—45-380 pf
- R₁, R₂, R₈, R₁₁—1K
- R₃—650 ohms
- R₄—2.5K
- R₅—500 ohms
- R₆—2.5K
- R₇—300 ohms
- R₉, R₁₂—2K
- R₁₀, R₁₃—150 ohms

- L₁—0.14 μh
 - L₂, L₄—68 μh RFC
 - L₃—0.35 μh
 - L₅—0.25 μh
 - L₆—0.14 μh, 5 T #16 wire, 1/4" OD coil form with green slug
 - L₁₀, L₁₃, L₈—0.47 μh RFC
 - L₇—0.1 μh, 4 turns #16 wire, 1/4" OD coil form with green slug
 - L₉—0.01 μh
 - L₁₁—0.21 μh
 - L₁₄—0.26 μh, 5 1/2 turns #16 wire, 1/4" OD coil form with white slug
 - L₁₅, L₁₆, L₁₇—4.7 μh RFC
 - L₁₂—0.018 μh
 - L₁₈—0.014 μh, 1/4" copper strip tapped as shown
- 2N2865 (6 RQD) (4th lead gnd)
 J₁ thru J₆ — UG —290/U
 T₁, T₂
- $$\frac{N_1}{N_2} = 4.5:1$$
- $$\frac{N_1}{N_3} = 2:1$$
- K = 0.128, PRI. IND. 0.5 μh
 SEC. IND. 0.03 μh
 EQUAL Q



Courtesy Texas Instruments Inc.

250 mc-to-60 mc converter.

80-6 METER CONVERTER

This circuit shows an 80- through 6-meter mobile converter using four transistors. It is designed to be used with an ordinary broadcast radio. Circuit parameters for 6, 10, 15, 20, 40, and 80 meters are shown in the circuit.

The converter uses a 2N2188 r-f amplifier, 2N2188 local oscillator, 2N2188 mixer stage, and 2N2188 beat-frequency oscillator. There is provision for the converter antenna, a 12-volt source, a broadcasting antenna, and the audio radio input.

The r-f amplifier (Q_1) is operated as a common emitter, with a 50K resistor in the emitter circuit used as a gain control. The output of this stage is coupled from a tap to the base of the common-emitter mixer stage (Q_2). Q_3 is the crystal-controlled conversion oscillator operating in a common-base stage, grounded at the crystal frequency. It provides injection voltage to the base of Q_2 .

The output frequency from transistor Q_2 is always in the broadcast band, and it is fed through the antenna terminal of the broadcast radio. In this way, the broadcast receiver is used as a tunable i-f stage so that the entire frequency of all the amateur bands below 10 meters may be tuned in, but only a little over 1 megacycle of the 10-meter and 6-meter bands can be covered. Transistor Q_4 is a beat frequency oscillator to cover the entire broadcast band.

CIRCUIT DATA FOR MOBILE CONVERTER

All coils and transformers wound on 9/32" coil forms. Cores are powdered iron.

Taps are referred to "cold" end of coil.

	80 Meters	40 Meters	20 Meters	15 Meters	10 Meters	6 Meters
Antenna	35 Turns	25 Turns	14 Turns	9 Turns	6 Turns	5 Turns
Base Tap	10	7	4	2	2	3
Ant. Tap	2	2	2	1	1	1
RF	35	25	14	9	6	5
Collector Tap	17	12	7	5	3	4
Output Tap	14	10	6	3	1 1/2	2
Oscillator	32	20	12	9	6	5
Collector Tap	16	10	7	5	3	3
Output Tap	9	8	2	2	2	1
Crystal	3250 KC	6600 KC	13.6 MC	20.5 MC	27.95 MC	49.55 MC
Wire Size	5-44 Litz	#27	#27	#25	#25	#22

80 Meter coils are universal wound. All others are single layer close wound.

Mixer transformer L \approx 125 mh

Primary 100 turns universal wound

Secondary 60 turns Bifilar wound from start.

S₁ Band Switch: shown in 80 meter position.

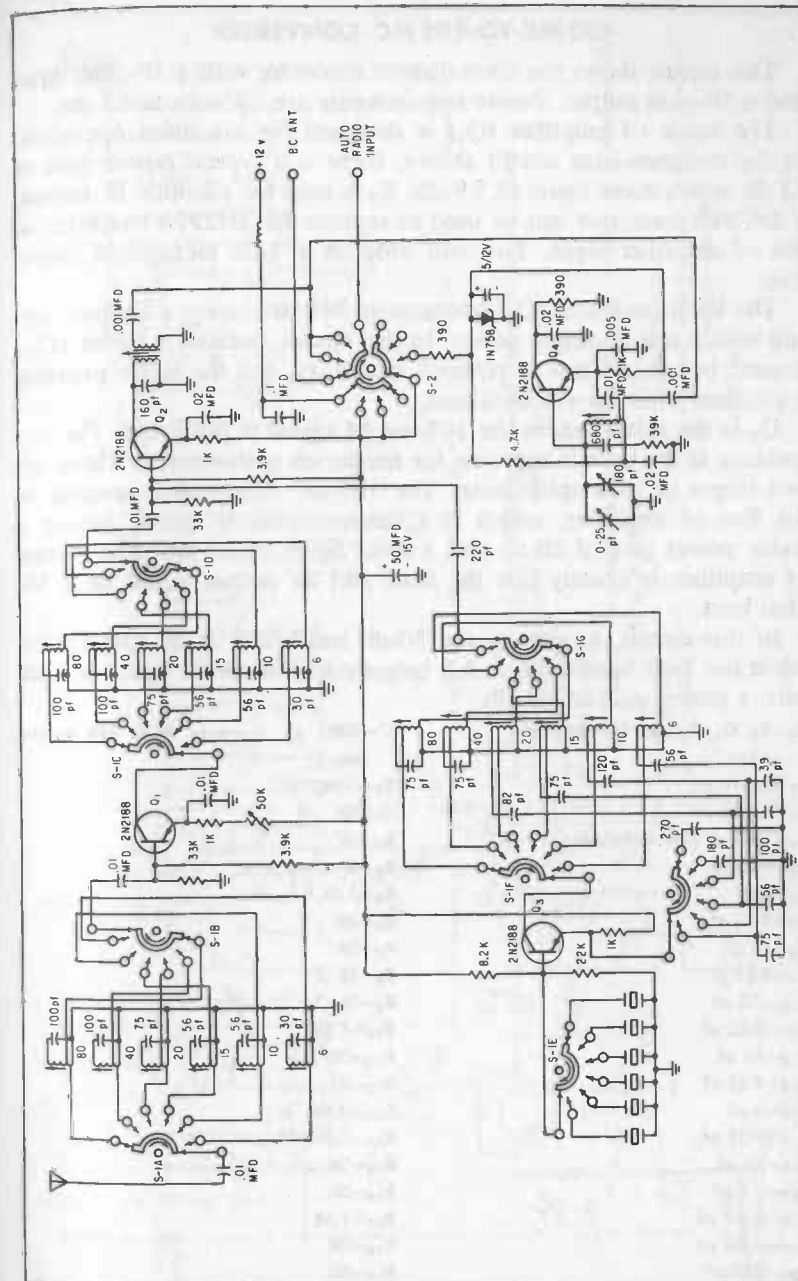
S₂ Junction Switch: shown in off position.

BFO Coil

52 turns #40 wire universal wound

Emitter tap at 12 turns

Output tap at 5 turns



Courtesy Texas Instruments Inc.

80-to-6-meter converter.

450 MC-TO-105 MC CONVERTER

This circuit shows the six-transistor converter with a 50-ohm input and a 50-ohm output. Power requirements are 12 volts at 42 ma.

The input r-f amplifier (Q_1) is designed for low-noise operation. In the common-base circuit shown, there is a typical power gain of 13 db with a noise figure of 5.9 db. R_3 is used for stability. If desired, a 2N2998 transistor can be used to replace the 2N2996 transistor in the r-f amplifier input. This will produce a 3-db increase in power gain.

The local oscillator (Q_3) operates at 345 mc, using a Colpitts circuit with 5 mw of output power. In this circuit, because a buffer (Q_4) is used, less than 1 mw of power is necessary, and the buffer provides a constant load for the oscillator.

Q_2 is the mixer where the 105-mc i-f signal is produced. The impedance at the base is kept low for maximum performance. There are two stages of i-f amplification. The 105-mc i-f signal is coupled to the first i-f amplifier, which is a common-emitter circuit having a stable power gain of 20 db and a noise figure of 2.5 db. The second i-f amplifier is exactly like the first, and its output is fed to a 50-ohm load.

In this circuit, as shown, the 30-db bandwidth is 20 megacycles, while the 3-db bandwidth is 6.5 megacycles; the noise figure is 7 db with a power gain of 63 db.

$Q_1, Q_2, Q_3, Q_4, Q_5, Q_6$ —2N2996

C_1 —10 pf

C_2 —1.8-13 pf

C_3 —1.8-13 pf

C_4 —1000 pf (See C' Below)

C_5 —9-35 pf

C_6 —3 pf

C_7 —9-35 pf

C_8 —10 pf

C_9 —9-35 pf

C_{10} —3.0 pf

C_{11} —9-35 pf

C_{12} —10 pf

C_{13} —9-35 pf

C_{14} —3 pf

C_{15} —9-35 pf

C_{16} —10 pf

C_{17} —2.5 pf

C_{18} —0.9-7 pf

C_{19} —0.9-7 pf

C_{20} —220 pf

C_{21} —110 pf

C_{22} —1.8-13 pf

C'—1000 pf (Aerovox Hi-Q EF4 bypass cap.)

R_1 —1.5K

R_2 —3K

R_3 —3K

R_4 —51 ohms

R_5 —1.5K

R_6 —3K

R_7 —3K

R_8 —3K

R_9 —3K

R_{10} —1.5K

R_{11} —3K

R_{12} —3K

R_{13} —1.5K

R_{14} —1.5K

R_{15} —3K

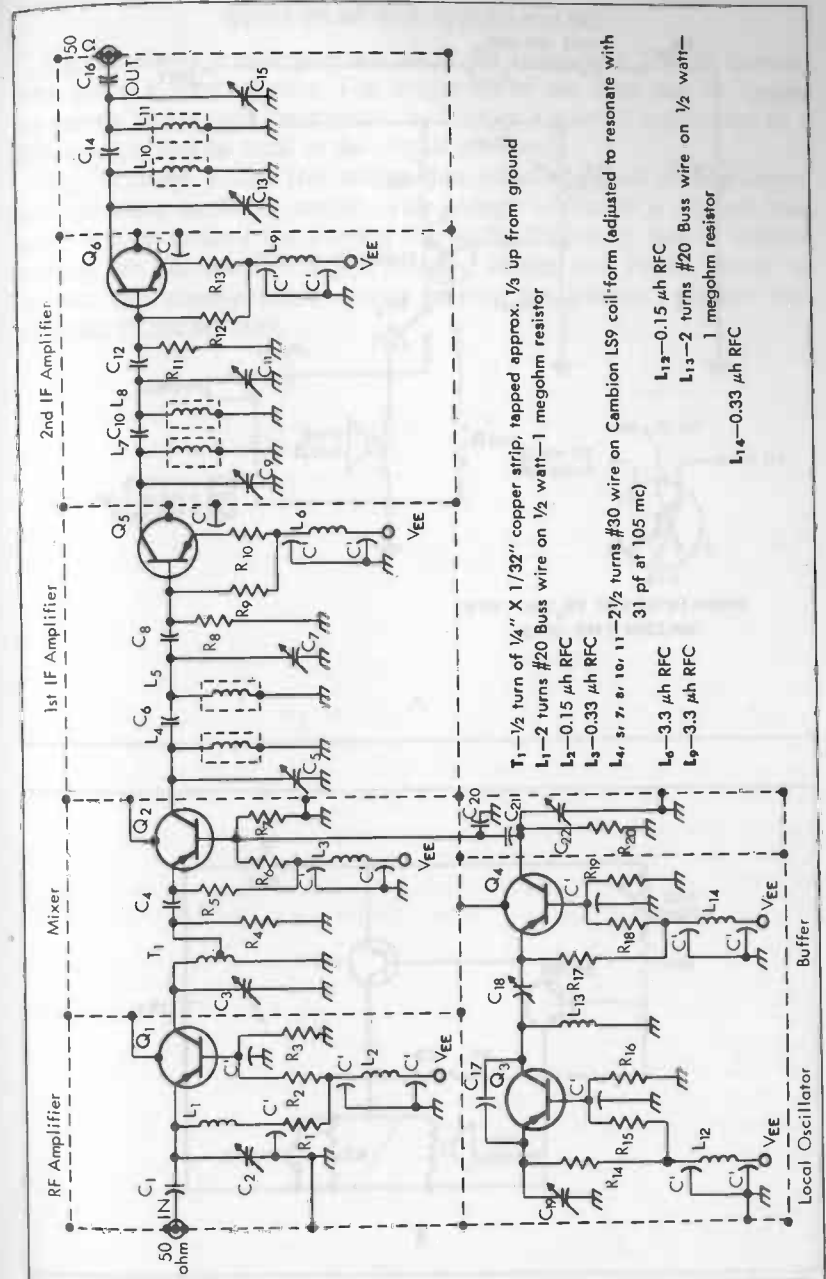
R_{16} —3K

R_{17} —1.5K

R_{18} —3K

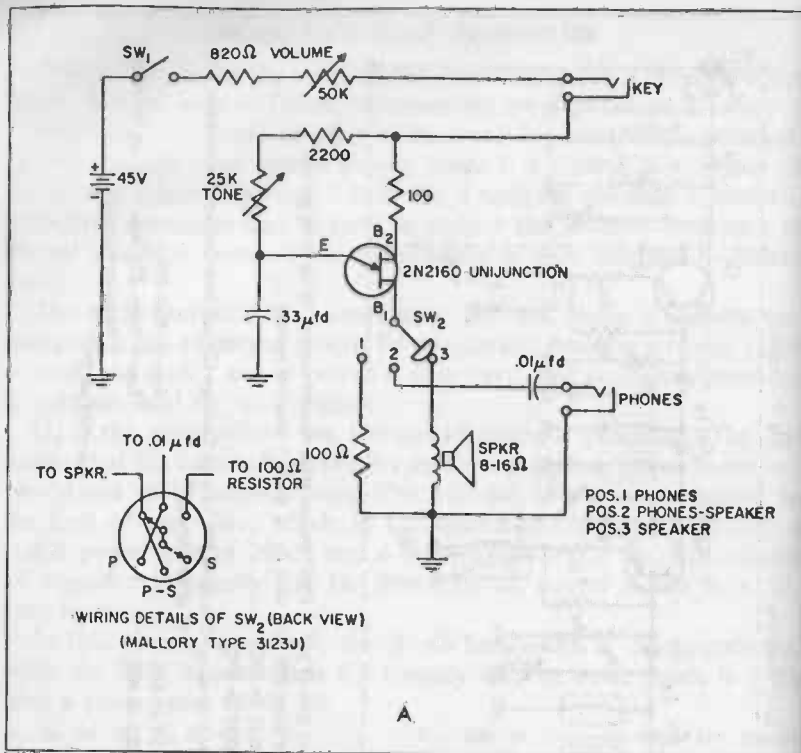
R_{19} —3K

R_{20} —510 ohms

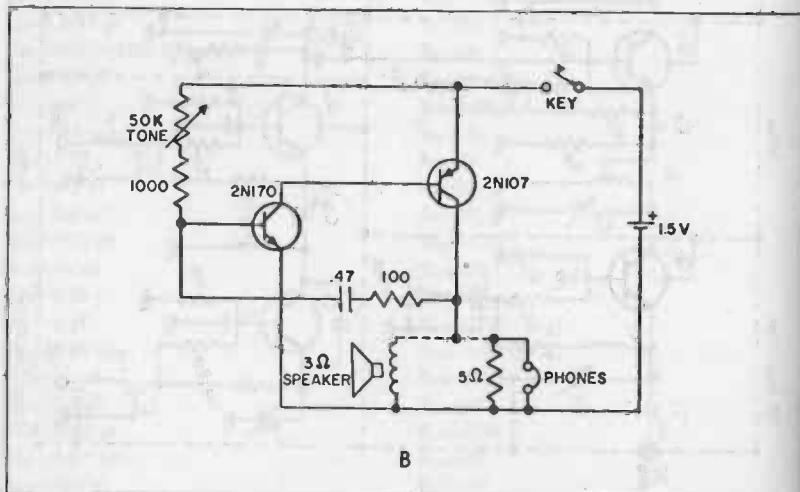


Courtesy Texas Instruments Inc.

450 mc-to-105 mc converter.



A



B

Courtesy General Electric Co.

Code-practice oscillators.

CODE-PRACTICE OSCILLATORS

Fig. A shows a code-practice oscillator using two 2N107 transistors and a 1.5-volt source. The frequency of the tone can be varied by means of the variable resistor, and either a pair of earphones or a PM speaker can be used in the circuit as shown.

Fig. B shows a 2N2160 unijunction transistor used in a different code-practice oscillator circuit. The voltage source is a 45-volt battery. A tone control for varying the audio frequency and a volume control are provided. A key is inserted in the jack in the circuit as shown; the three-position switch selects the phones, phones and speaker, or the speaker.

Section 3

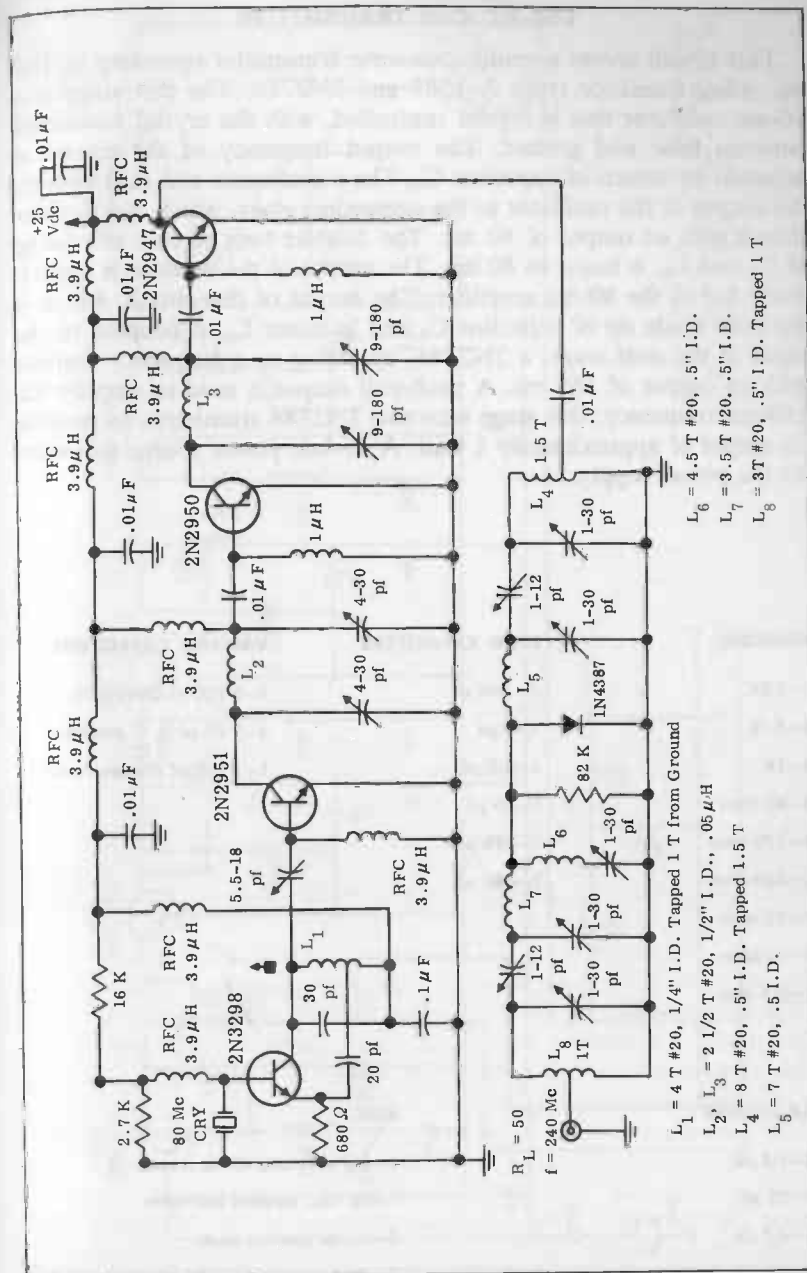
TRANSMITTERS AND RECEIVERS

240-MC 8-WATT TRANSMITTER

This circuit shows a four-transistor 8-watt continuous-wave transmitter operating at 240 mc; there is a varactor tripler circuit used for the output stage which triples the 80-mc signal to 240 mc and provides 8 watts of output power. Current drain for this circuit is 0.8 ampere from a 24-volt source.

The most significant part of this circuit is the tripler circuit. The 2N3298 is an 8-mc crystal oscillator that has three succeeding stages of amplification, a 2N2951, a 2N2950, and a 2N2947, as shown. The varactor circuit uses a 1M4387, and the circuit includes three tuned circuits. There is a tuned input, a tuned idler, and a tuned output circuit. The output circuit tuned to 240 mc is a double-tuned circuit with capacitive coupling; the idler circuit is tuned to 160 mc, and it is series tuned. The input circuit is capacitively coupled using double tuning, and it is adjusted for 80 mc.

Initial adjustment for the tripler circuit should be made using a 50-ohm, 80-mc source. The 80-mc drive should be adjusted for several watts, and each tuned circuit should be adjusted for maximum power output with a grid-dip meter. After the proper output is obtained, the drive source shown in the circuit should be used to feed the varactor or tripler. It will be necessary to retune the circuits for the proper rated power output and greatest circuit efficiency.



Courtesy Motorola Semiconductor Products

240-mc, 8-watt transmitter.

160-MC C-W TRANSMITTER

This circuit shows a continuous-wave transmitter operating at 160 mc, using transistor types A-1383 and 2N2786. The first stage is a 40-mc oscillator that is crystal controlled, with the crystal connected between base and ground. The output frequency of the crystal is adjusted by means of capacitor C_1 . The transformer coil (L_1) couples the output of the oscillator to the succeeding stage, which is a doubler circuit with an output of 80 mc. The doubler tank circuit, consisting of C_2 and L_2 , is tuned to 80 mc. The output of the doubler is capacitively fed to the 80-mc amplifier. The output of this circuit, which is the tank made up of capacitor C_3 and inductor L_3 , is coupled to the input of the next stage, a 2N2786, operating as a frequency doubler with an output of 160 mc. A push-pull output is used to amplify the 160-mc frequency; this stage uses two 2N2786 transistors to provide an output of approximately 1 watt. A 15-volt power source is needed for the power supply.

RESISTORS

1—8.2K
1—2.7K
1—1K
1—82 ohm
1—100 ohm
1—560 ohm
1—22 ohm
1—10 ohm
1—0.5 ohm

FIXED CAPACITORS

4—.001 pf
2—1 pf
1—2.2 pf
1—10 pf
1—270 pf
2—680 pf

VARIABLE CAPACITORS

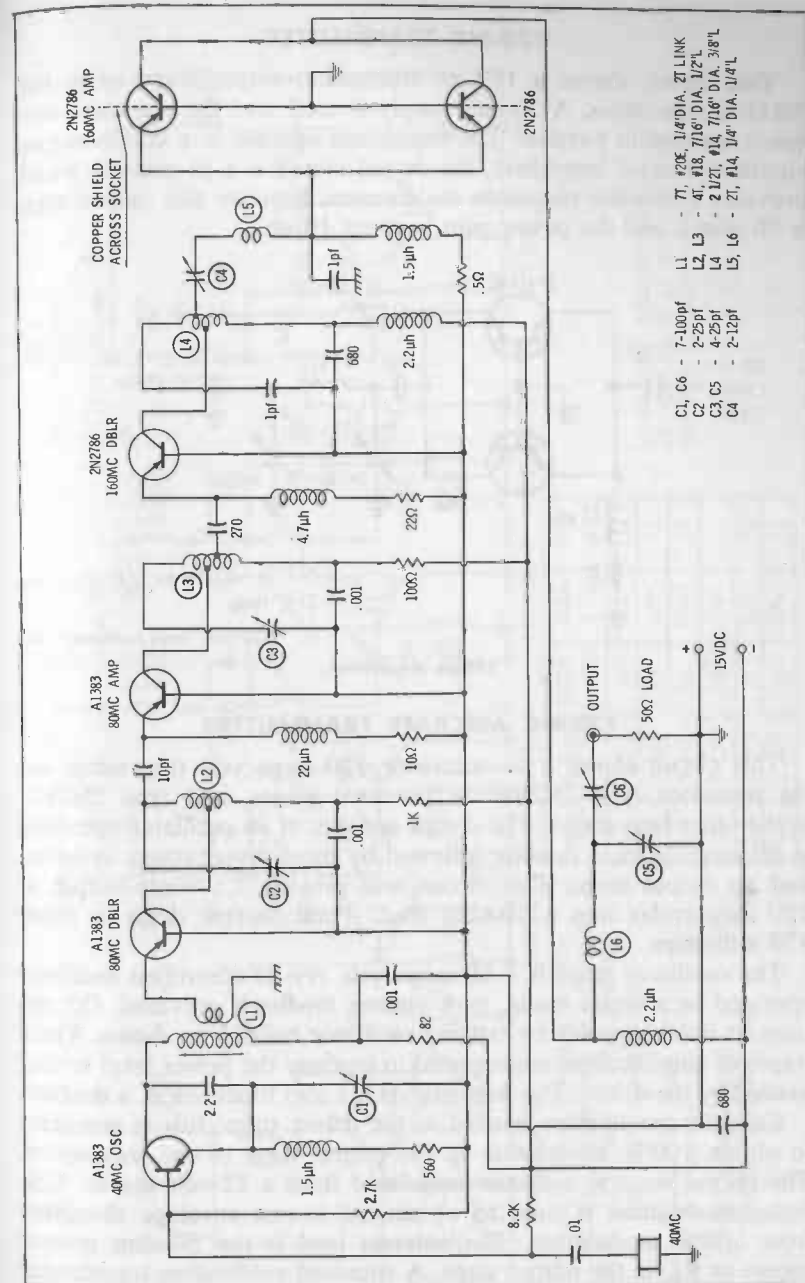
1—7-100 pf (Arco 423)
4—2.25 pf (E. F. Johnson)
1—7-100 pf (Hammarlund)

R-F CHOKES

2—1.5 μ h
1—22 μ h
1—4.7 μ h
2—2.2 μ h

MISC.

1—3rd overtone 40-mc crystal
1— $\frac{1}{4}$ "-dia. ceramic coil form
2—5-way binding posts
3—Heat sinks (Thermolly #2215B)
6—Transistor sockets



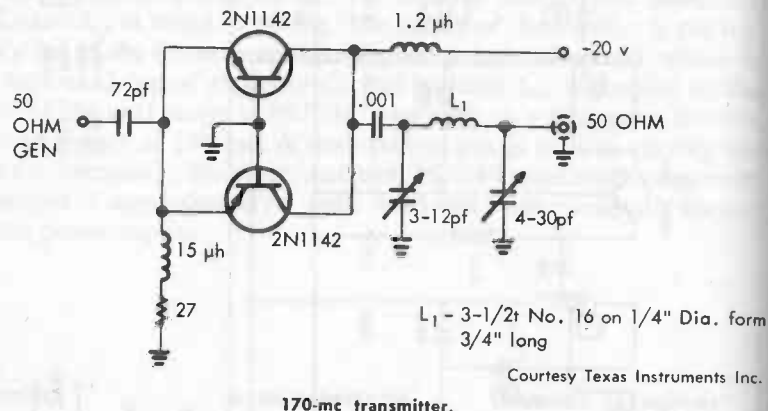
Courtesy Amperex Electronic Corp.

160-mc c-w transmitter.

L_1 - 71, 400E, $\frac{1}{4}$ " DIA. 2T LINK
 L_2 , L_3 - 41, 418, 7/16" DIA. 1/2" L
 L_4 - 2 1/2T, 414, 7/16" DIA. 3/8" L
 L_5 , L_6 - 21, 414, 1/4" DIA. 1/4" L
 C_1 , C_6 - 7-100pf
 C_2 - 2-25pf
 C_3 , C_5 - 4-25pf
 C_4 - 2-12pf

170-MC TRANSMITTER

This circuit shows a 170-mc transmitter-output stage using two 2N1142 transistors. A 20-volt supply is used, and the two transistors are connected in parallel. The transistors operate in a common-base circuit as class-C amplifiers; the output circuit is a pi network which provides a 50-ohm output to the antenna. Input to this output stage is 50 ohms, and the power gain is about 10 db.

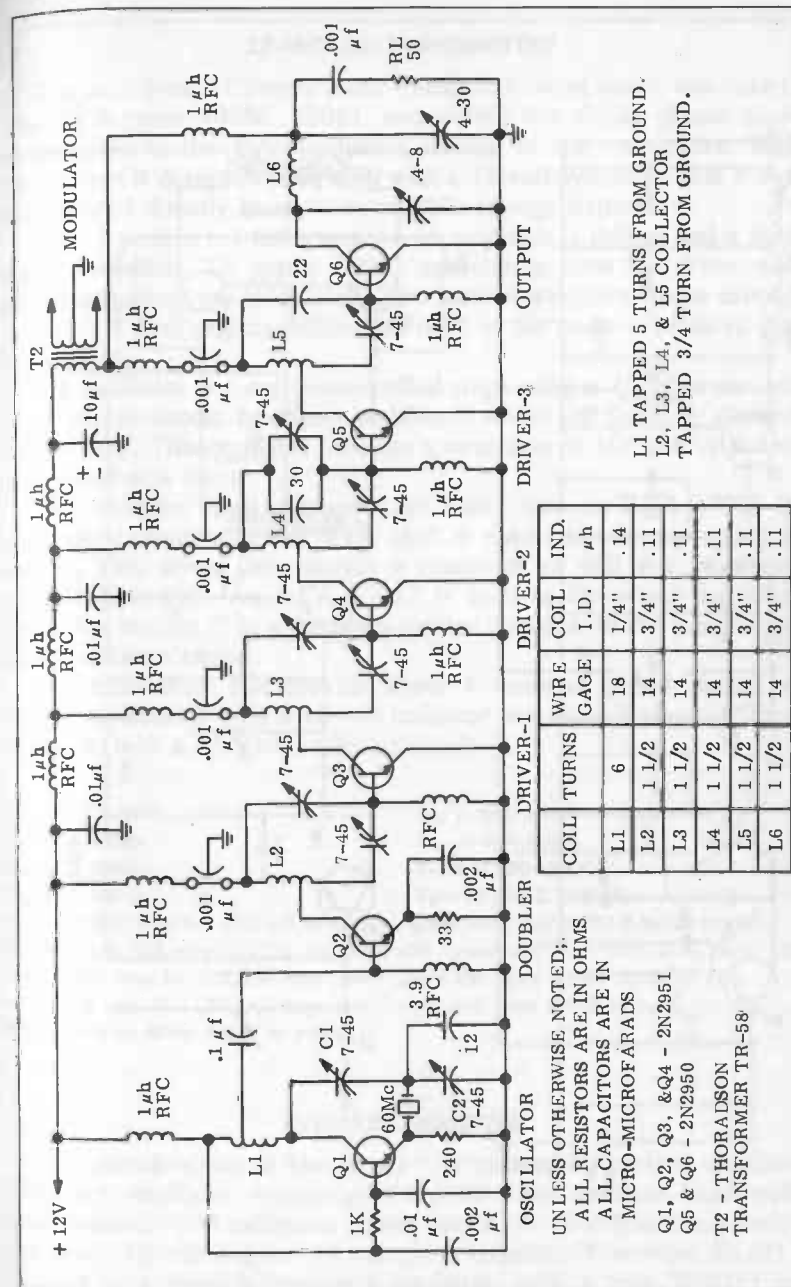


120-MC AIRCRAFT TRANSMITTER

This circuit shows a six-transistor 120-megacycle transmitter using transistor type 2N2950 in the final stages, and type 2N2951 in the other four stages. The circuit consists of an oscillator operating at 60 megacycles, a doubler followed by three driver stages in series, and an output stage. This circuit will provide 1.5 watts output at 120 megacycles into a 50-ohm load. Total current drain is about 370 milliamps.

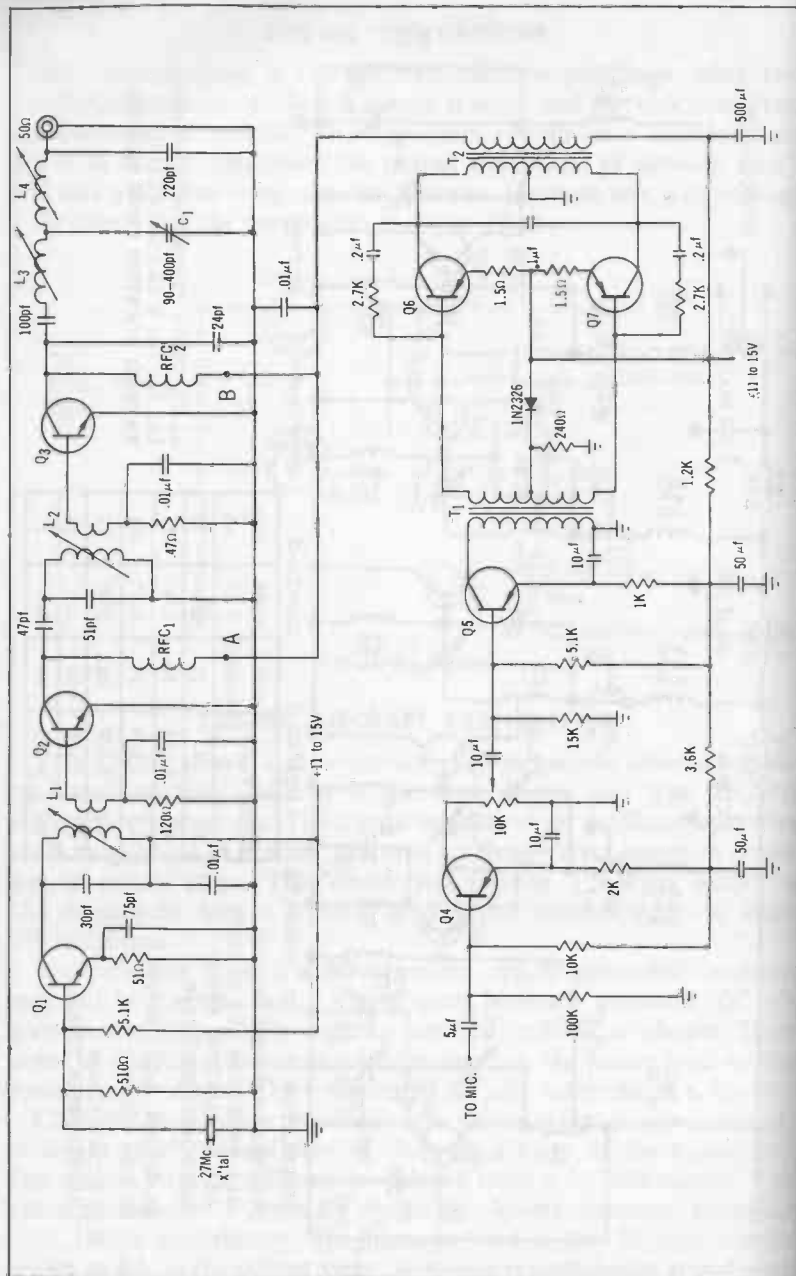
The oscillator stage is a 60-megacycle crystal-controlled oscillator operated in a series mode, with emitter feedback provided. Q2 obtains its driving power by tapping oscillator coil L1 as shown. Three stages of amplification are required to increase the power level to that needed by the driver. The transistor (Q2) also functions as a doubler.

Collector modulation is used in the driver stage; this is necessary to obtain 100% modulation in the output stage of the transmitter. The output stage is collector-modulated from a 12-volt source. Collector modulation is used to obtain the lowest envelope distortion from 100% modulation. The antenna load is the 50-ohm resistor shown as RL in the output stage. A standard modulation transformer is used in the audio-amplifier modulated circuit which feeds the r-f section of the transmitter.



Courtesy Motorola Semiconductor Products

120-mc aircraft transmitter.



Courtesy Radio Corporation of America

27-mc CB transmitter.

27-MC CB TRANSMITTER

This is a 5-watt Citizens band transmitter using seven transistors. The RCA types 40080, 40081, and 40082 are silicon planar transistors used in the radio-frequency section of the transmitter. This transmitter is designed to be used with a 12-volt system so that it can be operated directly from an automobile storage battery.

The r-f section has three stages—an oscillator, a driver, and a final power amplifier. To obtain 100% modulation both the driver and power amplifiers are modulated. Two class-A amplifier stages driving a class-AB push-pull modulator are used in the audio sections of this transmitter.

The oscillator is a crystal-controlled stage using a 40080 transistor in a Colpitts circuit; frequency stability is within the 0.005% allowed by the FCC. This oscillator provides a minimum of 100 mw of power using a 12-volt source.

The oscillator feeds a driver stage which uses an RCA 40081 in a common-emitter class-C stage that is modulated in the collector circuit. This driver can provide a minimum of 400 mw of power using a heat sink. An RCA 40082 is used as the power amplifier operating in class C in a common-emitter circuit with the modulation in the collector circuit.

The transmitter will provide about 4 watts of power output at 100% modulation with a 12-volt collector supply, and about 4 watts of output with a 13.5 volt collector supply.

C₁—ARCO #429 or equiv.

Q₁—RCA 40080

Q₂—RCA 40081

Q₃—RCA 40082

Q_{4, 5}—RCA 2N591

Q_{6, 7}—RCA 2N301

T₁—2.5K:200 ohm C.T.

T₂—100 ohm C.T.:30 ohm

L₁—14t:3t #22 wire 1/4" CTC coil form with "green dot" core 0.75-1.2 hy Q = 100

L₂—14t:2-3/4t #22 wire 1/4" CTC coil form with "green dot" core 0.75-1.2 hy Q = 100

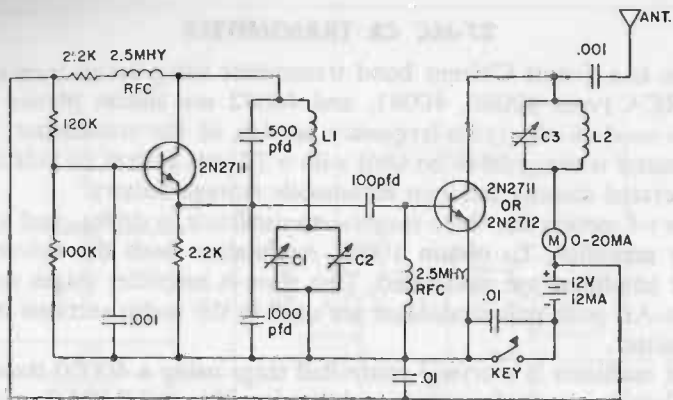
L₃—11t #22 wire 1/4" CTC coil form with "green dot" core 0.5-0.9 hy Q = 120

L₄—7t #22 wire 1/4" CTC coil form with "green dot" core 0.21-0.34 hy Q = 140

RFC_{1, 2}—15 hy Miller #4624 or equiv.

C-W TRANSMITTER

This circuit shows a low-power c-w transmitter with a variable-frequency oscillator operating in the 80-meter amateur band with approximately 100 milliwatts power output. A 12-volt source providing about 12 milliamperes of current is required. Transistor 2N2711 is used as a variable-frequency oscillator, with a type 2N2711 or 2N2712 used as the power-output stage. A key is shown for transmitting the c-w output.



C1 5-15pf BANDSPREAD VARIABLE
 C2 5-55pf BANSET VARIABLE
 C3 6-80pf FINAL TUNING VARIABLE

L1 57T
 L2 35T

B & W NO. 3016
 MINI-DUCTOR COILS
 1" DIA 32T/INCH

Courtesy General Electric Co.

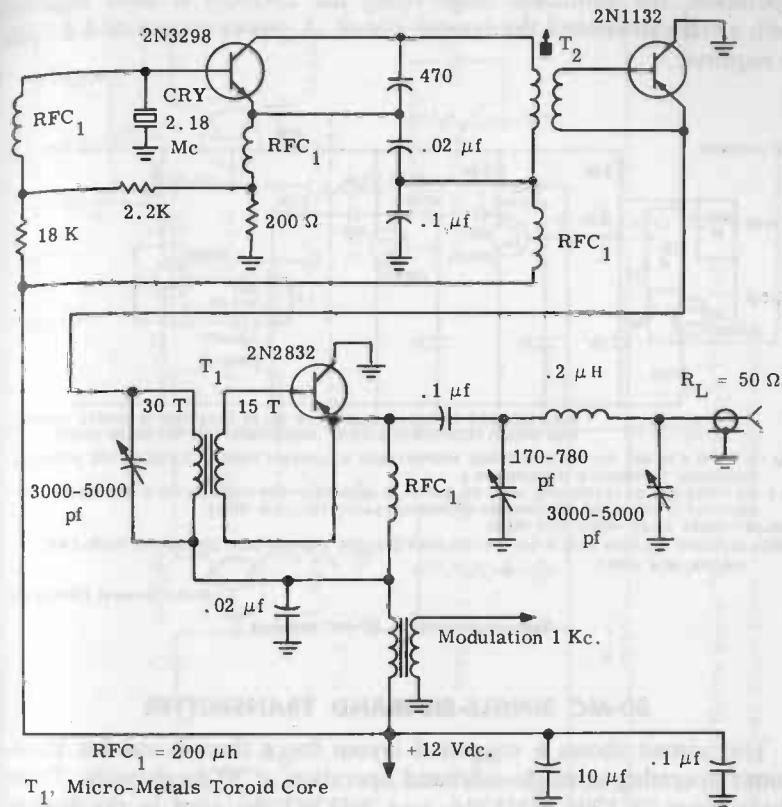
C-w transmitter.

20-WATT MARINE TRANSMITTER

This circuit shows a 20-watt marine transmitter operating on a frequency of 2.18 megacycles. Marine radio equipment of the radio-telephone type has transmitter power ratings (the d-c power required by the transmitter final) that vary from 15 watts up to several hundred watts in the frequency band from 2 to 3 megacycles. This transmitter uses three transistors in the r-f portion of the circuit as shown; the transistors are used in an output, a driver, and an oscillator stage. A 12-volt supply is used for this transmitter.

The transmitter will deliver 10 watts of carrier output into a 50-ohm load with an efficiency of about 48%. The modulation power required is about 7 watts at 10 ohms. A standard modulation transformer which will provide 10 ohms of secondary impedance into this circuit is used.

A crystal-controlled transmitter is used with direct crystal drive at 2.18 megacycles. The output stage is a 2N2832 which delivers the 10 watts of output power into a 50-ohm load; this is the approximate load of a 9-foot whip antenna which is bottom-loaded. Drive power for the output stage is about 1 watt, and the input impedance of this stage is 5 ohms. A special transformer, as shown, is used to provide this impedance transformation from the driver stage, which is a type 2N1132. The driver stage provides about 1 watt of carrier power to drive the output stage, and the required emitter loading for this power level is about 72 ohms.



RFC₁ = 200 μh

T₁, Micro-Metals Toroid Core
 T-50-2 Bifilar
 T₂, Pri. 40 T, #28, 1/4" ID Slug Tuned Form
 Sec. 8 T, #28, Wound over Pri.

Courtesy Motorola Semiconductor Products

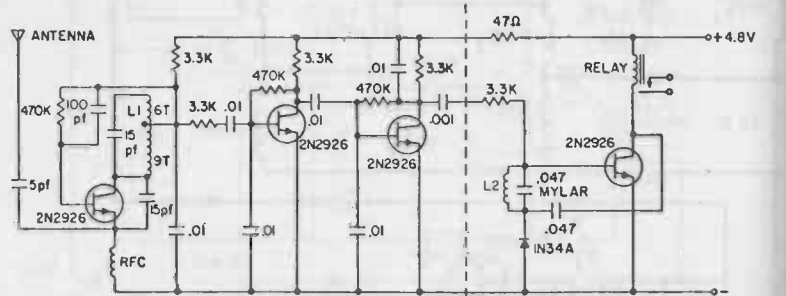
20-watt marine transmitter.

SUPERREGENERATIVE 27-MC RECEIVER

This circuit shows a four-transistor superregenerative receiver for operation in the 27-megacycle band. It is designed to be used for speech reception or for relay operation in remote control.

The regenerative detector uses a type 2N2926 transistor. This stage is followed by two stages of amplification, using type 2N2926 transistors. When the receiver is used for reception, the output is taken from the 0.001-mfd capacitor. If it is to be used for remote-control

operation, the additional stage using the 2N2926 is used together with a relay to control the remote circuit. A power source of 4.8 volts is required.



BUILD RECEIVER TO THIS POINT IF ONLY SPEECH RECEPTION IS DESIRED. FOR RELAY OPERATION IN REMOTE CONTROL APPLICATIONS ADD THIS RELAY CIRCUIT

- L1 - 15 TURNS #24 AWG TAPPED AT 6 TURNS, PROPORTIONED AS SHOWN 6 TURNS/9 TURNS ON CTC #SPC11-4L (CAMBRIDGE THERMIONICS CORPORATION)
- L2 - 180 TURNS AWG ON FERROXCUBE 1408-FID BOBBIN, IN 1408-PI00-385 CUPCORE, HELD BY 1408 BRACKET ASSEMBLY. (FERROXCUBE CORPORATION OF AMERICA, SAUGERTIES, NEW YORK)
- RELAY - OMEGA SALES HR300 REED RELAY
- RFC - 22μ HENRY DELAVAN TYPE #1537-44 (DELAVAN ELECTRIC CORPORATION, 270 QUAKER ROAD, EAST AURORA, NEW YORK)

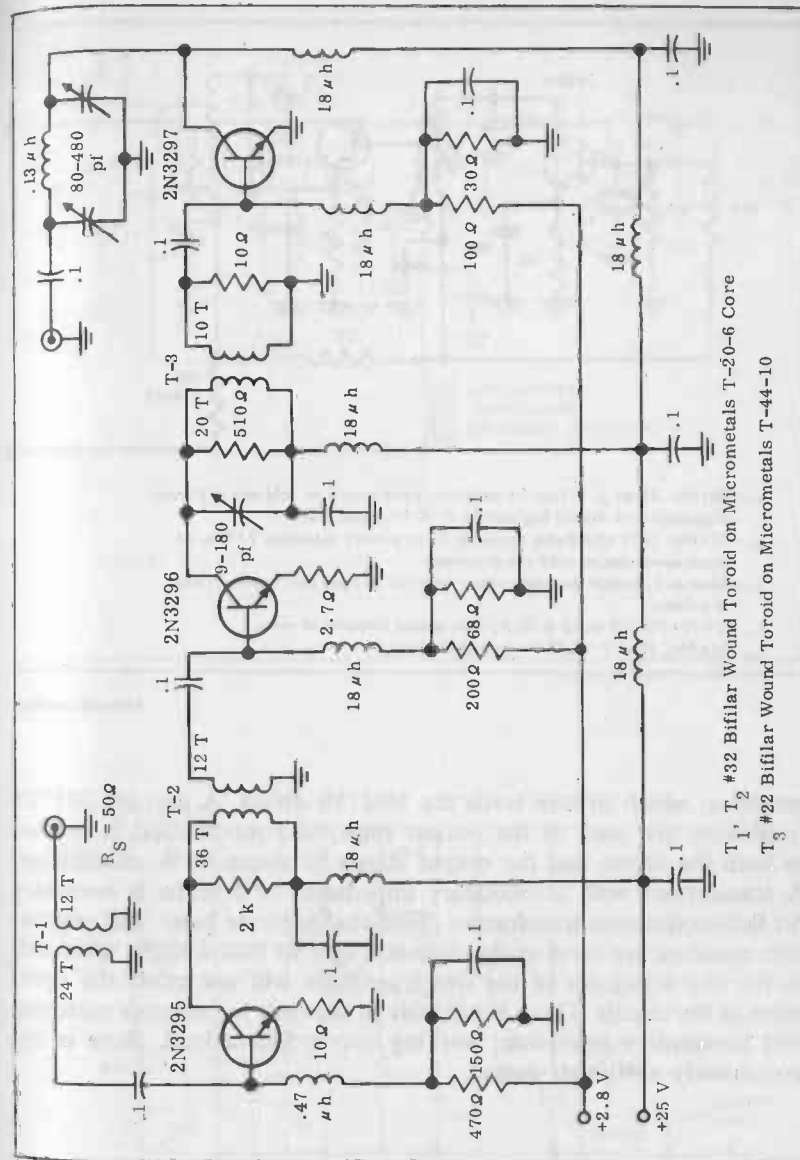
Courtesy General Electric Co.

Superregenerative 27-mc receiver.

30-MC SINGLE-SIDEBAND TRANSMITTER

This circuit shows a suggested layout for a three-transistor transmitter operating in single-sideband operation at 30 megacycles. Transistor types 2N3295, 2N3296, and 3N3297 are used in the circuit. Peak envelope power is 10 watts, and the overall power gain is about 35 db. Current feedback for stability is used in the first two stages by using resistors without bypass capacitors in the emitters. The circuit is a linear amplifier for 30-megacycle operation in single sideband, and it requires a driver with a 50-ohm input to transformer T-1, which feeds transistor 2N3295.

In testing this circuit, the odd-order distortion products measured on a two-tone test were greater than 30 db down from reference level. It is necessary to obtain the utmost in linear operation for a transmitter of this type. The driving-source impedance is obtained in this circuit by using toroid transformers with a high amount of coupling. Transformer T-1 provides a four-to-one step-up of the 50-ohm output from the exciter; T-2 steps up the 20-ohm input resistance of the 2N2950 to the 180 ohms required for the collector loading of the 2N2951. A three-to-one turns ratio is used. A resistor of 2K across the primary of transformer T-2 is used to obtain the maximum base-driving 220-ohm impedance for the 2N2950.

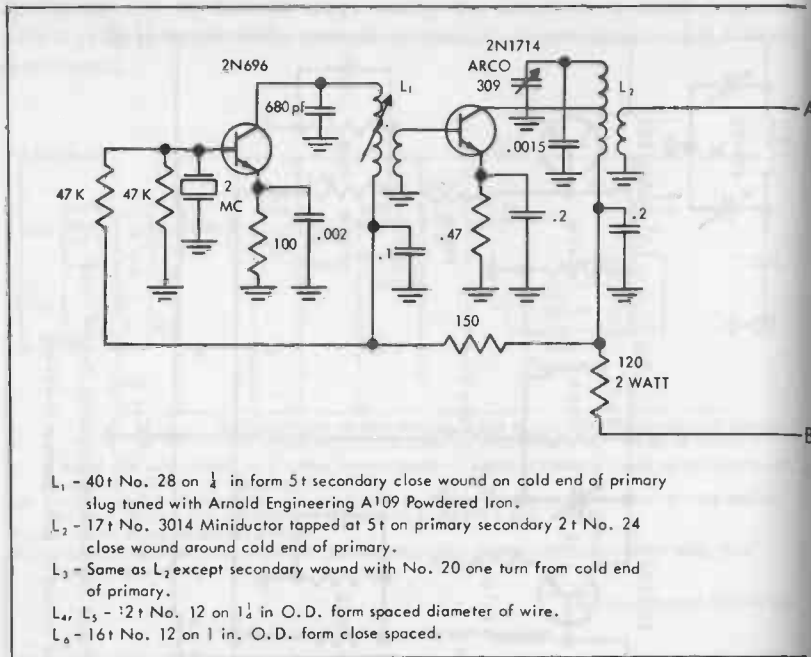


Courtesy Motorola Semiconductor Products

30-mc single-sideband transmitter.

40-WATT MARINE TRANSMITTER

This circuit shows five transistors in a 40-watt, 2-megacycle marine transmitter. A 2N696 is used as a local oscillator feeding the 2N1714

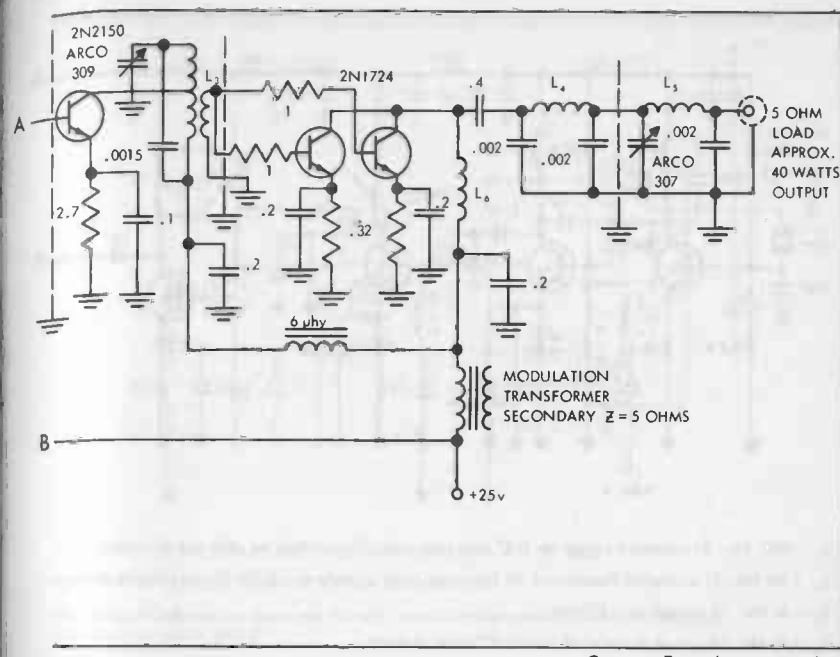


40-watt marine

amplifier, which in turn feeds the 2N2150 driver. A pair of 2N1724 transistors are used as the output stage, and modulation is applied to both the driver and the output stages to obtain 80% modulation. A transformer with a secondary impedance of 5 ohms is necessary for this modulation transformer. Note that separate base- and emitter-bias resistors are used in the output stages so that a slight mismatch in the characteristics of the two transistors will not affect the operation of the circuit. There is a double pi network for antenna matching and harmonic suppression; working into a 5-ohm load, there is approximately a 40-watt output.

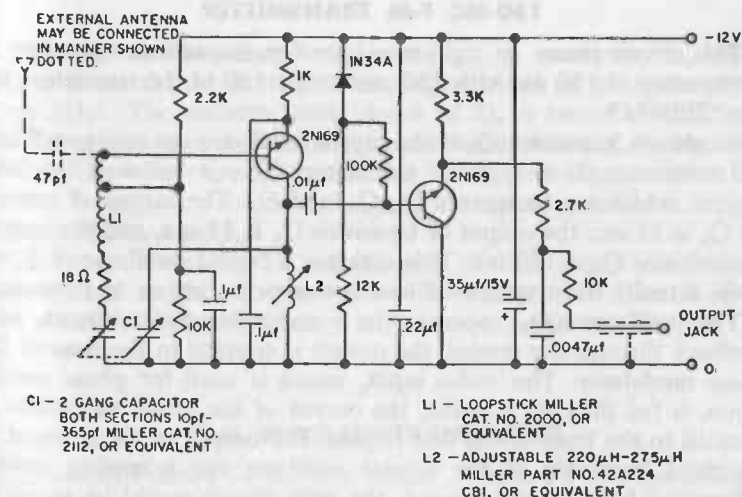
A-M TUNER

This circuit shows a very simple two-transistor a-m tuner using type 2N169 transistors and a 12-volt source. A loopstick is used for the antenna and, if desired, an external antenna can be connected. A 1N34A is used as the detector, and the output from the jack goes to the associated audio amplifier.



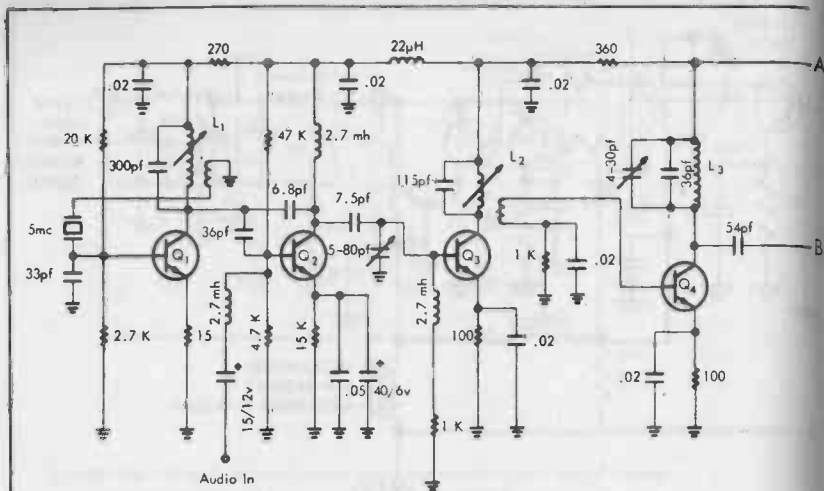
Courtesy Texas Instruments Inc.

transmitter.



Courtesy General Electric Co.

A-m tuner.



- L₁ - 18t No. 24 enameled copper on 1/4" form slug tuned-2t secondary on cold end of primary
- L₂ - 10t No. 21 enameled copper on 1/4" form slug tuned secondary - 2t No 24 on cold end of primary
- L₃ - 6t No. 18 spaced on 1/4" form
- L₄ - 2t No. 18 spaced diameter of wire 1/4" inside diameter

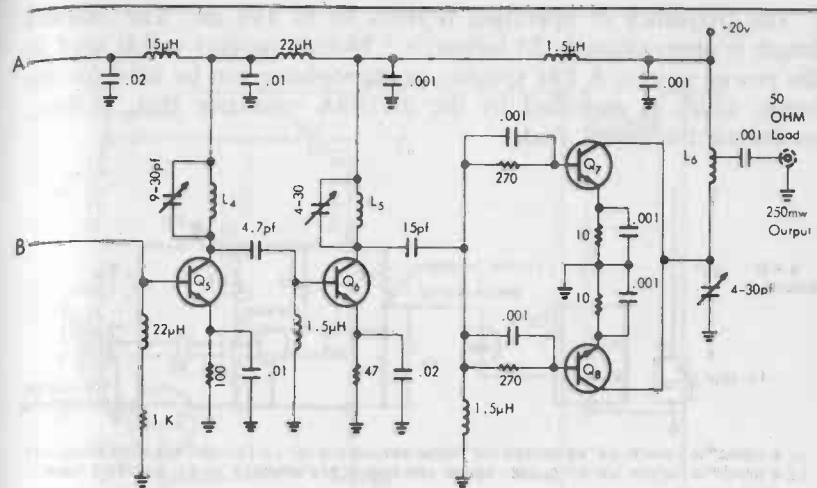
150-mc f-m

150-MC F-M TRANSMITTER

This circuit shows an eight-transistor f-m transmitter operating at a frequency of 150 mc with 250 mw output; all of the transistors are type TI2N743.

As shown, transistor Q₁ is the crystal oscillator operating at 5 mc, and transistor Q₂ is a phase modulator. This is followed by three triplers, which are transistors Q₃, Q₄, and Q₅. The output of transistor Q₃ is 15 mc, the output of transistor Q₄ is 45 mc, and the output of transistor Q₅ is 135 mc. This assumes a crystal oscillator of 5 mc, while actually the crystal oscillator is somewhat higher in frequency.

The oscillator (Q₁) operates in a common-emitter circuit, with feedback through the crystal; the output is coupled to the base of the phase modulator. The audio input, which is used for phase modulation, is fed through a choke; the output of the phase modulator is coupled to the base of the first tripler. The output of Q₃ is tuned to the third harmonic of the crystal oscillator for a tripling action. Where a 5.5-mc crystal is used, the tank circuit would be tuned to 16.5 mc, and the output of the first tripler is coupled to Q₄, the second tripler. The output from the second tripler is 49.5 mc.



- L₅ - 2t No. 18 spaced two times the diameter of the wire on 1/4" form

- L₆ - Same as L₅ except tapped at 3/4 turn from cold end

All values of inductances shown are for self resonate chokes made by Delevan Company
All transistors are TI 2N743

Courtesy Texas Instruments Inc.

transmitter.

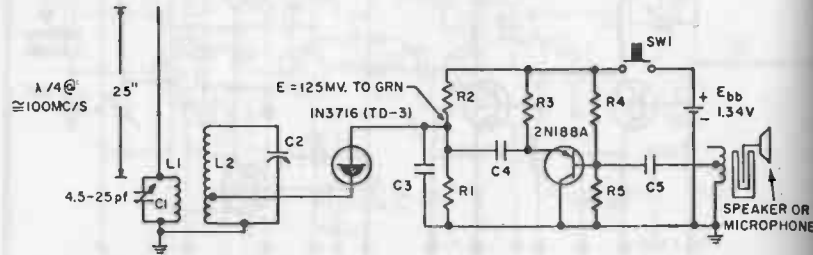
The 49.5-mc frequency is again tripled by transistor Q₅, whose output is tuned to 148.5 mc. This output is fed to the buffer-driver stage (Q₆). The collector tank circuit of Q₆ is tuned to 148.5 mc, and the output from the buffer is coupled to the bases of the two units Q₇ and Q₈, which are in parallel for the output. Separate bias and emitter resistors are used in the output stage to provide a balance between the two units.

Except for transistors Q₁ and Q₂, each of these stages is self-biased and operates as class C. This transmitter can provide 5 kc of deviation about the carrier frequency, with a power output of 250 mw.

F-M WIRELESS TRANSMITTER

This circuit shows the use of a tunnel diode in a f-m wireless short-range transmitter. As designed, the circuit will operate at a range of approximately 200 yards when it is used with a sensitive commercial f-m receiver.

The frequency of operation is from 96 to 110 mc. The antenna length is approximately 25 inches; a 1.34-volt mercury cell is used as the power source. A PM speaker or microphone can be used for the input, which is amplified by the 2N188A transistor that, in turn, modulates the tunnel diode.



- L1 2 TURNS #16 COPPER 3/8" ID SPACED 1/8" FROM GROUND END OF L2 (ADJUST FOR BEST STABILITY)
 L2 6 TURNS #16 COPPER 3/8" ID CLOSE-WOUND AND CONNECTED DIRECTLY TO C2. TAPPED 1 TURN FROM GROUND.
 C1 4.5-25 μfd CERAMIC TRIMMER
 C2 1.5-5 μfd VARIABLE
 C3 800 μfd (VOLTAGE NOT IMPORTANT-SELECT FOR SMALL SIZE)
 C4 50 μfd 6 VDC ELECTROLYTIC (VOLTAGE NOT IMPORTANT-SELECT FOR SMALL SIZE)
 C5 1 μfd 35 VDC (VOLTAGE NOT IMPORTANT-SELECT FOR SMALL SIZE)
 R1 18 Ω 1/2 W 5%
 R2 150 Ω 1/2 W 5%
 R3 470 Ω 1/4 W
 R4 10 K Ω 1/4 W
 R5 10 K Ω 1/4 W
 E_{bb} MALLORY RM-12R MERCURY CELL 1.34 VDC-3600 MAH
 SW1 NORMALLY OPEN SPST "PUSH-TO-TALK" SWITCH
 SPKR 2" PM SPEAKER
 IN3716 (TD-3) 4.7 MA AXIAL TUNNEL DIODE

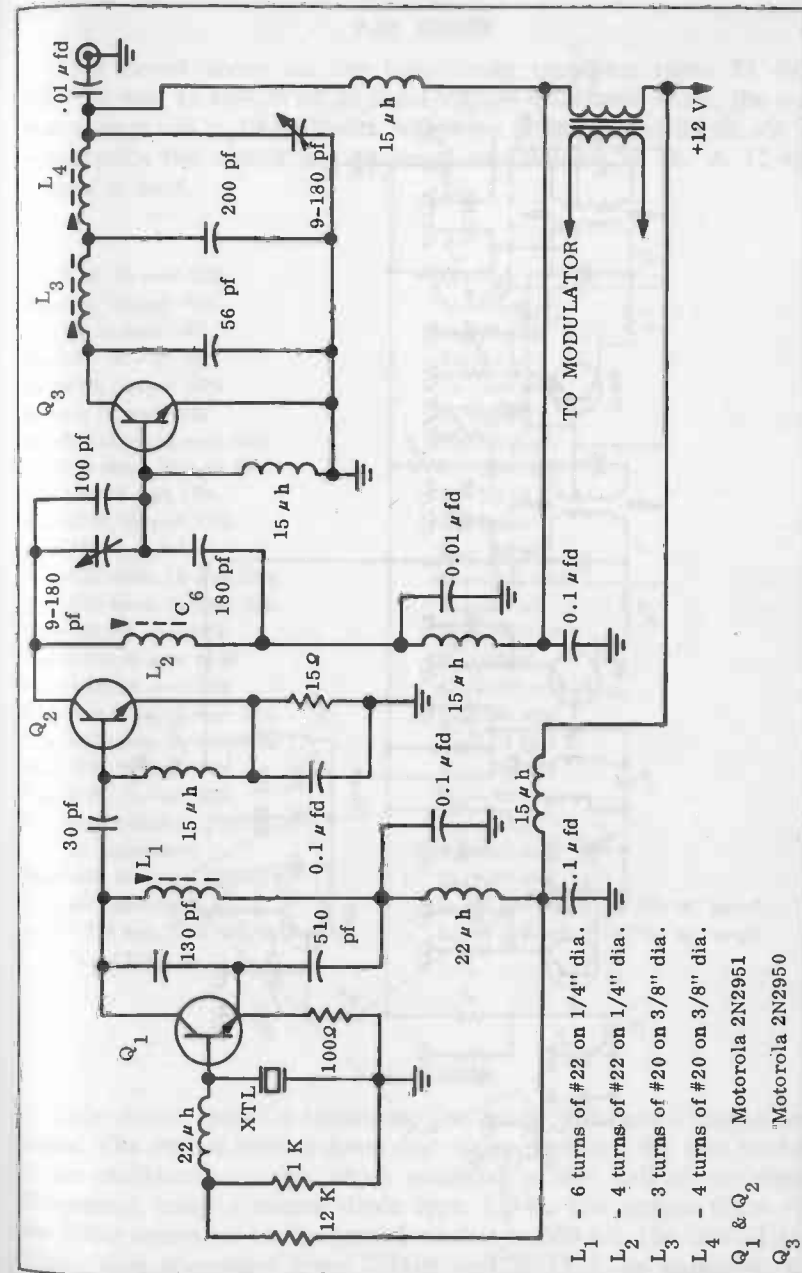
Courtesy General Electric Co.

F-m wireless transmitter.

27-MC CITIZENS BAND TRANSMITTER

This circuit shows a three-transistor Citizens band transmitter operating with a power output of 5 watts. The audio portion of the circuit is not shown; it is a standard audio amplifier which becomes a modulator for the transmitter. A 2N2950 transistor is used as the transmitter final stage. It provides a power output of greater than 2 watts unmodulated, and 3.2 watts modulated with a single transistor. This power transistor uses a stud mount with isolated leads so that it can be mounted directly on the chassis.

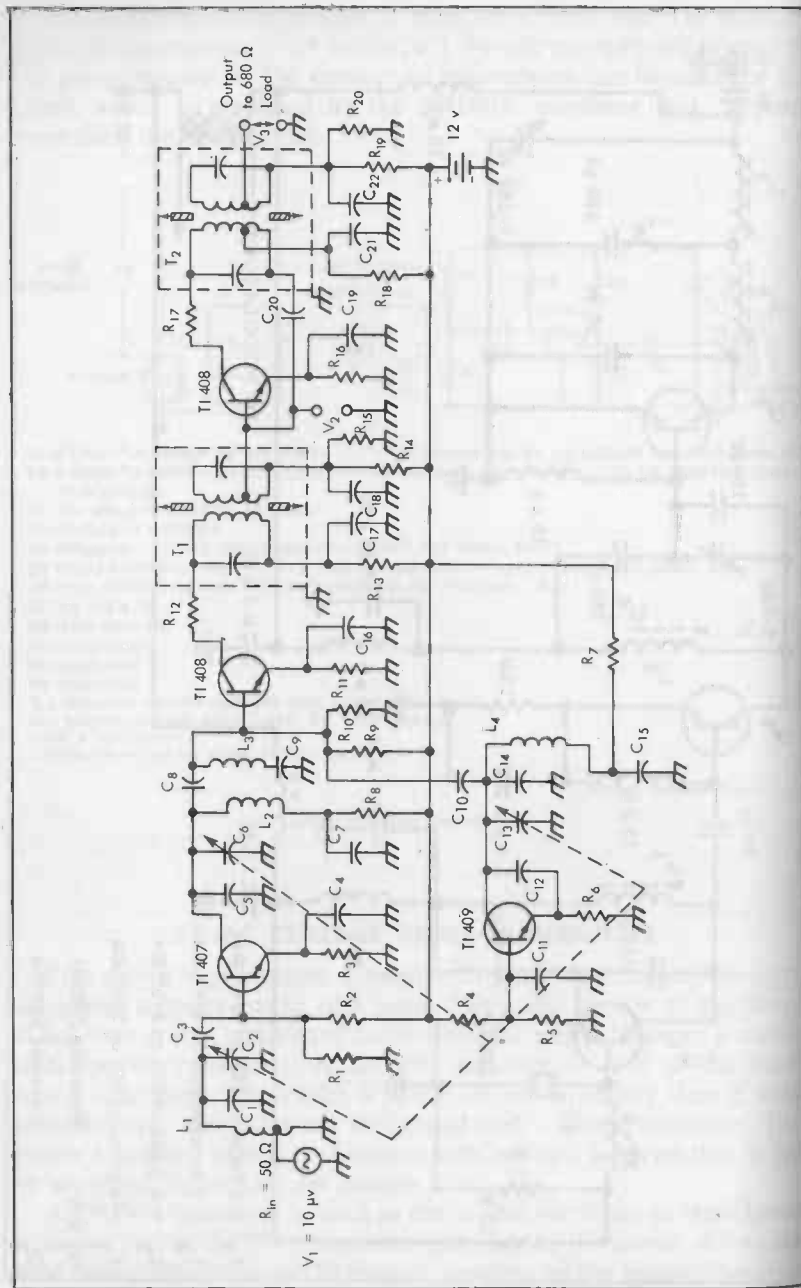
A 2N2951 transistor is used as the crystal oscillator in this circuit; it feeds a second 2N2951 transistor operating as the driver. An audio-modulating impedance of 39 ohms is required by the circuit; therefore the transformer that is chosen must match the modulator and provide an impedance of 39 ohms in series with the 12-volt supply.



- L1 - 6 turns of #22 on 1/4" dia.
 L2 - 4 turns of #22 on 1/4" dia.
 L3 - 3 turns of #20 on 3/8" dia.
 L4 - 4 turns of #20 on 3/8" dia.
 Q1 & Q2 Motorola 2N2951
 Q3 Motorola 2N2950

Courtesy Motorola Semiconductor Products

5-watt CB transmitter.



Courtesy Texas Instruments Inc.

F-m tuner.

F-M TUNER

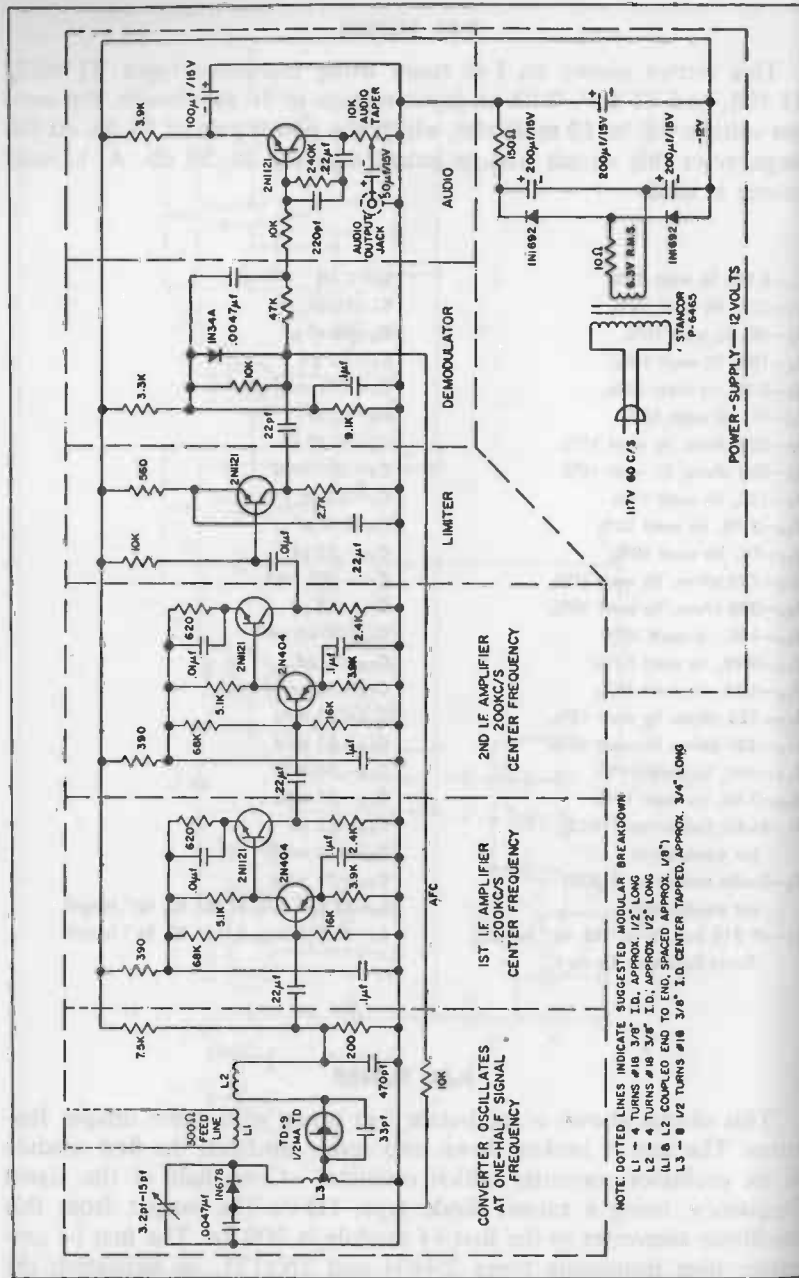
This circuit shows an f-m tuner using transistor types TI 407, TI 408, and TI 409. With an input voltage of 10 microvolts, the output voltage will be 19 millivolts, which is a power gain of 54 db. At 98 megacycles this circuit has an image rejection of 50 db. A 12-volt source is used.

- R₁—8.2K, 1/2 watt 10%
- R₂—33K, 1/2 watt 10%
- R₃—1K, 1/2 watt 10%
- R₄—12K, 1/2 watt 10%
- R₅—2.7K, 1/2 watt 10%
- R₆—1K, 1/2 watt 10%
- R₇—330 ohms, 1/2 watt 10%
- R₈—330 ohms, 1/2 watt 10%
- R₉—15K, 1/2 watt 10%
- R₁₀—2.7K, 1/2 watt 10%
- R₁₁—1K, 1/2 watt 10%
- R₁₂—120 ohms, 1/2 watt 10%
- R₁₃—330 ohms, 1/2 watt 10%
- R₁₄—10K, 1/2 watt 10%
- R₁₅—3.9K, 1/2 watt 10%
- R₁₆—1.2K, 1/2 watt 10%
- R₁₇—120 ohms, 1/2 watt 10%
- R₁₈—330 ohms, 1/2 watt 10%
- R₁₉—10K, 1/2 watt 10%
- R₂₀—3.9K, 1/2 watt 10%
- T₁—Radio Industries #18300
(or equivalent)
- T₂—Radio Industries #18301
(or equivalent)
- L₁—4T #18 bus, 5/16" ID, 3/4" length,
Turns Ratios ≈ 1/2 to 4

- L₃—1 μh
- C₁—10 pf
- C₂—30-45 pf
- C₃—3.3 pf
- C₄—.001 mfd
- C₅—10 pf
- C₆—30-45 pf
- C₇—.001 mfd
- C₈—3.3 pf
- C₉—240 pf
- C₁₀—.82 pf
- C₁₁—.001 mfd
- C₁₂—3.3 pf
- C₁₃—30-45 pf
- C₁₄—10 pf
- C₁₅—.001 mfd
- C₁₆—.01 mfd
- C₁₇—.01 mfd
- C₁₈—.01 mfd
- C₁₉—.01 mfd
- C₂₀—2.2 pf
- C₂₁—.01 mfd
- C₂₂—.01 mfd
- L₂—4T #18 bus, 5/16" ID, 3/4" length
- L₄—3T #18 bus, 5/16" ID, 3/4" length

F-M TUNER

This circuit shows a solid-state f-m tuner with some unique features. The unit is broken down into seven modules; the first module is an oscillator-converter which oscillates at one half of the signal frequency, using a tunnel diode type TD-9. The output from this oscillator-converter to the first i-f module is 200 kc. The first i-f amplifier uses transistors types 2N404 and 2N1121, as indicated; the second i-f module, operating at the same center frequency, uses the same type transistors as the first i-f stage.



Courtesy General Electric Co.

F-m tuner.

The limiter uses a type 2N1121 transistor as a single-stage limiter feeding the demodulator, a 1N34A diode. The output from the demodulator is fed to the audio module which uses a type 2N1121 transistor as an audio amplifier to provide an audio output to the necessary amplifier. The power-supply module provides 12 volts from a standard a-c line.

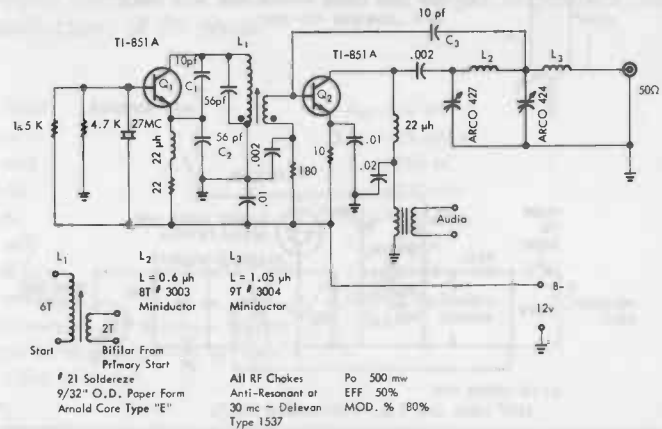
1-WATT 27-MC TRANSMITTER

This circuit shows a 27-megacycle Citizens band transmitter operating with a d-c power input to the final of 1 watt with an r-f power output of 500 milliwatts. This circuit can be considered typical of a 1-watt 27-megacycle unit; it consists of a crystal-controlled oscillator and a modulated power amplifier.

Transistor Q₁, a TI851A, is operated as a common-base stage, with the base being grounded only at the crystal frequency. Collector-to-emitter feedback is through capacitor C₁, and the feedback depends on the ratio between capacitor C₂ and capacitor C₁.

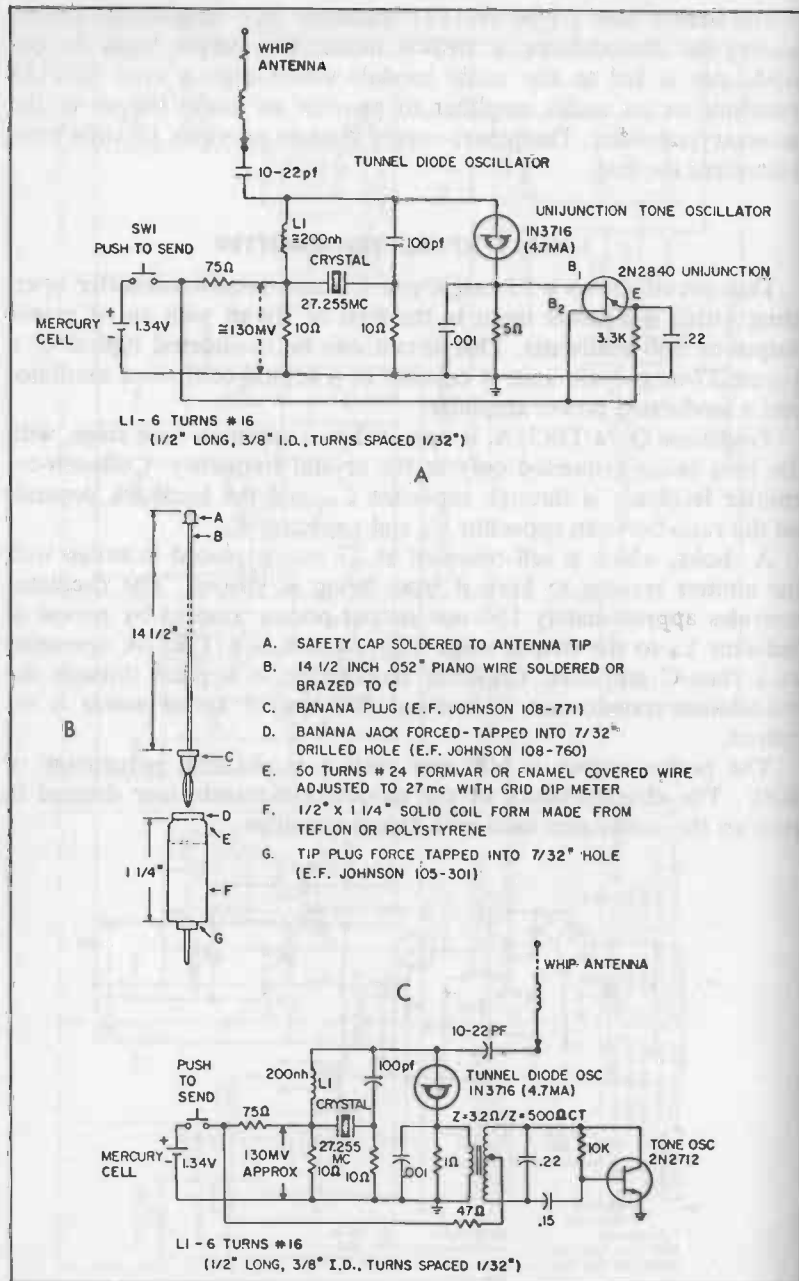
A choke, which is self-resonant at 27 mc, is placed in series with the emitter resistor to keep it from being at ground. The oscillator provides approximately 150 mw output power coupled by means of inductor L₁ to the output stage (Q₂), which is a TI851A operating as a class-C amplifier. Collector modulation is applied through the modulation transformer, and about 500 mw of audio power is required.

The power output is 500 mw with a modulation percentage of 80%. The characteristics of the modulation transformer depend in part on the modulator used with this transmitter.



Courtesy Texas Instruments Inc.

1-watt, 27-mc transmitter.



Ultra-low-powered transmitters.

Courtesy General Electric Co.

ULTRALOW-POWERED TRANSMITTERS

The tunnel diode can be used to provide a low power source of radio-frequency energy, as in a remote-control transmitter for operating garage doors or toys. Voice modulation is also possible, as shown in the following circuits.

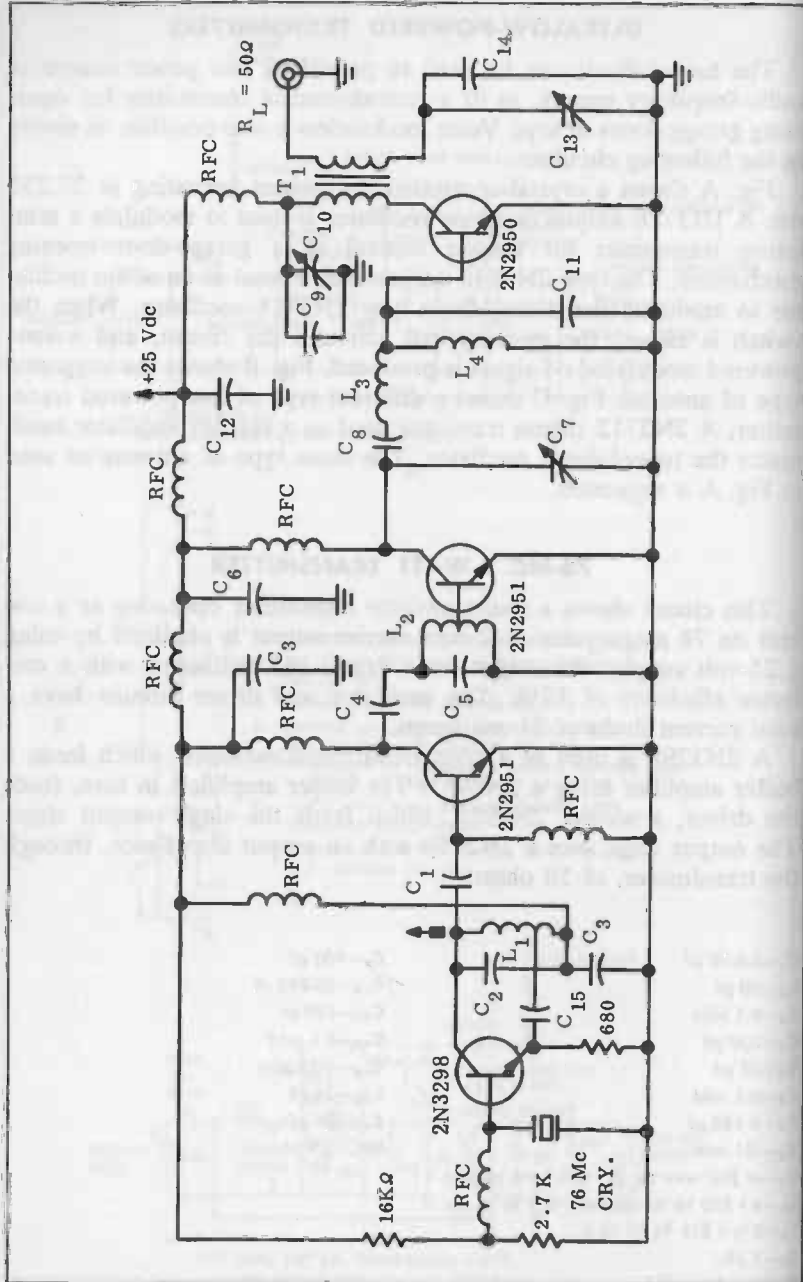
Fig. A shows a crystal-controlled transmitter operating at 27.255 mc. A 1N3716 unijunction tone oscillator is used to modulate a miniature transmitter for remote control of a garage-door opening mechanism. The type 2N2840 unijunction is used as an audio oscillator to modulate the tunnel-diode type 1N3716 oscillator. When the switch is closed, the mercury cell activates the circuit, and a low-powered modulated r-f signal is produced. Fig. B shows the suggested type of antenna. Fig. C shows a different type of low-powered transmitter. A 2N2712 silicon transistor used as a Hartley oscillator modulates the tunnel-diode oscillator. The same type of antenna as used in Fig. A is suggested.

76-MC 2-WATT TRANSMITTER

This circuit shows a four-transistor transmitter operating as a c-w unit on 76 megacycles. A 2-watt carrier output is obtained by using a 25-volt supply; the output stage draws 145 milliamps with a collector efficiency of 55%. The oscillator and driver circuits have a total current drain of 21 milliamps.

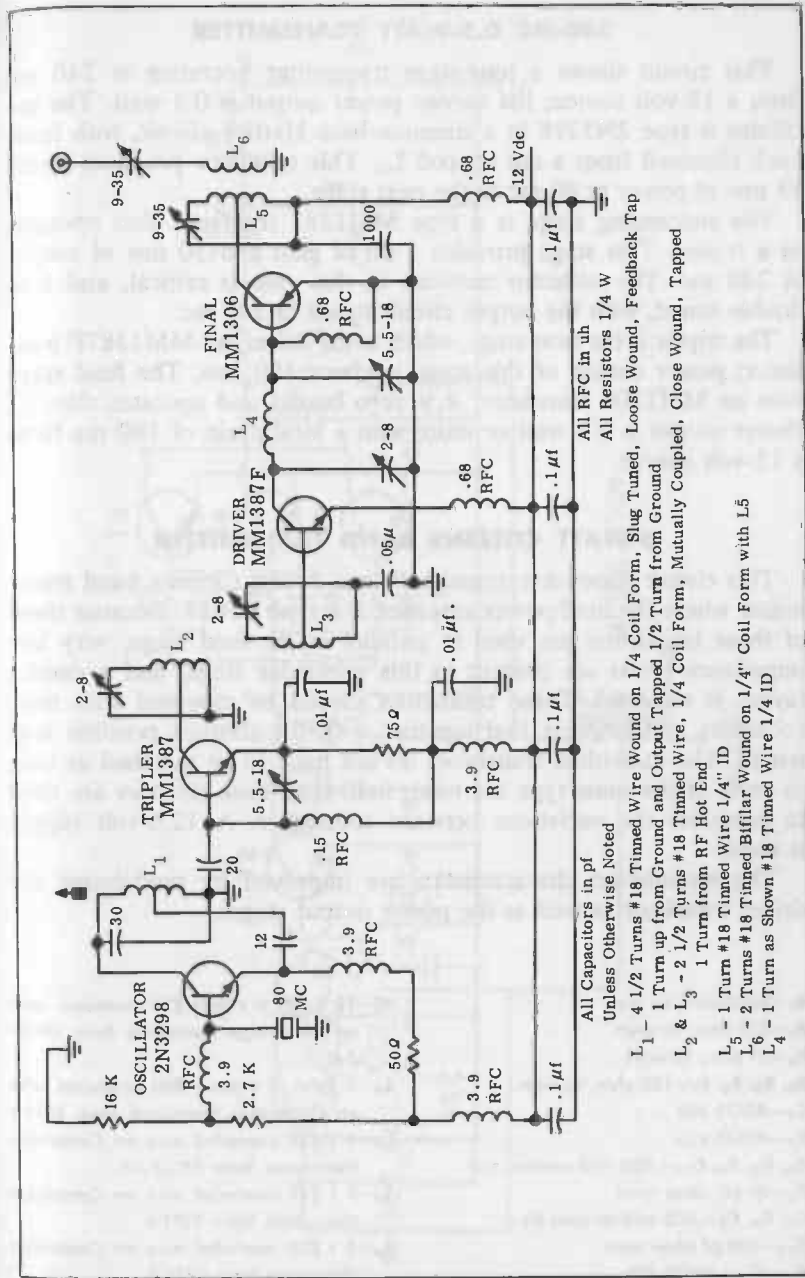
A 2N3298 is used as a crystal-controlled oscillator which feeds a buffer amplifier using a 2N2951. The buffer amplifier, in turn, feeds the driver, a second 2N2951, which feeds the single output stage. The output stage uses a 2N2950 with an output impedance, through the transformer, of 50 ohms.

- | | |
|---------------------------|----------------------------|
| C ₁ —5.5-18 pf | C ₉ —100 pf |
| C ₂ —30 pf | C ₁₀ —25-280 pf |
| C ₃ —0.1 mfd | C ₁₁ —120 pf |
| C ₄ —330 pf | C ₁₂ —0.1 mfd |
| C ₅ —27 pf | C ₁₃ —9-35 pf |
| C ₆ —0.1 mfd | C ₁₄ —24 pf |
| C ₇ —9-180 pf | C ₁₅ —20 pf |
| C ₈ —0.1 mfd | RFC—3.9 μh |
- L₁—4t #20 wire on 1/4" coil form tapped 1 t
 L₂—4 t #20 1/4 ID tapped 1 3/4 t 1/2" L
 L₃—2 1/2 t #16 5/8 ID 3/8 L
 L₄—1 μh
 T₁—PRI 3 1/4 t #18 enameled wire bifilar wound with sec. 3/4 ID
 SEC 2 3/4 t #18 Plain



Courtesy Motorola Semiconductor Products

76-mc c-w transmitter.



Courtesy Motorola Semiconductor Products

240-mc, 0.5-watt transmitter.

240-MC 0.5-WATT TRANSMITTER

This circuit shows a four-stage transmitter operating at 240 mc from a 12-volt source; the carrier power output is 0.5 watt. The oscillator is type 2N3298 in a common-base Hartley circuit, with feedback obtained from a tap on coil L_1 . This oscillator produces about 15 mw of power at 80 mc to the next stage.

The succeeding stage is a type MM1387 transistor that operates as a tripler. This stage provides 3 db of gain and 30 mw of output at 240 mc. The collector network in this case is critical, and it is double tuned, with the output circuit tuned to 240 mc.

The tripler is the next stage, which is the driver, an MM1387F transistor; power output of this stage is about 150 mw. The final stage uses an MM1306 transistor; it is zero biased and operates class C. Power output is 0.5 watt or more with a total drain of 180 ma from a 12-volt source.

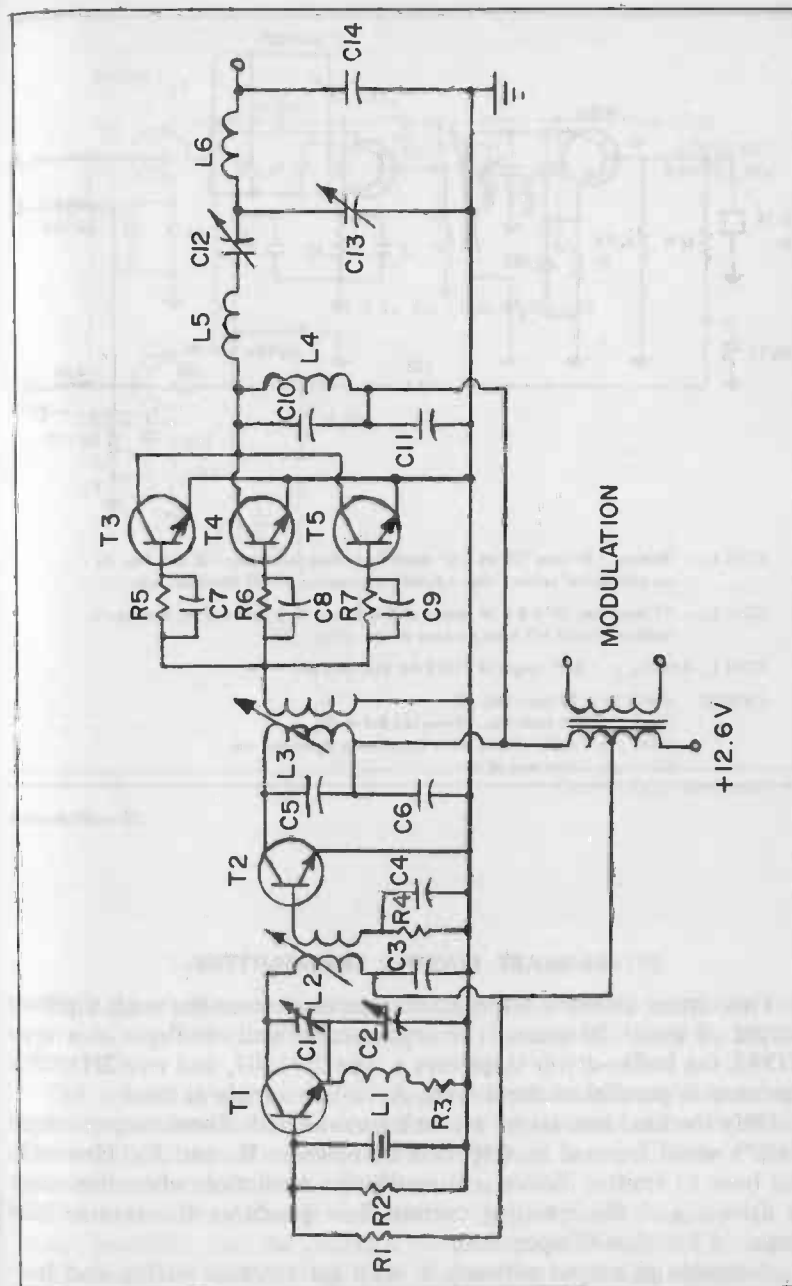
5-WATT CITIZENS BAND TRANSMITTER

This circuit shows five transistors in a 5-watt Citizens band transmitter where the final power amplifier is a type PT888. Because three of these transistors are used in parallel in the final stage, very low impedance levels are present in this particular stage, and a careful layout is required. These transistors should be mounted with their collectors and emitters tied together with the shortest possible lead length. The individual transistors do not have to be matched as long as units of the same type are used; individual base resistors are used to minimize the variations between transistors. A 12.6-volt supply is used.

The modulation characteristics are improved by modulating the driver transistor as well as the power output stages.

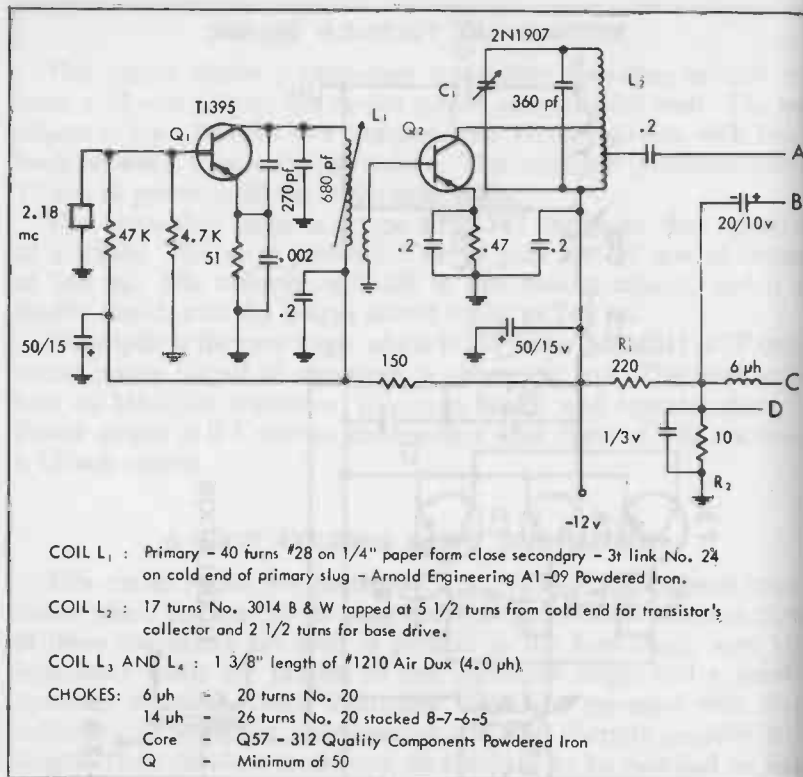
R_1 —3600 ohm, 1/2 watt
 R_2 —510 ohm, 1/2 watt
 R_3 —51 ohm, 1/2 watt
 R_4, R_5, R_6, R_7 —120 ohm, 1/2 watt
 C_1 —ARCO 404
 C_2 —ARCO 425
 C_3, C_4, C_6, C_{11} —.005 mfd ceramic disc
 C_5 —68 pf, silver mica
 C_7, C_8, C_9 —.002 mfd ceramic disc
 C_{10} —100 pf silver mica
 C_{12}, C_{13} —ARCO 429
 C_{14} —200 pf silver mica
 L_1 —50 μ h choke Miller J 300-50

L_2 —12 t Pri, 3 t Sec—#24 enameled wire on Cambridge thermionic form SPC-2-J-4L
 L_3 —7 t Pri, 3 t Sec—#20 enameled wire on Cambridge thermionic form 2270-4
 L_4 —4 t #20 enameled wire on Cambridge thermionic form SPC-2-J-2L
 L_5 —7 t #20 enameled wire on Cambridge thermionic form 2271-4
 L_6 —5 t #20 enameled wire on Cambridge thermionic form 2271-4
 T_1 —PT886, T_2 —PT887
 T_3, T_4, T_5 —PT888



Courtesy Pacific Semiconductor, Inc.

5-watt CB transmitter.



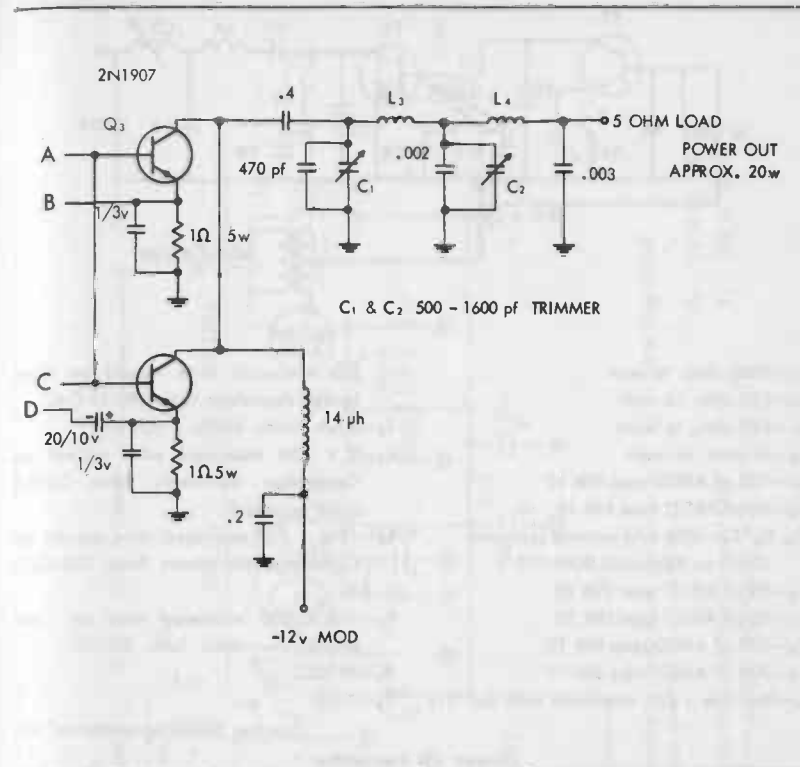
20-watt marine

20-WATT MARINE TRANSMITTER

This circuit shows a 2-megacycle marine transmitter with a power output of about 20 watts. The crystal-controlled oscillator is a type TI395, the buffer-driver stage uses a type 2N1907, and two 2N1907's are used in parallel as the output. A 12-volt supply is used.

Only the final two stages are being modulated. These output stages have a small forward bias applied by resistors R_1 and R_2 . However, the base to emitter diodes will rectify the excitation when this stage is driven, and the resulting current flow produces the reverse bias required for class-C operation.

A double pi output network is used for antenna mixing and harmonic suppression. Working into a 5-ohm load, the power output is about 20 watts with 90% modulation.



Courtesy Texas Instruments Inc.

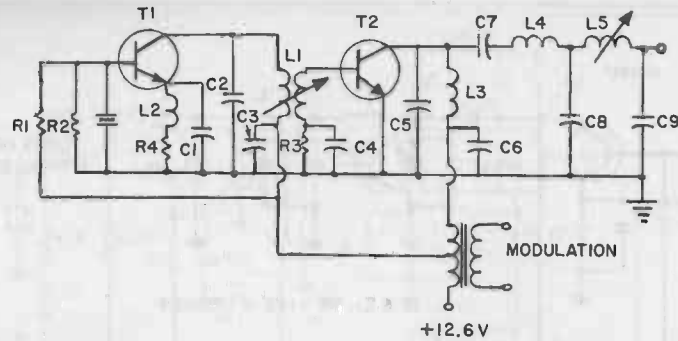
transmitter.

1-WATT CITIZENS BAND TRANSMITTER

This figure shows a two-transistor Citizens band transmitter with a power output of 1 watt; the transistor types that are used are PT703 and PT897.

The crystal circuit uses a series-mode crystal with a common-base Colpitts circuit where capacitors C_1 and C_2 determine the feedback. The oscillator transistor can be the PT703 as shown, or the PT886 which can provide a higher power output.

The crystal oscillator is inductively coupled to the final stage or power amplifier, and the collector circuit is parallel tuned. The power source is 12.6 volts through the standard modulation transformer having a center-tapped secondary. The primary of the modulation transformer is driven by the audio amplifier or modulator.



- | | |
|---|--|
| R ₁ —4300 ohm, 1/2 watt | #24 enameled wire wound on Cambridge thermionic form SPC-11-C-4L |
| R ₂ —820 ohm, 1/2 watt | L ₂ —50μh choke Miller J 300-50 |
| R ₃ —120 ohm, 1/4 watt | L ₃ —9 t #20 enameled wire wound on Cambridge thermionic form 2270-3 (core removed) |
| R ₄ —56 ohm, 1/2 watt | L ₄ —12 1/4 t #20 enameled wire wound on Cambridge thermionic form SPC-11-C-4L |
| C ₁ —100 pf ARCO type DM 10 | L ₅ —6 1/2 t #20 enameled wire on Cambridge thermionic form 2270-3 |
| C ₂ —30 pf ARCO type DM 10 | T ₁ —PT703 |
| C ₃ , C ₄ , C ₆ —.005 mfd ceramic Lafayette C-611 or Centralab DDM-502 | T ₂ —PT897 |
| C ₅ —75 pf ARCO type DM 10 | |
| C ₇ —50 pf ARCO type DM 10 | |
| C ₈ —120 pf ARCO type DM 10 | |
| C ₉ —200 pf ARCO type DM 10 | |
| L ₁ —Pri 10 3/4 t #24 enameled wire Sec 3 1/4 | |

1-watt CB transmitter.

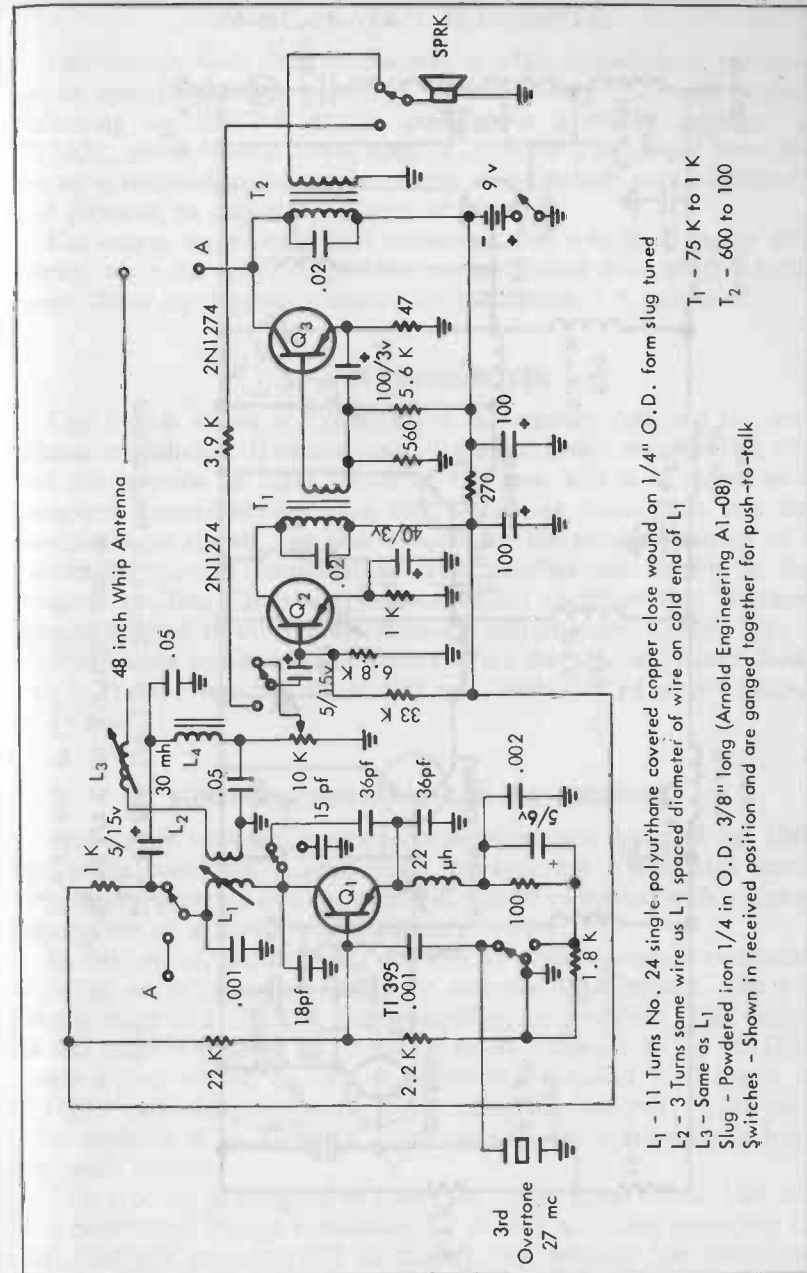
Courtesy Pacific Semiconductor, Inc.

CITIZENS BAND TRANSCEIVER

This circuit shows a three-transistor Citizens band combination transmitter and receiver. This circuit is designed to be used in the license-free type of operation in the 27-megacycle Citizens band.

Transistor Q₁, a TI395, operates both as a crystal-controlled 100-milliwatt modulated power oscillator in the transmitting mode, and as a superregenerative detector in the receiver mode. Transistor type 2N1274 is used for both transistor Q₂ and transistor Q₃. These are the audio sections of the transceiver, and in the receiving mode they are used as an audio driver and an output stage. In the transmit mode they are used as an audio driver in a modulator. The speaker can be used either as a microphone to transmit, or as a speaker to receive.

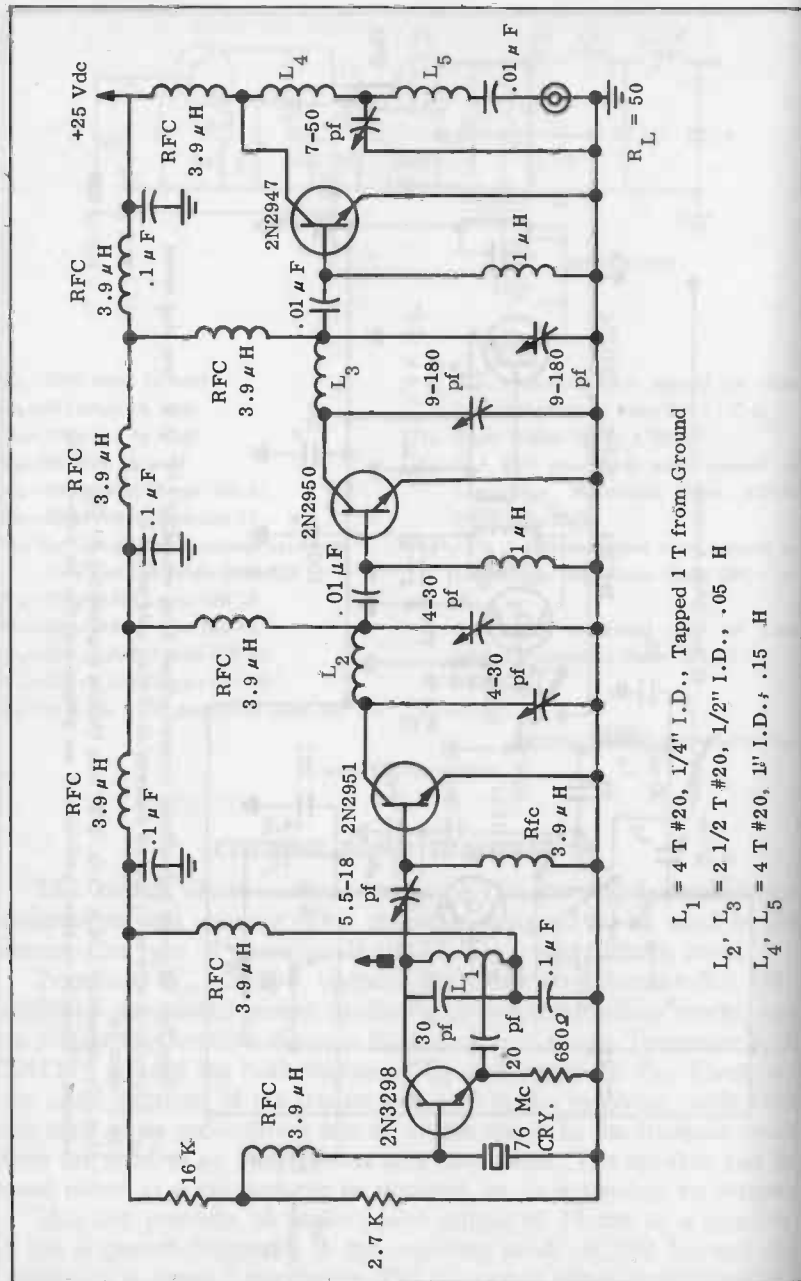
This unit provides an audio power output of 35 mw as a receiver; it has a quench frequency in the receiving mode of 200 kc, and the sensitivity is about 3 microvolts. The d-c power input for transmitting is 100 milliwatts, while the r-f power output for transmitting is 30 milliwatts.



- L₁ - 11 Turns No. 24 single-polythene covered copper close wound on 1/4" O.D. form slug tuned
- L₂ - 3 Turns same wire as L₁ spaced diameter of wire on cold end of L₁
- L₃ - Same as L₁
- Slug - Powdered iron 1/4 in O.D. 3/8" long (Arnold Engineering AI-08)
- Switches - Shown in received position and are ganged together for push-to-talk
- T₁ - 75 K to 1 K
- T₂ - 600 to 100

Courtesy Texas Instruments Inc.

CB transceiver.



Courtesy Motorola Semiconductor Products

76-mc, 10-watt transmitter.

$L_1 = 4 \text{ T \#20, } 1/4" \text{ I.D., Tapped } 1 \text{ T from Ground}$

$L_2, L_3 = 2 \text{ } 1/2 \text{ T \#20, } 1/2" \text{ I.D., } .05 \text{ H}$

$L_4, L_5 = 4 \text{ T \#20, } 1" \text{ I.D., } .15 \text{ H}$

76-MC 10-WATT TRANSMITTER

This circuit, with four transistors, is a 76-megacycle c-w transmitter operating with a power of 10 watts using a 25-volt supply. Following the 2N3298 crystal amplifier is a buffer amplifier, a 2N2951, which feeds a driver stage, a 2N2950. The output from the driver is coupled to the power output stage, which uses a 2N2947 and provides an output impedance of 50 ohms.

The output stage draws 600 milliamps with a 66% collector efficiency, while the driver stages have a total current drain of 166 milliamps. Total input power required for this circuit is 6 milliwatts.

27-MC TRANSMITTER

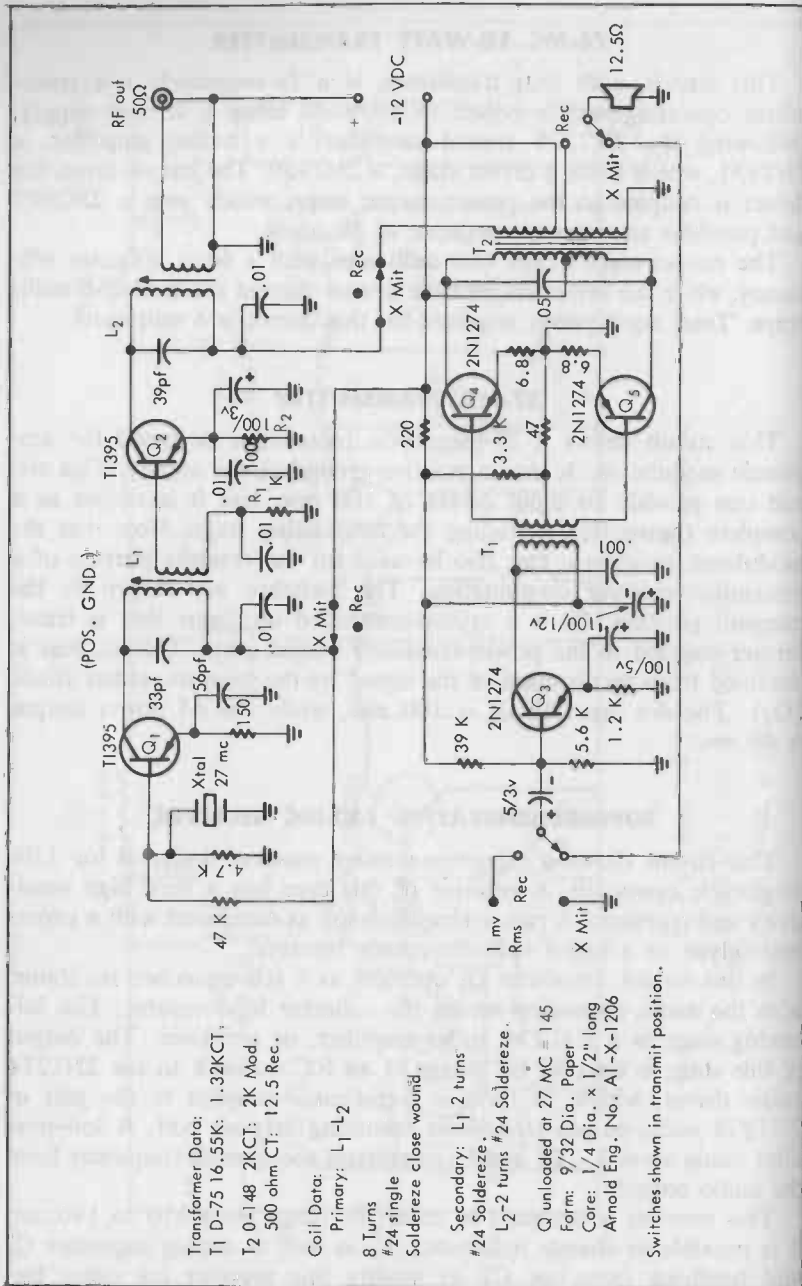
This circuit shows a 27-megacycle transmitter designed for amplitude modulation. It uses a positive-ground power supply. This circuit can provide an input power of 100 mw, and it is shown as a complete transmitter, including the modulating stage. Note that the modulator, as shown, can also be used for the receiver portion of a transmitter-receiver combination. The switches are shown in the transmitter position. Q_1 is a crystal-controlled oscillator that is transformer-coupled to the power transistor output stage. Output bias is obtained from rectification of the signal by the base-to-emitter diode (Q_2). The d-c input to Q_2 is 100 mw, while the r-f power output is 40 mw.

SUPERREGENERATIVE 130-MC RECEIVER

This circuit shows a superregenerative receiver designed for 130-megacycle operation. A receiver of this type has a very high sensitivity and represents a rather simple circuit as compared with a superheterodyne or a tuned radio-frequency receiver.

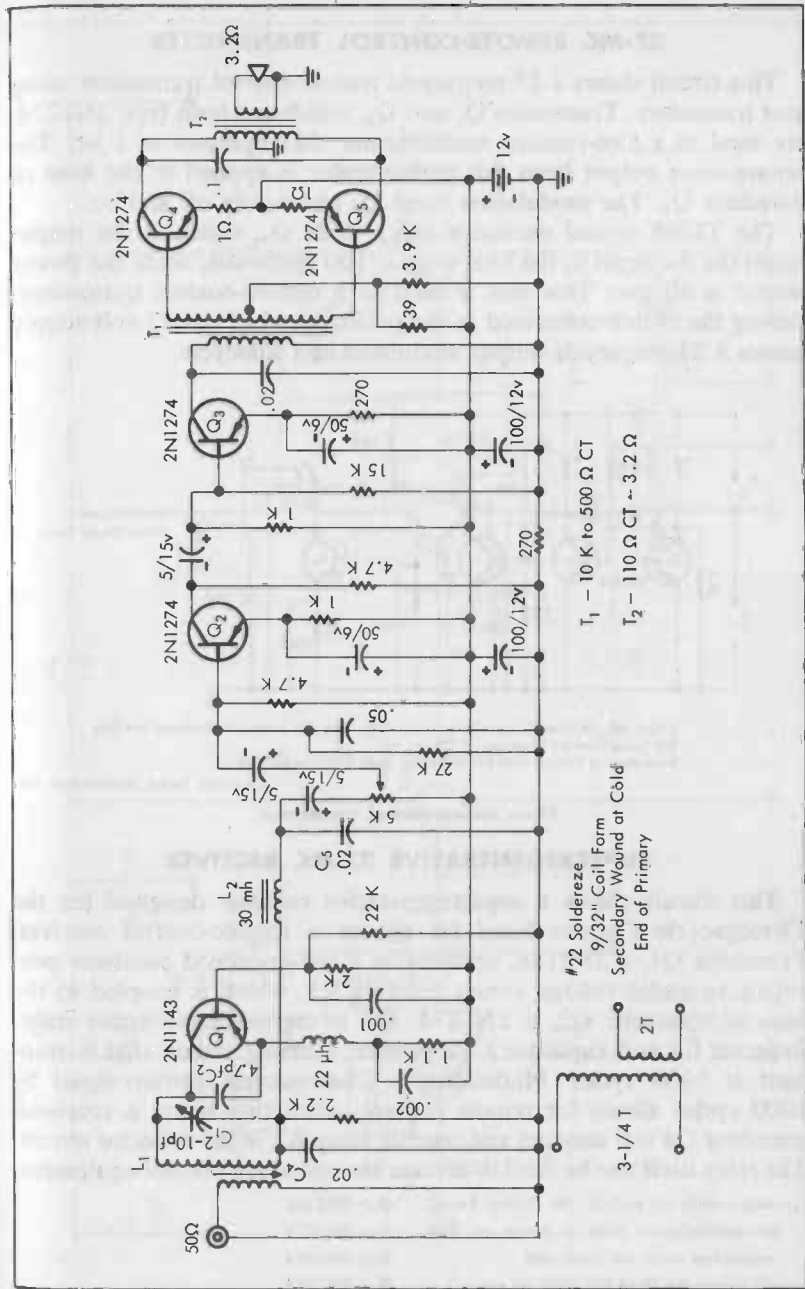
In this circuit, transistor Q_1 operates as a self-quenched oscillator, with the audio appearing across the collector load resistor. The following stage is a 2N1274 audio amplifier, or predriver. The output of this stage is coupled by means of an RC network to the 2N1274 audio driver, which, in turn, is transformer-coupled to the pair of 2N1274 audio-output transistors operating in push-pull. A low-pass filter made up of L_2 , C_4 and C_5 eliminates the quench frequency from the audio output.

This receiver is designed to cover the range from 110 to 140 mc; it is possible to change inductance L_1 as well as tuning capacitor C_1 and feedback capacitor C_2 to modify this receiver for other frequency bands. The circuit shown has a sensitivity of about 4 microvolts, and a bandwidth of 4 megacycles.



Courtesy Texas Instruments Inc.

27-mc a-m transmitter.



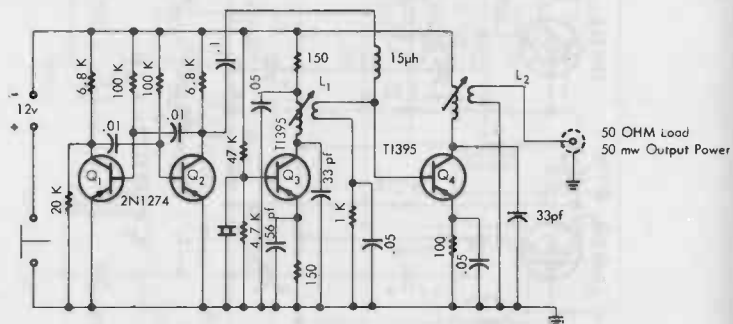
Courtesy Texas Instruments Inc.

Superregenerative 130-mc receiver.

27-MC REMOTE-CONTROL TRANSMITTER

This circuit shows a 27-megacycle remote-control transmitter using four transistors. Transistors Q_1 and Q_2 , which are both type 2N1274, are used as a free-running multivibrator that operates at 1 kc. The square-wave output from this multivibrator is applied to the base of transistor Q_4 . The modulation turns Q_4 alternately off and on.

The TI395 crystal oscillator (Q_3) feeds Q_4 , which is the output stage; the d-c input to the final stage is 100 milliwatts, while the power output is 40 mw. This unit is used as a remote-control transmitter; closing the switch connected in the positive lead of the 12-volt supply causes a 27-megacycle output modulated at 1 kilocycle.



L_1, L_2 — 8 Turns NO. 24 Enamel Copper Wire on 1/4" O.D. Form Slug Tuned with Powdered Iron Slug 3/8" Long (Arnold Engineering A1-08)
Secondary — 2 Turns on Cold End of Primary Same Wire Size as Primary

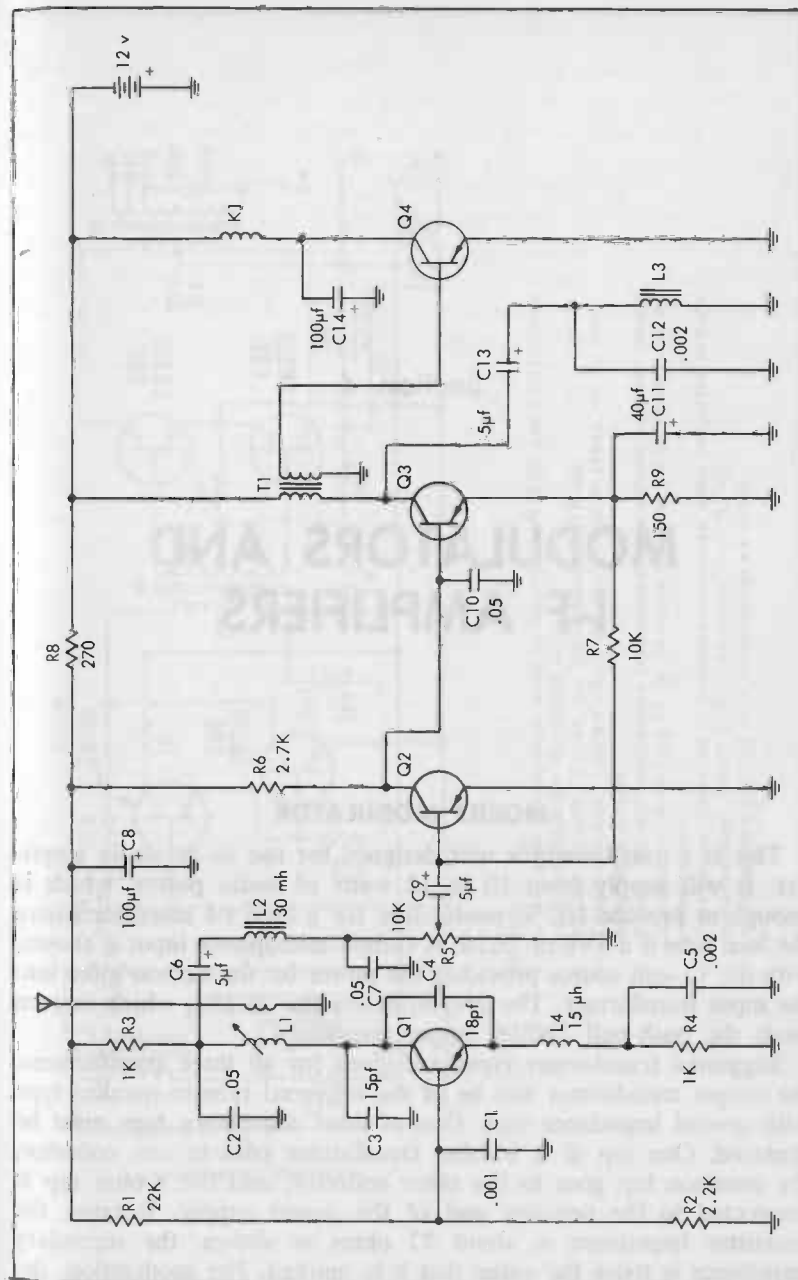
Courtesy Texas Instruments Inc.

27-mc remote-control transmitter.

SUPERREGENERATIVE 27-MC RECEIVER

This circuit shows a superregenerative receiver designed for the 27-megacycle Citizens band for use as a remote-control receiver. Transistor Q_1 , a 2N2188, operates as a self-quenched oscillator providing an audio voltage across resistors R_5 , which is coupled to the base of transistor Q_2 , a 2N1274. Q_2 is the predriver audio stage. Inductor L_3 and capacitor C_{12} provide a tuning circuit that is resonant at 1000 cycles. Modulating a 27-megacycle carrier signal by 1000 cycles allows for remote control; when this signal is received, transistor Q_4 will conduct and operate relay K_1 in the collector circuit. The relay itself can be used to actuate the necessary control equipment.

- | | |
|--|------------------------------|
| L_1 —Adjustable r-f coil (J. W. Miller #4403 or equivalent). Add 2 turns of #24 enameled wire on cold end. | Q_1 —2N2188 |
| L_2 —30 mc choke (Bud CH 1228 or equiv.) | Q_2 —2N1274 |
| L_3 —8.5 hy (Stancor C1279 or equiv.) | Q_3 —2N1274 |
| L_4 —RFC, 15 μ h (Delevan 1537-40 or equiv.) | Q_4 —2N1274 |
| | K_1 —Sigma #11F-2300-G/Sil |
| | T_1 —10K to 2K |



Courtesy Texas Instruments Inc.

Superregenerative 27-mc receiver.

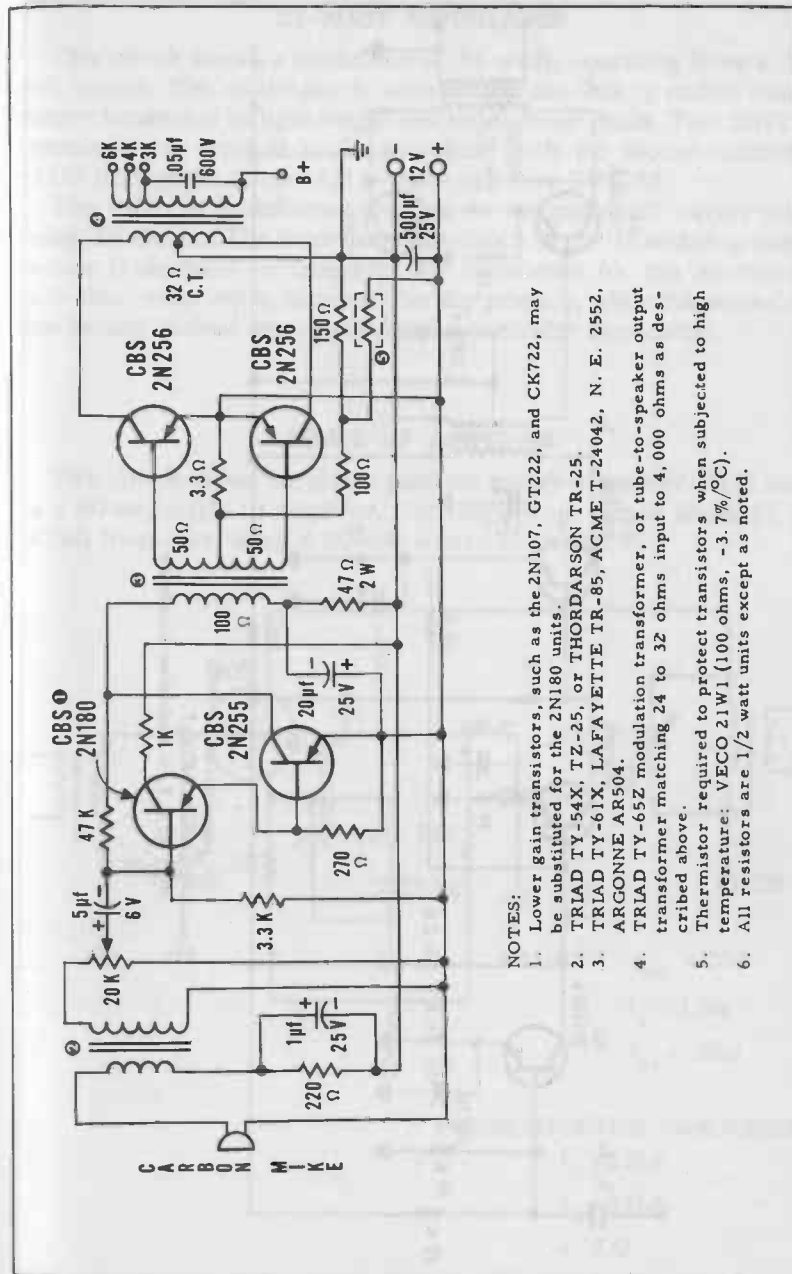
Section 4

MODULATORS AND I-F AMPLIFIERS

MOBILE MODULATOR

This is a four-transistor unit designed for use as an audio amplifier. It will supply from 10 to 12 watts of audio power, which is enough to provide 100% modulation for a final r-f amplifier where the final tube is a 6V6 or 2E26. A carbon-microphone input is shown, with the 12-volt source providing the power for the carbon mike into the input transformer. The 2N180 drives the 2N255, which in turn feeds the push-pull 2N256 output transistors.

Suggested transformer types are given for all three transformers; the output transformer can be of the universal tube-to-speaker type with several impedance taps. One of these impedance taps must be centered. One tap of a 16-ohm transformer goes to one collector, the common tap goes to the other collector, and the 8-ohm tap is connected to the negative end of the power supply. Because the transistor impedance is about 32 ohms as shown, the secondary impedance is twice the value that it is marked. For modulation, the secondary is connected in series with the B+ and the anode, or plate, of the final r-f amplifier.

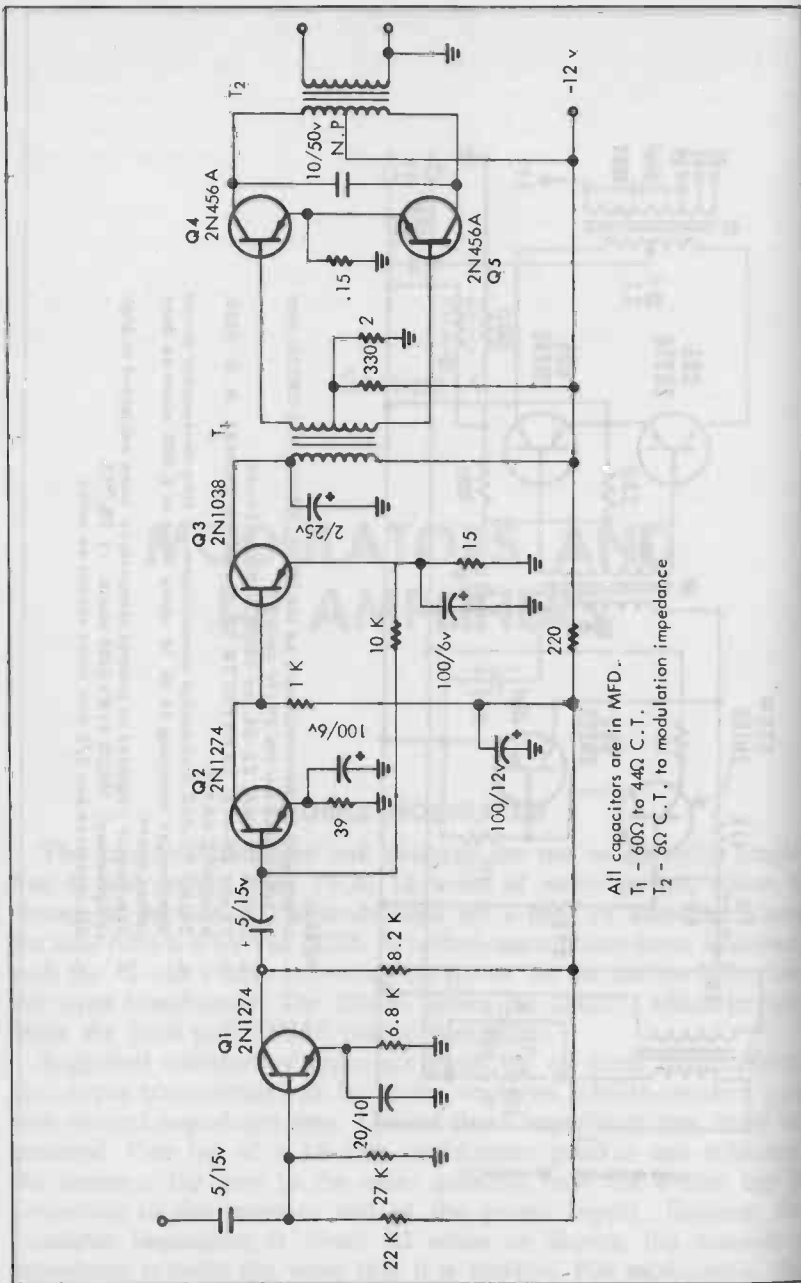


NOTES:

1. Lower gain transistors, such as the 2N107, GT222, and CK722, may be substituted for the 2N180 units.
2. TRIAD TY-54X, TZ-25, or THORDARSON TR-25.
3. TRIAD TY-61X, LAFAYETTE TR-85, ACME T-24042, N. E. 2552, ARGONNE AR504.
4. TRIAD TY-65Z modulation transformer, or tube-to-speaker output transformer matching 24 to 32 ohms input to 4,000 ohms as described above.
5. Thermistor required to protect transistors when subjected to high temperature: VECO 21W1 (100 ohms, $-3.7\%/^{\circ}\text{C}$).
6. All resistors are 1/2 watt units except as noted.

Courtesy CBS Electronic Div., CBS Inc.

Mobile modulator.



All capacitors are in MFD.
 T_1 - 60Ω to 44Ω C.T.
 T_2 - 6Ω C.T. to modulation impedance

25-watt modulator.

Courtesy Texas Instruments Inc.

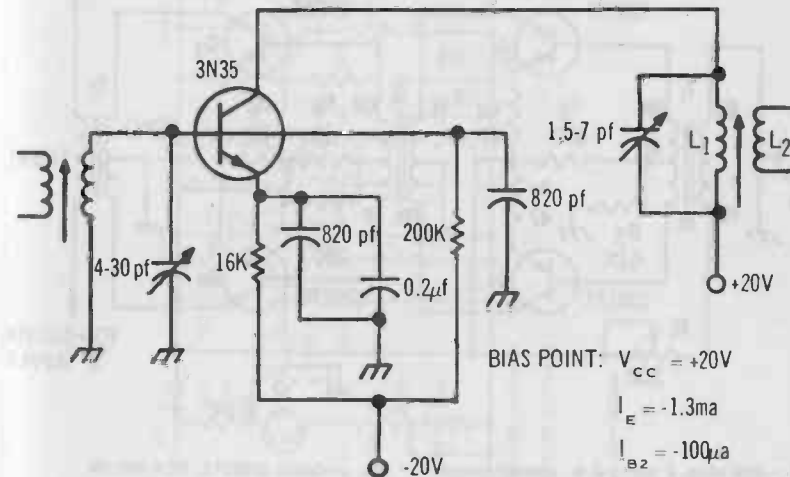
25-WATT MODULATOR

This circuit shows a modulator of 25 watts, operating from a 12-volt supply. The modulator is suitable for use with a mobile transmitter, because of its light weight and small power drain. Two 2N1274 transistors are used as audio amplifiers, with the second transistor (Q2) feeding the driver (Q3), which is a type 2N1038.

The driver is transformer-coupled to the push-pull output stage using 2N456A's. The secondary impedance of the modulating transformer is designed for the particular application for this modulator. A 6-ohm center tap is necessary for the primary, while the secondary can be any desired impedance for the particular application.

60-MC I-F AMPLIFIER

This circuit shows the grown-junction tetrode-transistor 3N35 used as a 60-megacycle i-f amplifier. The single-stage gain is about 12 db at this frequency, using a 20-volt source as shown.



BIAS POINT: $V_{CC} = +20V$

$I_E = -1.3ma$

$I_{B2} = -100\mu a$

TYPICAL INTERSTAGE TRANSFORMER:

$L_1 = 1.36\mu h$

$L_2 = 0.24\mu h$

$k \approx 0.43$

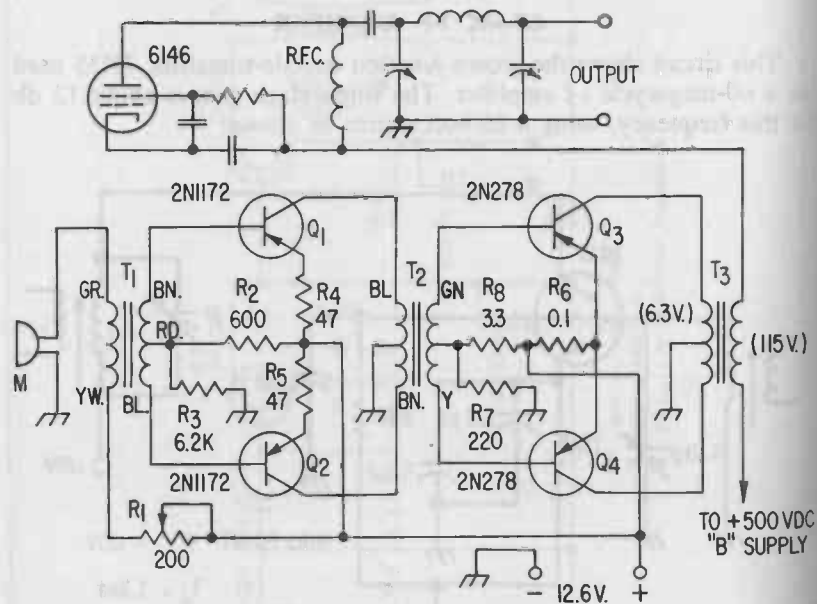
60-mc i-f amplifier.

Courtesy Texas Instruments Inc.

25-WATT MODULATOR

This circuit shows a four-transistor modulator that is essentially a high-power audio amplifier. Resistor R_1 is used to limit the microphone current; resistor R_2 biases transistors Q_1 and Q_2 collector current; resistors R_6 , R_7 , and R_8 provide collector bias for transistors Q_3 and Q_4 . It is necessary that transformer T_2 have a center tap on the secondary, and this is obtained by unwinding 46 turns on the outside winding, bringing out the center tap, and rewinding the transformer.

This circuit requires very little current drain when it is not operating as a modulator without an input. The frequency response is essentially flat from 200 cycles to 7000 cycles.

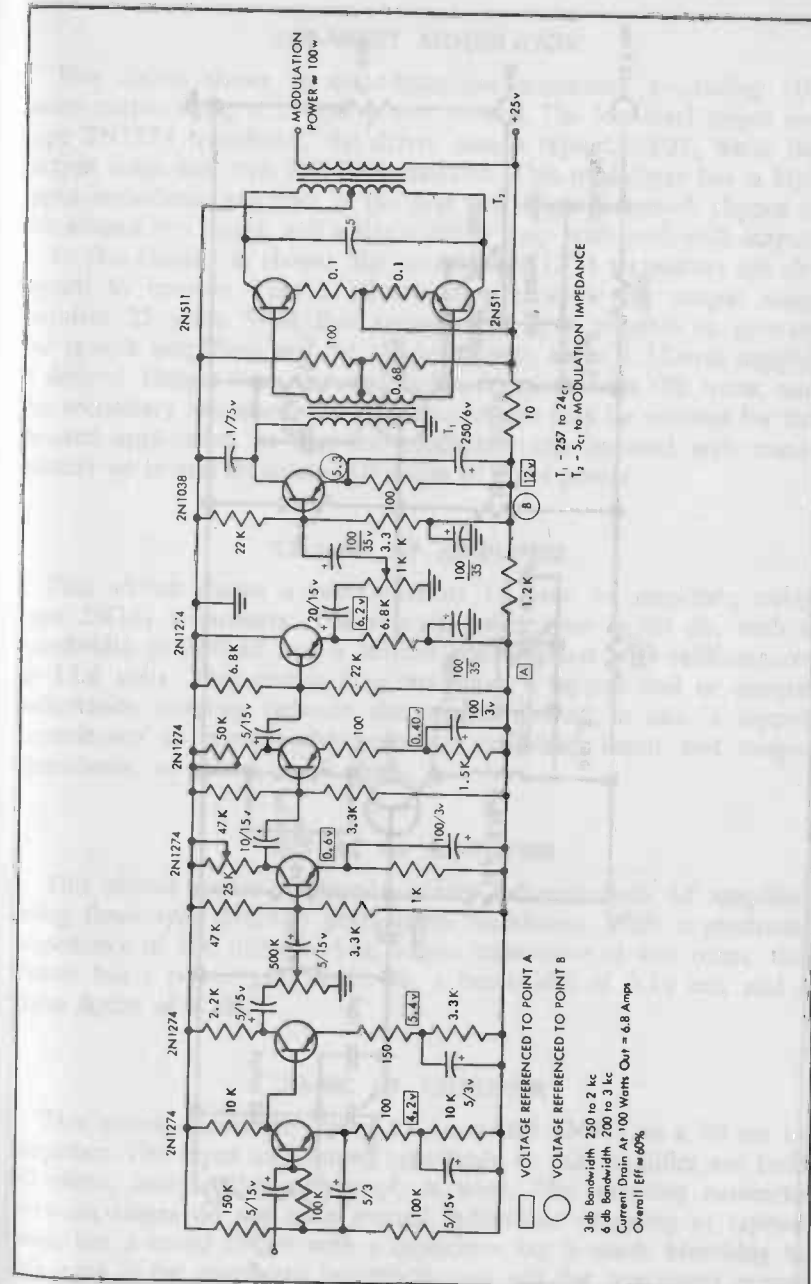


R_1 —200 ohm, 2 watt, w.w. potentiometer
 R_2 —600 ohm, 1/2 watt, carbon resistor
 R_3 —62K, 1/2 watt, carbon resistor
 R_4 , R_5 —47 ohm, 1/2 watt, carbon resistor
 R_6 —0.1 ohm, 5 watt, w.w. resistor
 R_7 —220 ohm, 1 watt, carbon resistor
 R_8 —3.3 ohm, 1 watt, w.w. resistor

Q_1 , Q_2 —Delco 2N3215, RCA 2N109,
 GE 2N43 or equivalent
 Q_3 , Q_4 —Delco 2N278 or DS-501 power
 transistor
 T_1 —Thordarson TR-5 or equiv.
 T_2 —Thordarson TR-21 or equiv.
 T_3 —Thordarson 21F10 or equiv.
 M—SB carbon microphone

Courtesy Delco Radio Div., General Motors Corp.

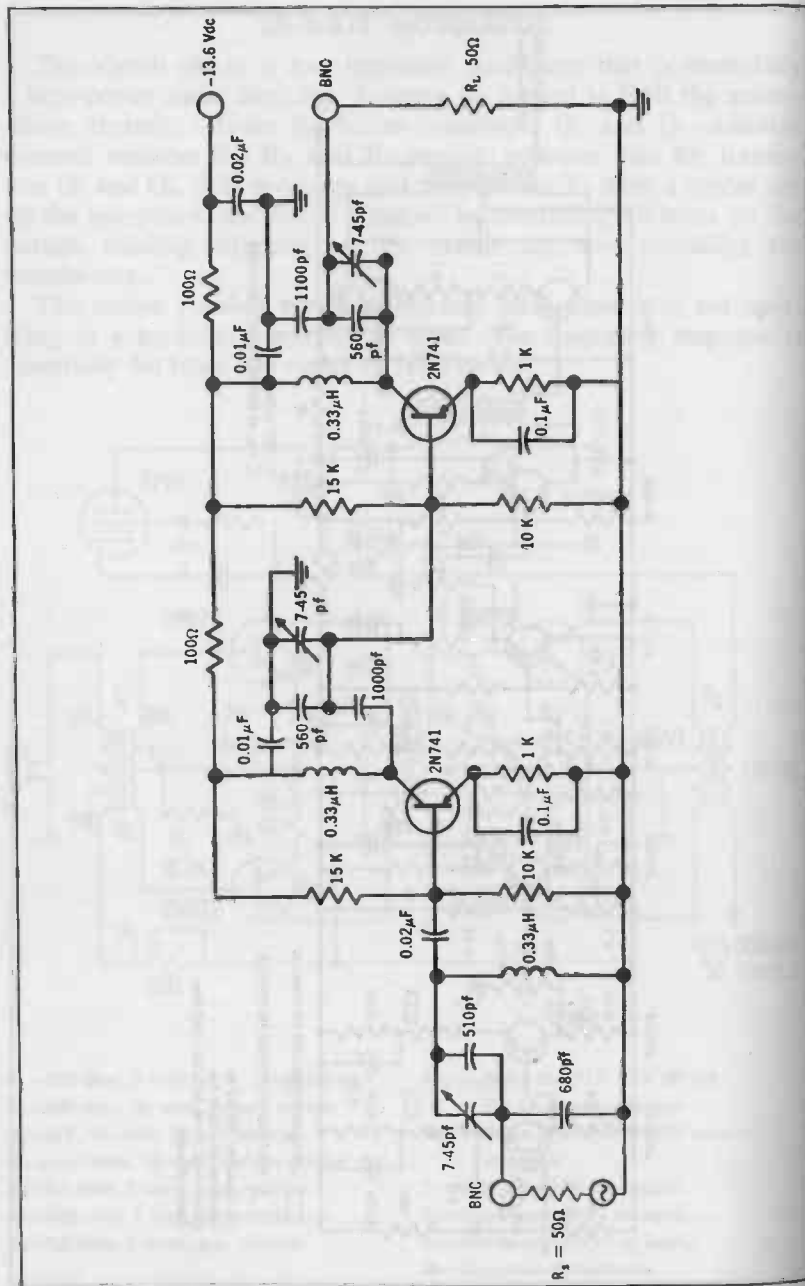
25-watt modulator.



□ VOLTAGE REFERENCED TO POINT A
 ○ VOLTAGE REFERENCED TO POINT B
 3 db bandwidth 250 to 2 kc
 6 db bandwidth 200 to 3 kc
 Current Drain At 100 Watts Out = 6.8 Amps
 Overall Eff = 60%

Courtesy Texas Instruments Inc.

100-watt modulator.



Courtesy Motorola Semiconductor Products

12.5-mc. i-f amplifier.

100-WATT MODULATOR

This circuit shows an eight-transistor modulator producing 100 watts output using a 25-volt power source. The low-level stages use type 2N1274 transistors, the driver uses a type 2N1038, while the output stage uses two 2N511 transistors. This modulator has a high input-impedance amplifier in the first two stages, a speech clipper in the second two stages, and a single driver stage with push-pull output.

In this circuit, as shown, the first five 2N1274 transistors are designed to operate from a 12-volt supply, while the output stage requires 25 volts. With this arrangement it is possible to operate the speech amplifiers and the clipper directly from a 12-volt supply, if desired. Output from the modulation transformer is 100 watts, and the secondary impedance for this transformer may be selected for the desired application so that this modulator can be used with transmitters up to and including 200 watts of input power.

12.5-MC I-F AMPLIFIER

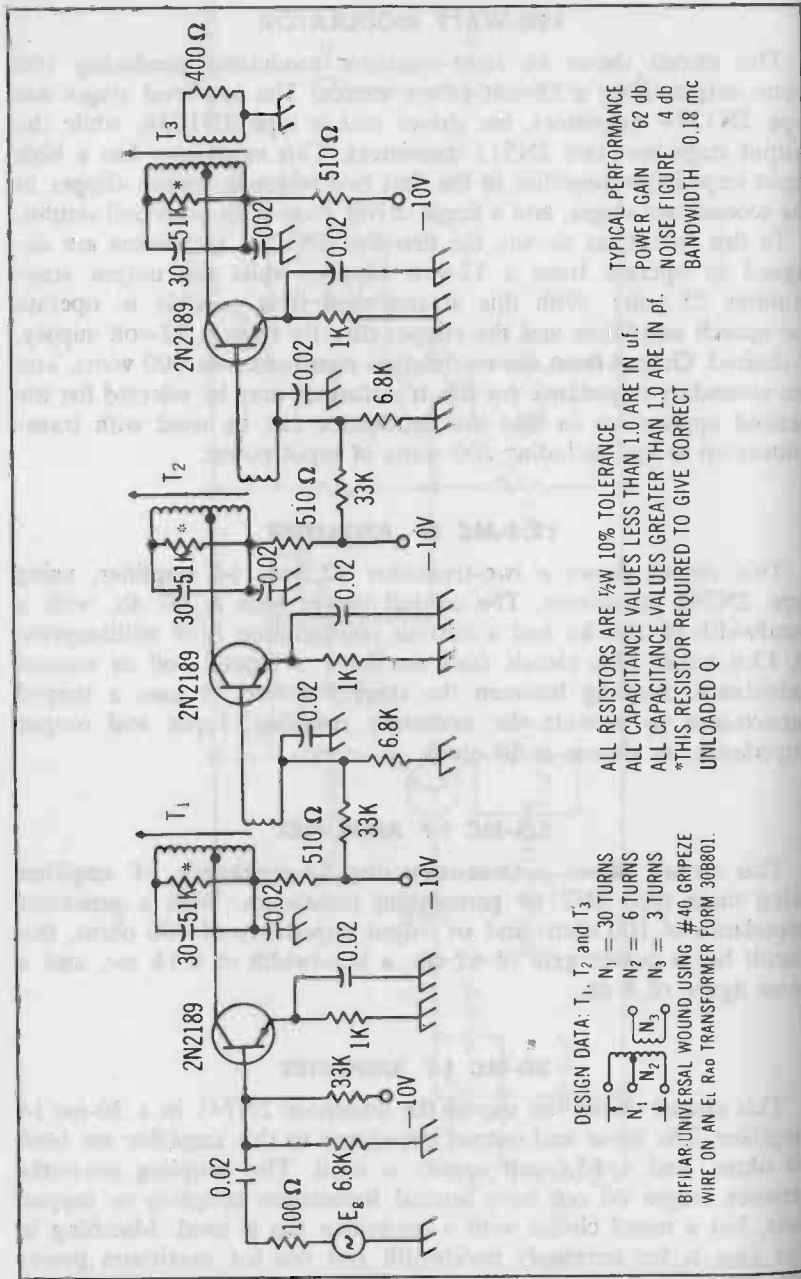
This circuit shows a two-transistor 12.5-mc i-f amplifier, using type 2N741 transistors. The overall power gain is 60 db, with a bandwidth of 200 kc and a current consumption of 9 milliamperes at 13.6 volts. This circuit does not have a tapped coil or mutual inductance coupling between the stages; instead, it uses a tapped capacitance to provide the necessary coupling. Input and output impedance, as shown, is 50 ohms.

5.5-MC I-F AMPLIFIER

This circuit shows a three-transistor 5.5-megacycle i-f amplifier using three type 2N2189 germanium transistors. With a generator impedance of 100 ohms and an output impedance of 400 ohms, this circuit has a power gain of 62 db, a bandwidth of 0.18 mc, and a noise figure of 4 db.

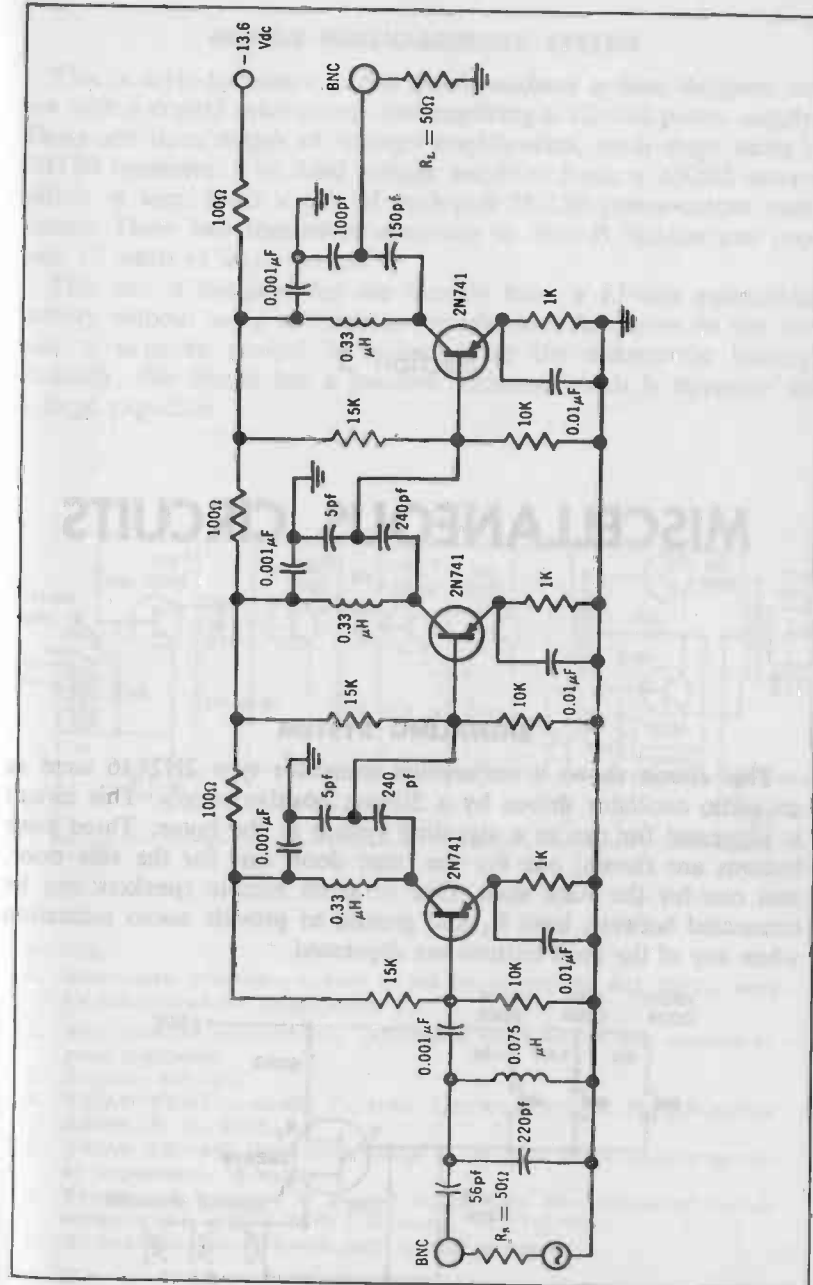
30-MC I-F AMPLIFIER

This circuit shows the use of the transistor 2N741 in a 30-mc i-f amplifier. The input and output impedance to this amplifier are both 50 ohms, and a 13.6-volt supply is used. The coupling networks between stages do not have mutual inductance coupling or tapped coils, but a tuned circuit with a capacitive tap is used. Matching in this case is for necessary bandwidth and not for maximum power gain. This circuit provides a gain of 53 db and a bandwidth of 15 mc, with a center frequency of 30 mc.



5.5-mc i-f amplifier.

Courtesy Texas Instruments Inc.



30-mc i-f amplifier.

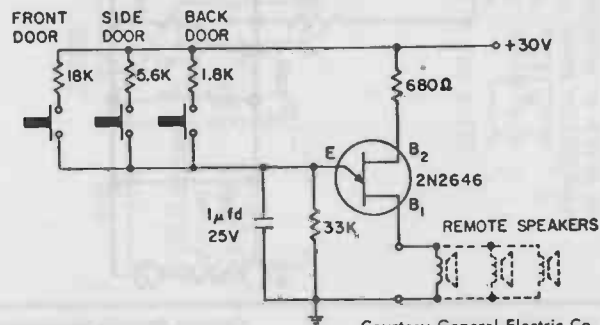
Courtesy Motorola Semiconductor Products

Section 5

MISCELLANEOUS CIRCUITS

SIGNALING SYSTEM

This circuit shows a unijunction transistor type 2N2646 used as an audio oscillator driven by a 30-volt positive supply. This circuit is suggested for use as a signaling system in the home. Three push buttons are shown; one for the front door, one for the side door, and one for the back door. One or more remote speakers can be connected between base B₁ and ground to provide audio indication when any of the push buttons are depressed.



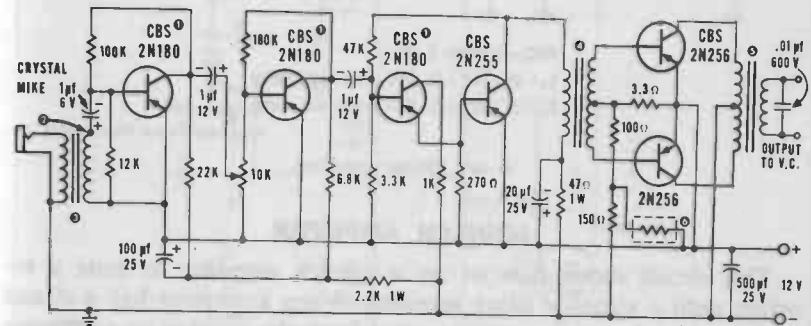
Courtesy General Electric Co.

Signaling system.

MOBILE PUBLIC-ADDRESS SYSTEM

This is a six-transistor mobile public-address system designed for use with a crystal microphone and requiring a 12-volt power supply. There are three stages of voltage amplification, each stage using a 2N180 transistor. The third voltage amplifier feeds a 2N255 driver, which, in turn, feeds a pair of push-pull 2N256 power-output transistors. These two transistors operating in class-B fashion can provide 10 watts of audio power.

This unit is designed for use directly from a 12-volt automobile battery without using a converter or vibrator. As shown in the circuit, a negative ground is indicated for the automobile battery. Actually, this circuit has a positive common which is bypassed by a large capacitor.



NOTES:

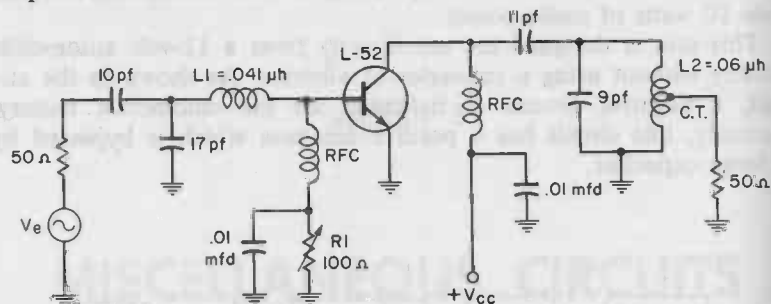
1. Lower gain transistors, such as the 2N107, GT222, and CK722, may be substituted for 2N180 units.
2. For dynamic microphone, eliminate transformer and connect at point indicated.
3. Argonne AR-100.
4. TRIAD TY-61X, ACME T-24042, LAFAYETTE TR-85, ARGONNE AR504, N. E. 2252.
5. TRIAD TY-64X, CHICAGO TAMS-12 (24 to 32 ohms input to speaker impedance, 10 watts).
6. Thermistor required to protect transistors when subjected to high temperature: VECO 21W1 (100 ohms, -3.77%/°C)
7. All resistors are 1/2 watt units except as noted.

Courtesy CBS Electronic Div., CBS Inc.

Mobile PA system.

5-WATT 150-MC AMPLIFIER

This circuit shows a special type of high-frequency amplifier, the L-52 transistor, used in a 5-watt, 150-mc, class-C circuit. Both the input impedance and the output impedance are 50 ohms, and the supply voltage is 28 volts. Input bias is varied by adjusting resistor R_1 , while the output to a 50-ohm load is from the center tap of the output tank circuit.



RFC—Ohmite Z-50

L_1 —2t, $\frac{3}{8}$ " I.D. #16 wire, $\frac{1}{4}$ " long

L_2 —3t, $\frac{3}{8}$ " I.D. #14 wire, $\frac{3}{4}$ " long

Courtesy Texas Instruments Inc.

5-watt 150-mc amplifier.

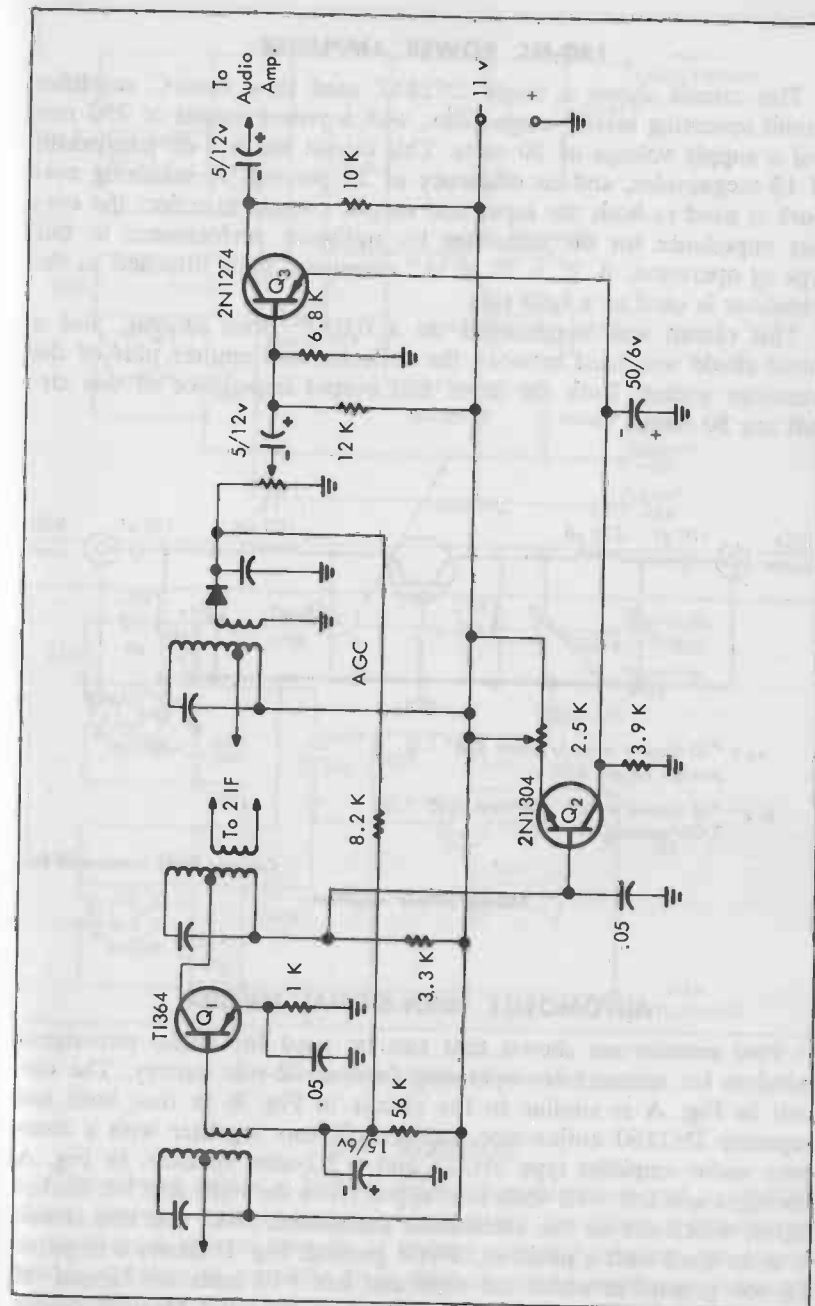
SQUELCH AMPLIFIER

This circuit shows how to use a squelch amplifier to mute a receiver until a signal is being received. When a receiver has a circuit such as this, there is no audio output from the speaker or earphones until a station is being received.

Transistor Q_1 , a TI364, is an i-f amplifier which has automatic gain control applied; thus, the current flow through this transistor depends on signal strength. The Q_1 current is used to control the bias on the squelch transistor Q_2 ; the squelch-transistor amplifier controls the current through transistor Q_3 , the audio amplifier.

If no signal is being received, Q_3 is shut off, and there is no audio output. However, when a signal is received, Q_3 conducts to allow the audio to pass to the output stages. A variable resistor used in the Q_2 emitter circuit is used to establish the minimum signal that will bias the audio amplifier on.

This circuit will squelch up to approximately a 300-microvolt signal, while maintaining control over very small signals of approximately 1 microvolt. Not shown in the circuit are the parameters for the i-f amplifiers. These are the i-f amplifiers used in the present receiver to which this squelch amplifier can be adapted.



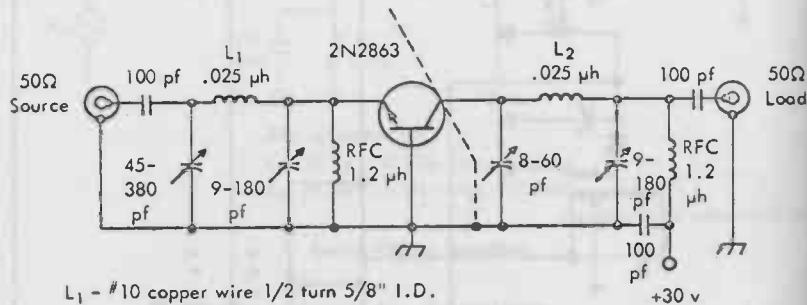
Courtesy Texas Instruments Inc.

Squelch amplifier.

160-MC POWER AMPLIFIER

This circuit shows a single 2N2863 used in a class-C amplifier circuit operating at 160 megacycles, with a power output of 750 mw and a supply voltage of 30 volts. This circuit has a 3-db bandwidth of 15 megacycles, and an efficiency of 25 percent. A matching network is used in both the input and output circuits to reflect the correct impedance for the transistor for optimum performance in this type of operation. A 2" x 2" x 1/2" aluminum plate attached to the transistor is used as a heat sink.

This circuit was constructed on a 0.032" brass chassis, and a metal shield was used between the collector and emitter pins of the transistor socket. Both the input and output impedance of this circuit are 50 ohms.



L₁ - #10 copper wire 1/2 turn 5/8" I.D. overall height 3/4".

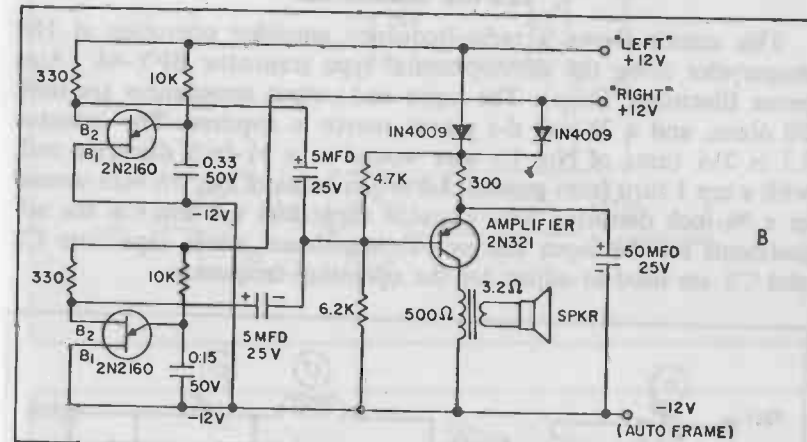
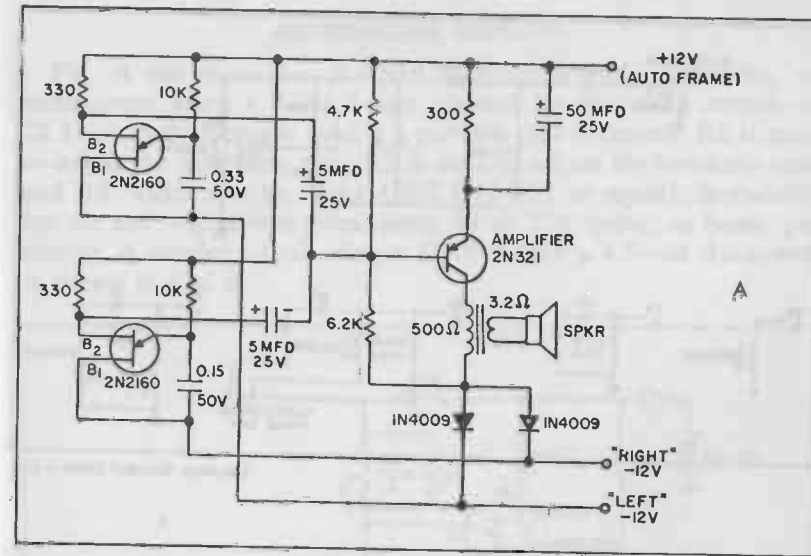
L₂ - #14 tinned wire 1 1/2 turns 1/2" I.D. 1/3" spacing.

Courtesy Texas Instruments Inc.

160-mc power amplifier.

AUTOMOBILE TURN-SIGNAL MINDER

Two circuits are shown that can be used for audio turn-signal minders for automobiles operating from a 12-volt battery. The circuit in Fig. A is similar to the circuit in Fig. B in that both use separate 2N2160 unijunction audio oscillators together with a common audio amplifier type 2N321 and a 3.2-ohm speaker. In Fig. A the right and left -12 volts are tapped from the right and left flasher lights, which are on the automobile dashboard. Note that this circuit is to be used with a positive 12-volt ground. Fig. B shows a negative 12-volt ground in which the right and left +12 volts are tapped off the right and left flasher lights. In both circuits the 1N4009 diodes are used to prevent a short-circuit.

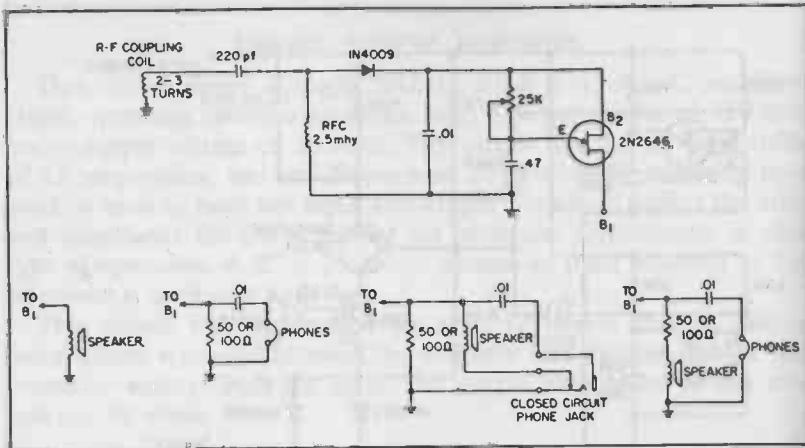


Courtesy General Electric Co.

Automobile turn-signal minder.

C-W MONITOR

This circuit shows a 2N646 unijunction transistor and a 1N4009 diode detector operating as a c-w monitor. The various outputs are a speaker, a pair of phones, a phone jack and speaker, or phones and a speaker in parallel. Note that no power source is necessary other than the coupling to the transmitter from which the monitor obtains the necessary drive.

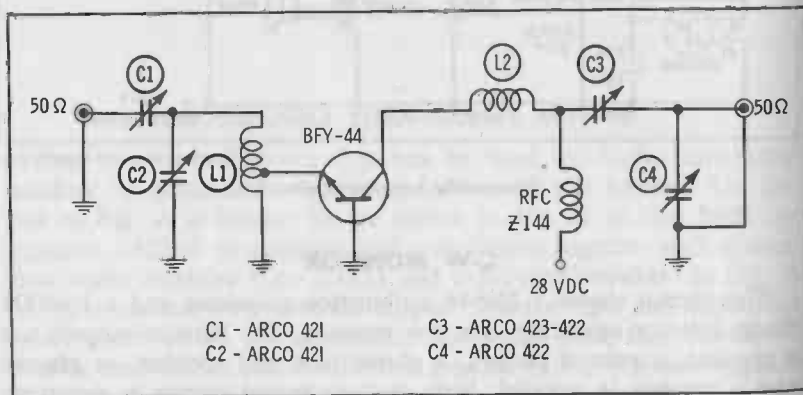


Courtesy General Electric Co.

C-w monitor.

160-MC AMPLIFIER

This circuit shows a radio-frequency amplifier operating at 160 megacycles using the developmental type transistor BFY-44 (Amperex Electronic Corp). The input and output impedances are both 50 ohms, and a 28-volt d-c power source is required. The inductor L1 is 3½ turns of No. 16 wire wound in a ¼-inch diameter coil, with a tap 1 turn from ground. L2 is 3½ turns of No. 16 wire wound in a ⅜-inch diameter coil. Variable capacitors C1 and C4 are adjustments for the input and output impedance, while capacitors C2 and C3 are used to adjust for the operating frequency.

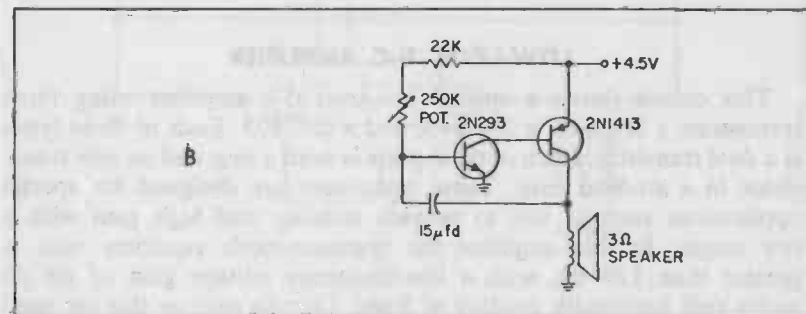
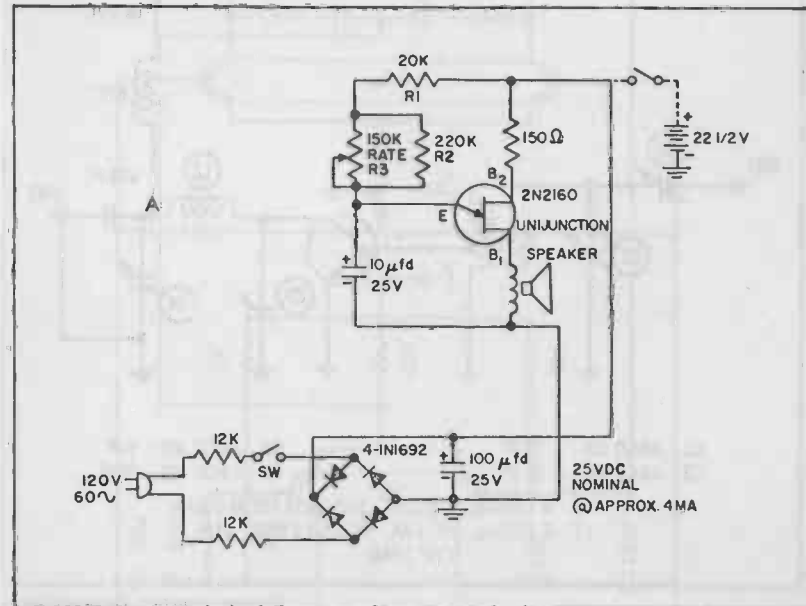


Courtesy Amperex Electronic Corp.

160-mc amplifier.

METRONOME CIRCUITS

Fig. A shows an a-c powered unijunction audio oscillator, or metronome, using a 3- to 5-ohm speaker for the audio output. A 22.5-volt battery can be used if a portable unit is desired. R1 is used to adjust the high-limit rate, R2 is used to adjust the low-limit rate, and R3, which is a log taper (IRC Q13-328 or equal), is variable for the rate adjustment from about 40 to 220 cycles, or beats, per minute. A simpler circuit using a 2N1413 with a 4.5-volt d-c source is shown in Fig. B.

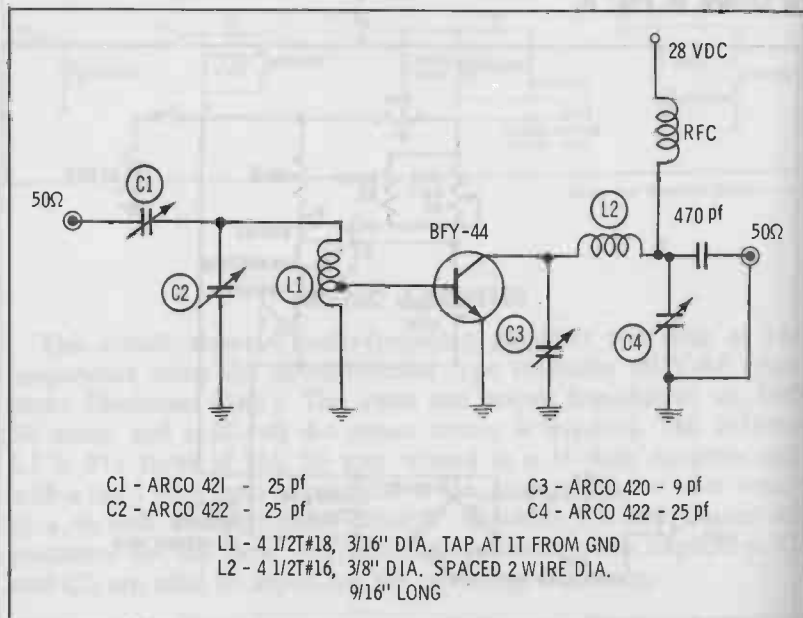


Courtesy General Electric Co.

Metronome circuits.

100-MC AMPLIFIER

This circuit shows a 100-mc amplifier using a single BFY-44 (Amperex Electronic Corporation) transistor. The input and output impedance are both 50 ohms, and a 28-volt d-c source is required. Inductor L1 is comprised of 4½ turns of No. 18 wire wound on a 3/16-inch diameter coil, with a tap one turn from ground. Inductor L2 is 4½ turns of No. 16 wire wound to make a 3/8-inch diameter coil that is 9/16-inch long.

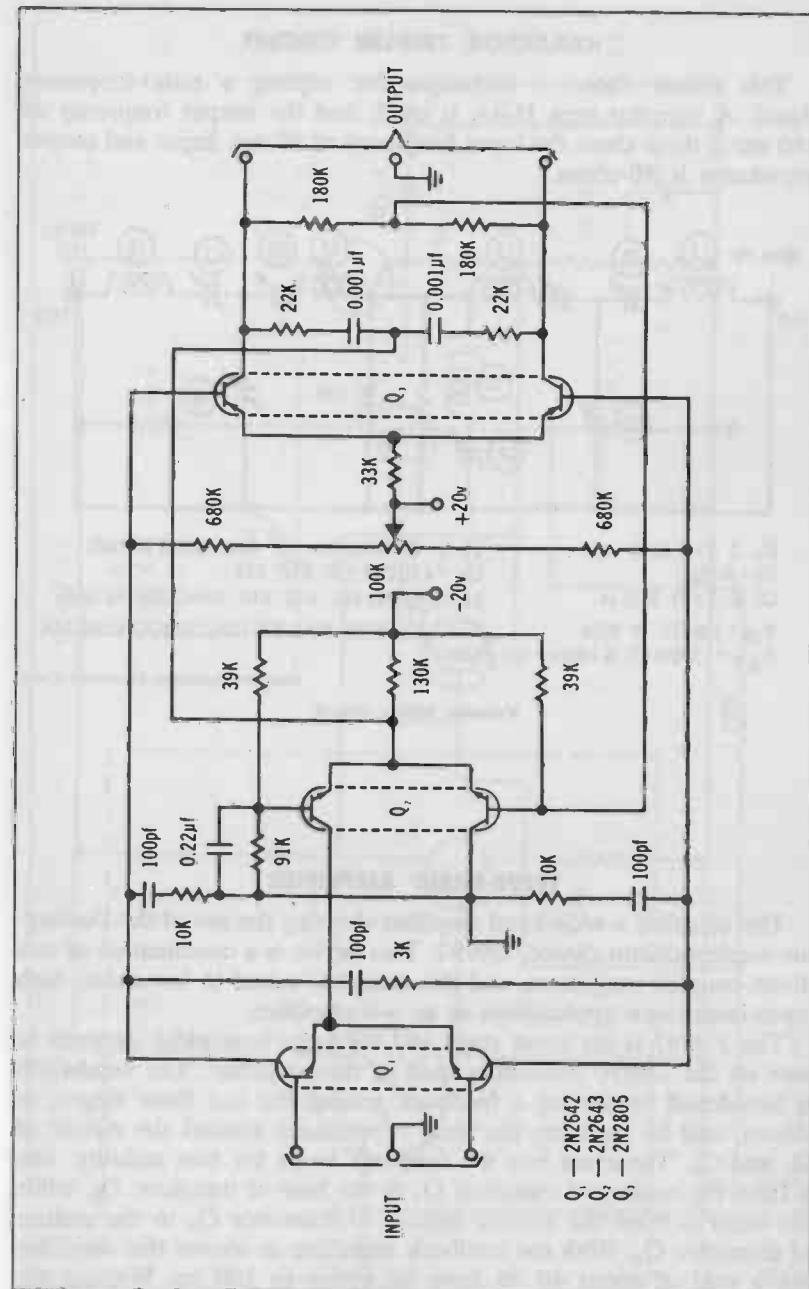


Courtesy Amperex Electronic Corp.

100-mc amplifier.

LOW-LEVEL D-C AMPLIFIER

This circuit shows a special low-level d-c amplifier using three transistors: a 2N2642, a 2N2643, and a 2N2805. Each of these types is a dual transistor. Each of these units is both a pnp and an npn transistor in a six-lead case. These transistors are designed for special applications such as this to provide stability and high gain with a few stages. In this amplifier the common-mode rejection ratio is greater than 120 db, with a low-frequency voltage gain of 68 db and a gain bandwidth product of 5 mc. Circuits such as this are used in instrumentation and in analog computers to provide a differential voltage amplification.

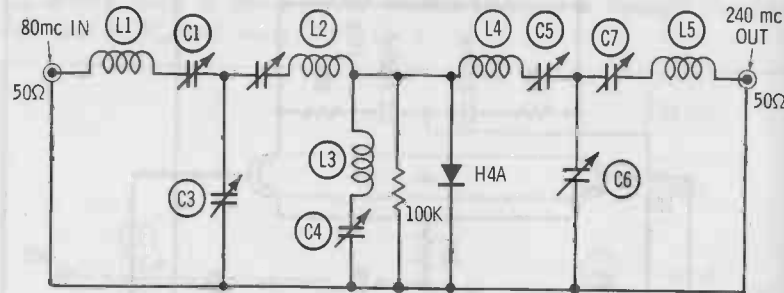


Courtesy Texas Instruments Inc.

Low-level d-c amplifier.

VARACTOR TRIPLER CIRCUIT

This circuit shows a technique for tripling a radio-frequency signal. A varactor type H-4A is used, and the output frequency of 240 mc is three times the input frequency of 80 mc. Input and output impedance is 50-ohms.



- C1, 2, 3 = 3-30 pf
 C4 = 3-15pf
 C5, 6, 7 = 21 2-15 pf
 P_{IN} = 1 WATT @ 80mc
 P_{OUT} = .580 WATT @ 240mc = EFF = 58%
- L1, 2 = 8 TURNS #16, 1/2" DIA. CLOSE WOUND
 L3 = 4 TURNS #18, 3/16" DIA. " "
 L4 = 2 TURNS #16, 3/16" DIA. SPACED WIRE DIA.
 L5 = 3 1/2 TURNS #16, 3/16 DIA. SPACED WIRE DIA.

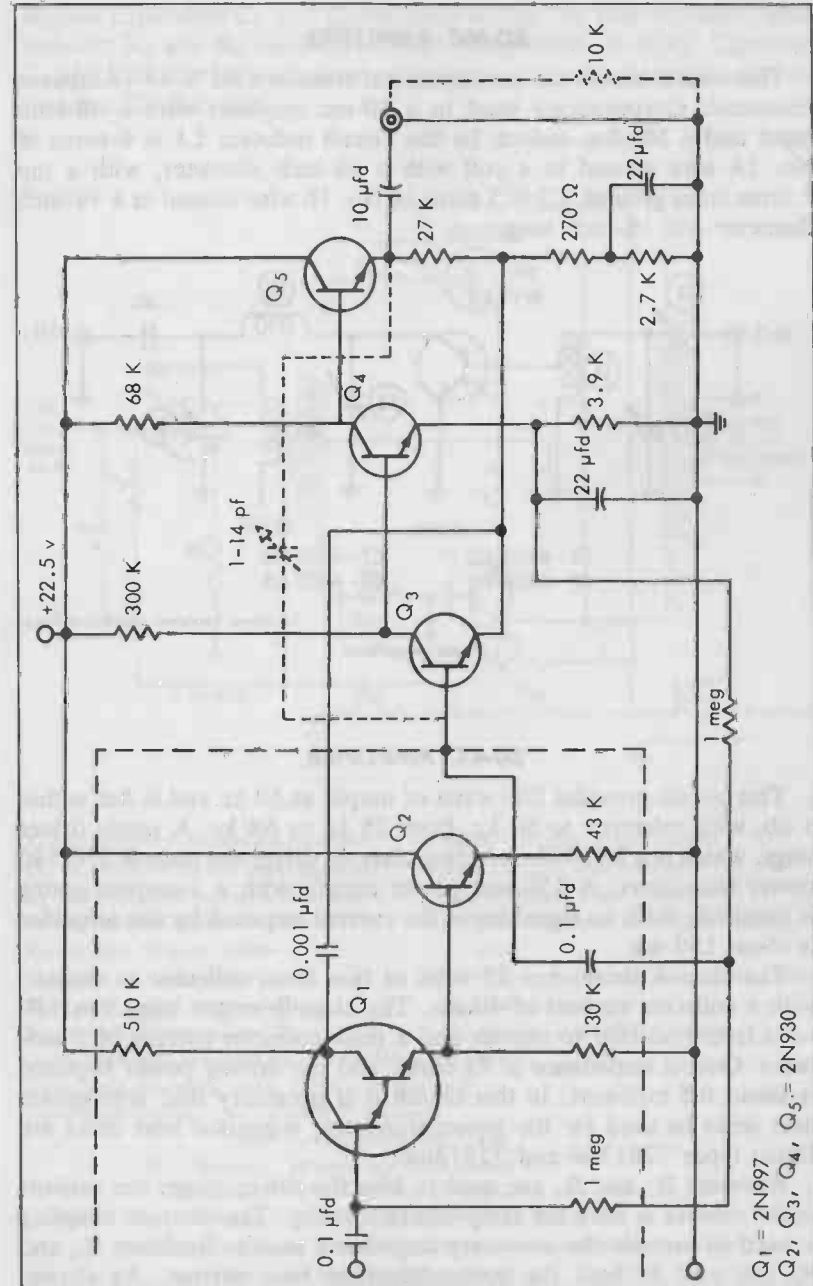
Courtesy Amperex Electronic Corp.

Varactor tripler circuit.

WIDE-BAND AMPLIFIER

This circuit is a wide-band amplifier showing the use of the Darlington semiconductor device, 2N997. This device is a combination of two direct-coupled transistors, and this circuit is suited to low-noise, high input-impedance applications as an a-c amplifier.

The 2N997 is the input stage and the large bandwidth depends in part on the 2N930 transistors used in this amplifier. The bandwidth is broadened by placing a feedback around the last three stages, as shown, and by reducing the stray capacitance around the circuit of Q₁ and Q₂. There are two d-c feedback loops for bias stability; one is from the emitter of transistor Q₄ to the base of transistor Q₁, while the other is from the emitter resistor of transistor Q₅ to the emitter of transistor Q₃. With the feedback capacitor as shown this amplifier has a gain of about 40 db from 30 cycles to 100 kc. Without the feedback capacitor, the gain is the same value from about 30 cycles to about 50 kc.



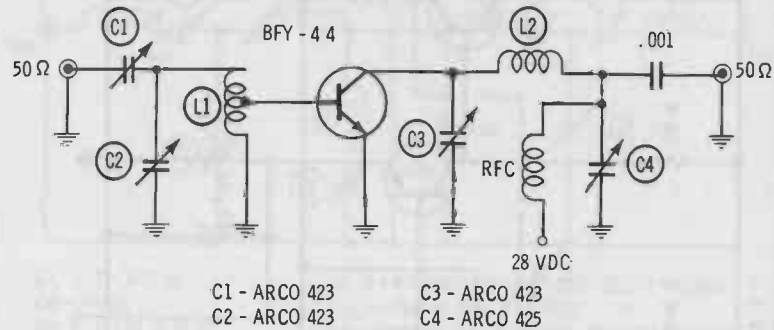
Q₁ = 2N997
 Q₂, Q₃, Q₄, Q₅ = 2N930

Courtesy Texas Instruments Inc.

Wide-band amplifier.

50-MC AMPLIFIER

This circuit shows the developmental transistor BFY-44 (Amperex Electronic Corporation) used in a 50-mc amplifier with a 50-ohm input and a 50-ohm output. In this circuit inductor L1 is 6 turns of No. 18 wire wound in a coil with a 1/8-inch diameter, with a tap 2 turns from ground. L2 is 5 turns of No. 16 wire wound in a 3/8-inch diameter coil 1/2-inch long.



C1 - ARCO 423
C2 - ARCO 423

C3 - ARCO 423
C4 - ARCO 425

Courtesy Amperex Electronic Corp.

50-mc amplifier.

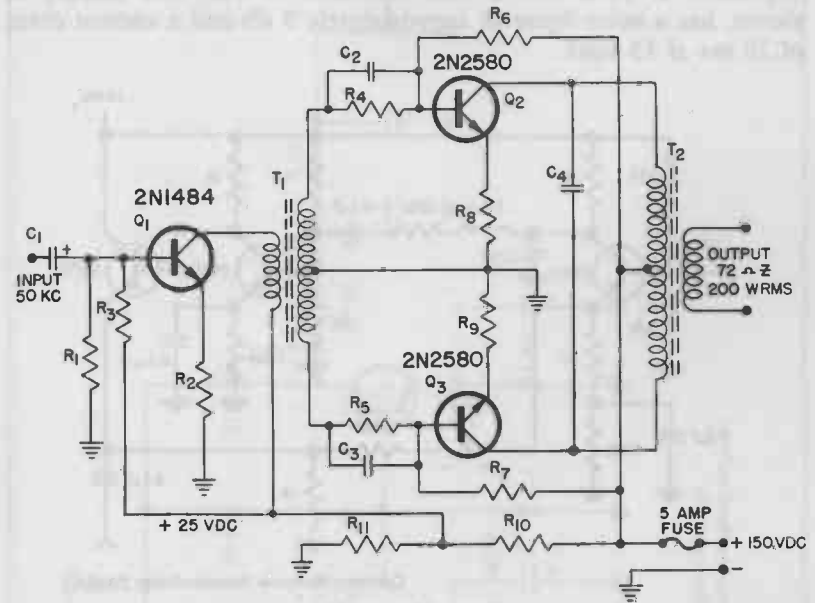
50-KC AMPLIFIER

This circuit provides 200 watts of output at 50 kc and is flat within 3 db, with reference to 50 kc, from 25 kc to 68 kc. A single driver stage, which is a 2N1484 operating class A, drives the class-B 2N2580 power transistors. A 150-volt power supply with a 3-ampere rating is required. With no signal input the current required by the amplifier is about 150 ma.

The class-A driver has 25 volts of bias from collector to emitter, with a collector current of 40 ma. The class-B output stage has 150 volts from collector to emitter and a peak collector current of 3 amperes. Output impedance is 72 ohms, and the driving power required is about 0.5 milliwatt. In this circuit it is necessary that appropriate heat sinks be used for the power transistor; suggested heat sinks are Delco types 7281366 and 7281369.

Resistors R₁ and R₂ are used to bias the driver stage; the resistor in the emitter is used for temperature stability. Transformer coupling is used to provide the necessary impedance match. Resistors R₄ and R₅ are used to limit the power-transistor base current. As shown, 50 ma of collector current will be obtained in the output stage, with resistors R₄, R₅, R₆ and R₇ used to reduce any crossover distortion.

Bypass capacitors C₂ and C₃ are used across the bias resistors, while resistors R₈ and R₉ are used for high temperature stability. Capacitor C₄ will filter any high-frequency transients; the output transformer will match a 72-ohm load.



C₁—6 mfd, 5 volt electrolytic capacitor

C₂, C₃—1.0 mfd, 50 volt paper capacitor

C₄—.02 mfd, 1000 volt ceramic capacitor

R₁—1K, 1/2 watt resistor

R₂—33 ohm, 1/2 watt resistor

R₃—6.2 K, 1/2 watt resistor

R₄, R₅—15 ohm, 2 watt resistor

R₆, R₇—6 K, 5 watt resistor

Delco Radio heat sink 7281366 or 7281369 (2 required)

Delco Radio insulating spacer 7269634 (4 required)

Delco Radio mounting kit 7274633 (2 required)

Core: Ferroxcube 3C 206 F 440

T₁ Primary: 40 turns No. 26 enameled wire

Secondary: 12 turns CT No. 22 enameled wire bifilar wound

Core: Allen Bradley U2375C127A ferrite

T₂ Primary: 50 turns CT No. 20 enameled wire bifilar wound

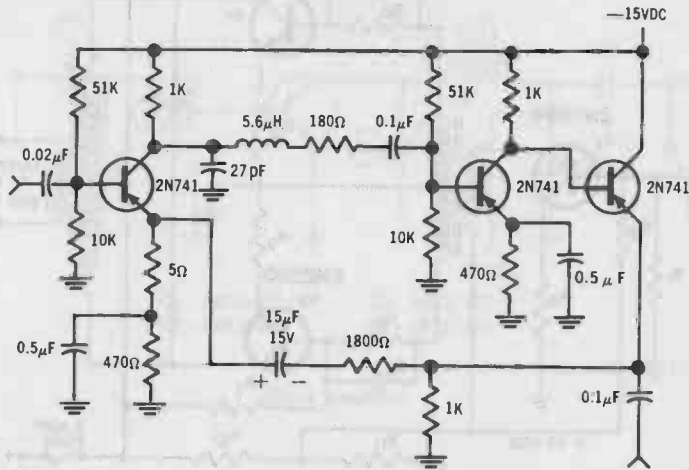
Secondary: 40 turns No. 20 enameled wire

Courtesy Delco Radio Div., General Motors Corp.

50-kc amplifier.

10-MC VIDEO AMPLIFIER

This circuit shows a 10-mc video amplifier using two 2N741 transistors. The amplifier produces a gain in excess of 50 db, with a 3-db bandwidth of 10 mc. The power source is 15 volts dc, and the input impedance is 1.5K. With a load resistance of 1K. This circuit, as shown, has a noise figure of approximately 3 db and a current drain of 20 ma at 15 volts.



Courtesy Motorola Semiconductor Products

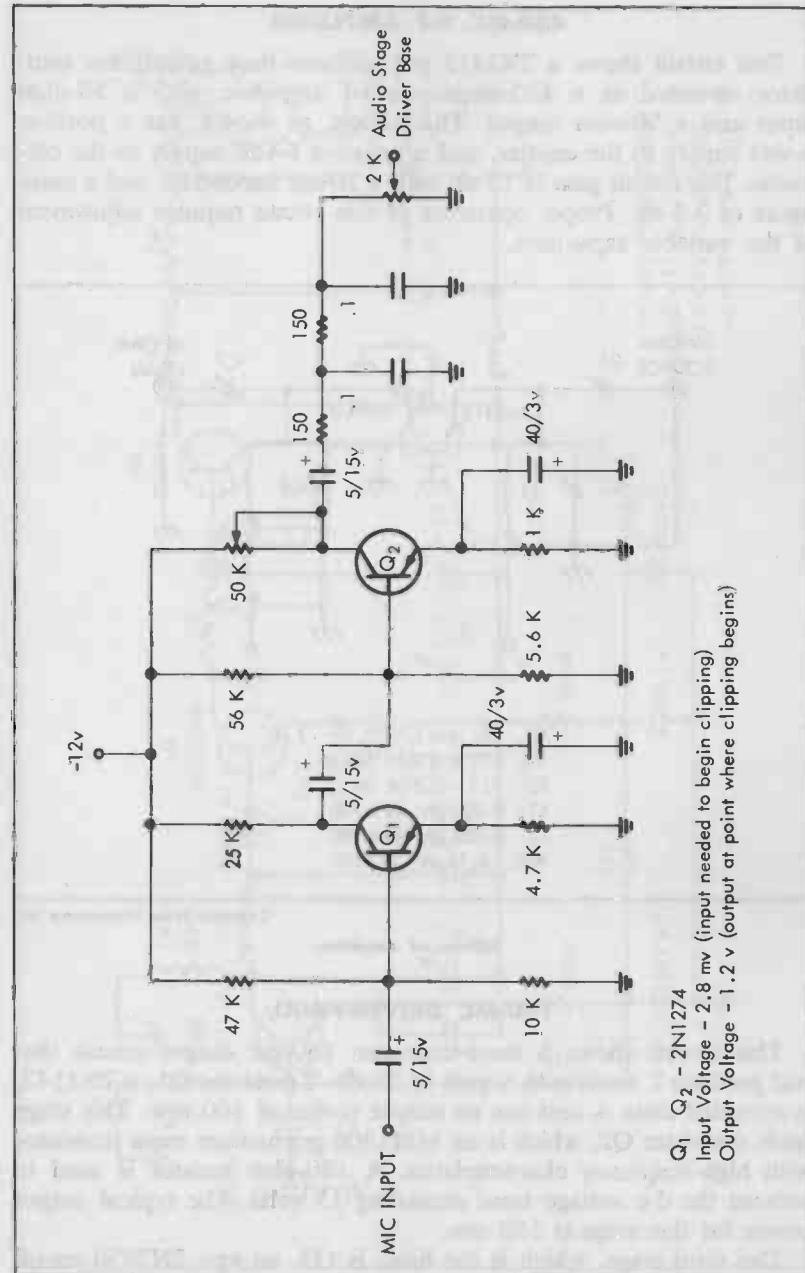
10-mc video amplifier.

SPEECH CLIPPER

This circuit shows a two-transistor speech clipper using type 2N1274 transistors. This circuit amplifies and clips audio voltage applied at the microphone input. This circuit also filters the high-frequency harmonics, and then the audio is fed to the driver stage of a modulator for a transmitter.

This speech clipper is designed to be used with an amateur radio transmitter, and the input voltage where the clipping begins is 2.8 millivolts and the output voltage is 1.2 volts. The result of using a speech clipper is a higher average power output using an a-m transmitter, without going beyond the 100 percent maximum modulation percentage.

Q₁ is a class-A common-emitter amplifier used to increase the amplitude of the microphone audio before it is clipped. Q₂ is the clipper transistor whose collector-to-emitter voltage and collector current are set to clip both sides of the audio wave. A 50K control in the collector is used to adjust the level of clipping.



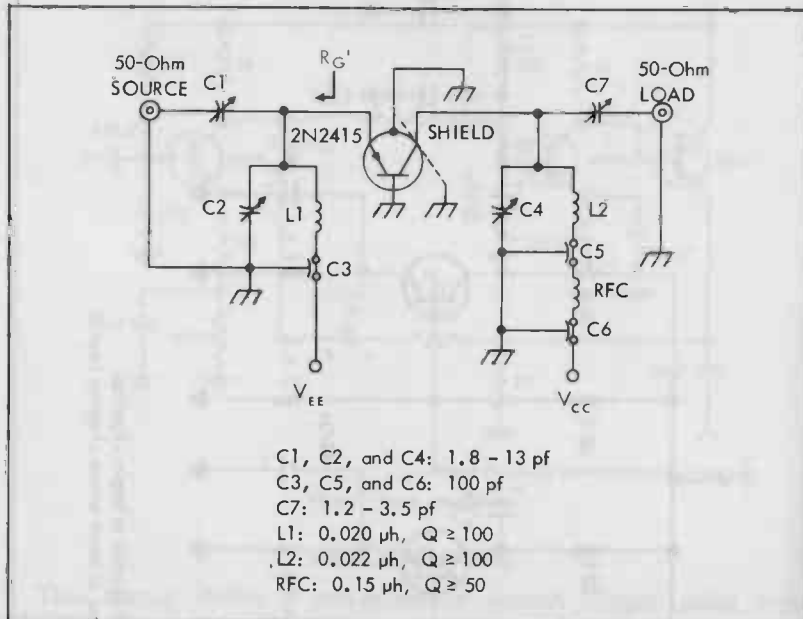
Q₁ Q₂ - 2N1274
Input Voltage - 2.8 mv (input needed to begin clipping)
Output Voltage - 1.2 v (output at point where clipping begins)

Courtesy Texas Instruments Inc.

Speech clipper.

450-MC R-F AMPLIFIER

This circuit shows a 2N2415 pnp diffused-base germanium transistor operated as a 450-megacycle r-f amplifier, with a 50-ohm input and a 50-ohm output. This circuit, as shown, has a positive 6-volt supply to the emitter, and a negative 6-volt supply to the collector. The circuit gain is 13 db with a 20-mc bandwidth and a noise figure of 3.9 db. Proper operation of this circuit requires adjustment of the variable capacitors.



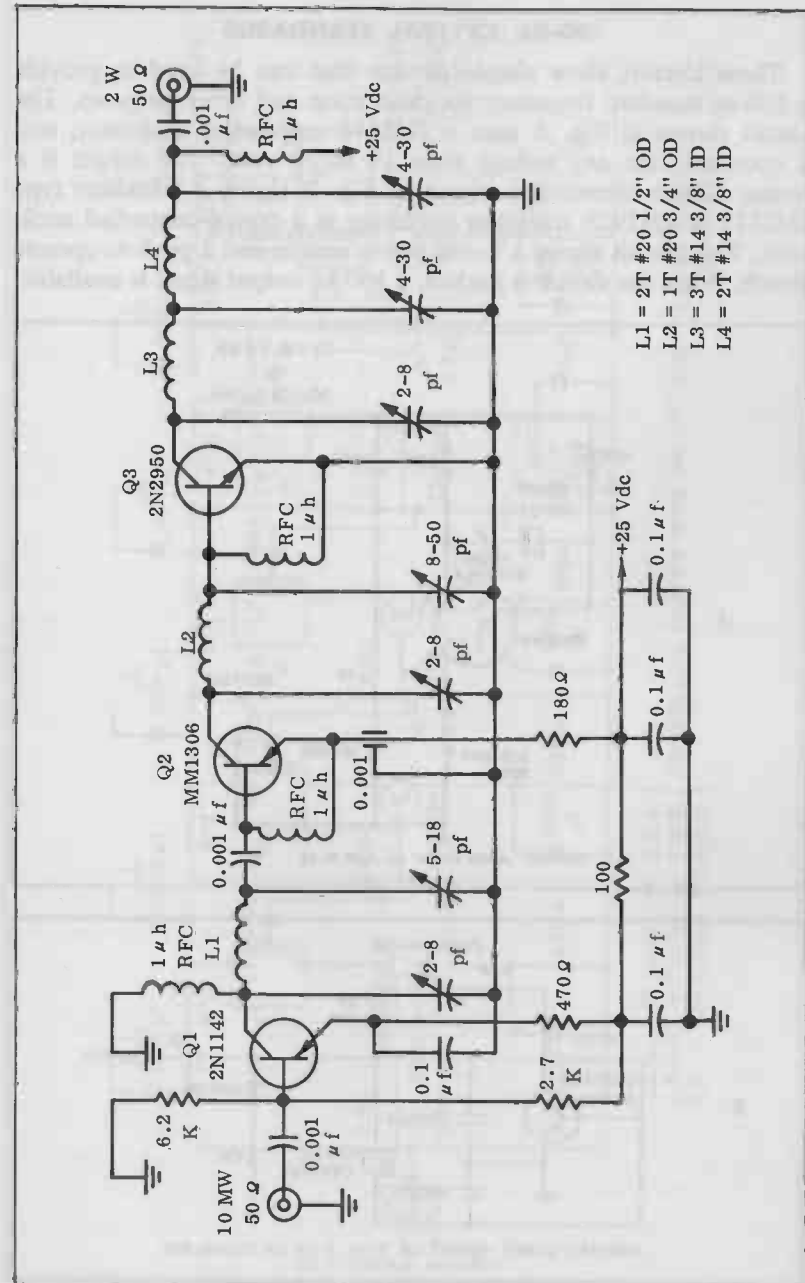
Courtesy Texas Instruments Inc.

450-mc r-f amplifier.

160-MC DRIVER-FINAL

This circuit shows a three-transistor 160-mc output circuit that will produce 2 watts with a gain of 23 db. Transistor Q1, a 2N1142, is operated class A and has an output power of 100 mw. This stage feeds transistor Q2, which is an MM1306 germanium mesa transistor with high-frequency characteristics. A 180-ohm resistor is used to prevent the d-c voltage from exceeding 15 volts. The typical output power for this stage is 550 mw.

The third stage, which is the final, is Q3, an npn 2N2950 on-off amplifier transistor. This stage provides 2 watts of power at 160 mc, with a power gain of 6 db.

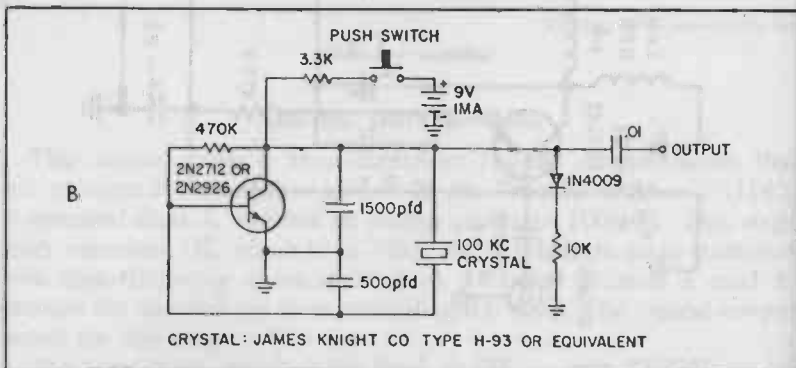
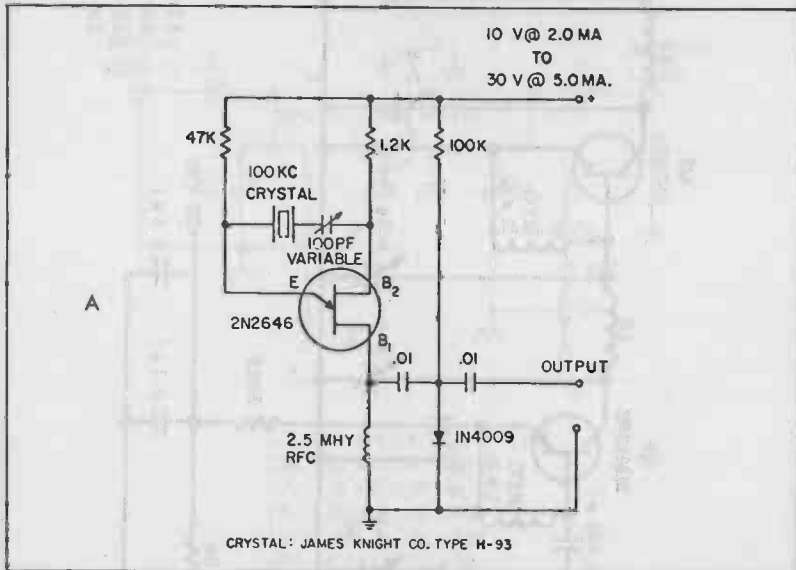


Courtesy Motorola Semiconductor Products

160-mc driver-final.

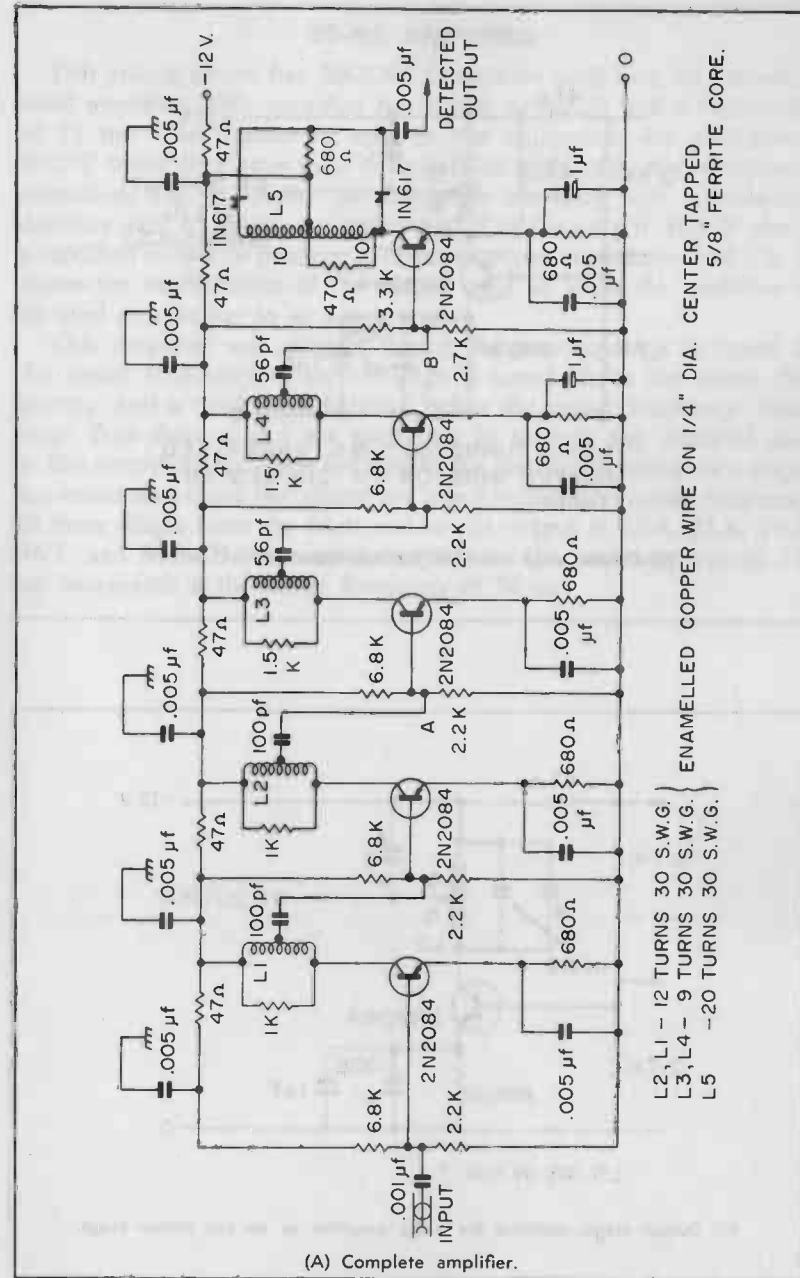
100-KC CRYSTAL STANDARDS

These circuits show simple devices that can be used to provide a 100-kc standard frequency for calibration and other purposes. The circuit shown in Fig. A uses a 2N2646 unijunction transistor, and it operates from any voltage from 10 to 30 volts. The output is a strong 100-kc signal. The circuit in Fig. B shows a transistor type 2N2712 or 2N2926 transistor operating as a crystal-controlled oscillator. This circuit shows a 9-volt power source and a push-to-operate switch. When the switch is pushed, a 100-kc output signal is available.



Courtesy General Electric Co.

100-kc crystal standards.



(A) Complete amplifier.

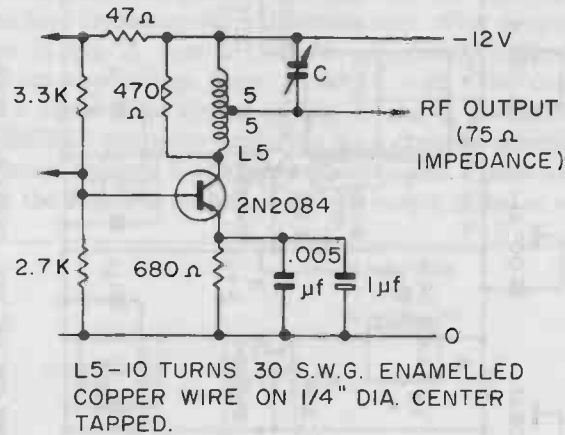
Courtesy Amperex Electronic Corp.

30-mc amplifier.

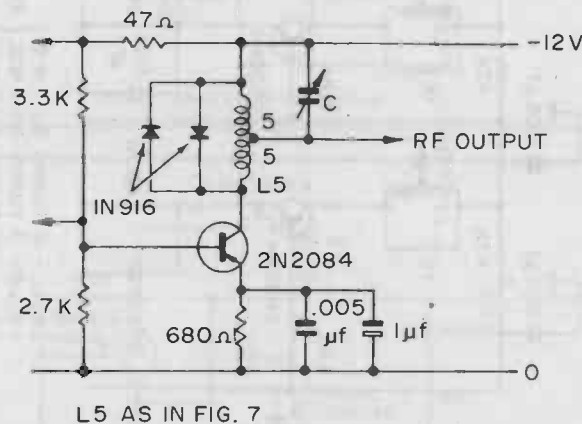
30-MC AMPLIFIER

This circuit shows five 2N2084 transistors used in a 30-mc wide-band amplifier. This amplifier has a gain of 60 db and a bandwidth of 15 mc. The transistors used in this equipment are germanium PADT transistors especially designed for high gain, high-frequency operation. Fig. A shows the complete amplifier with a balanced detector used to reduce the amount of rf in the output. Fig. B shows a modified output to produce a 75-ohm output impedance, and Fig. C shows the modification of the output stage to allow the amplifier to be used as a limiter in an f-m system.

This amplifier uses stagger tuning, where one stage is tuned to the center frequency, a second stage is tuned above the center frequency, and a third stage is tuned below the center frequency. Since more than three stages are necessary to provide the required gain in this amplifier, one stage is tuned to the center frequency, two stages are tuned above and two stages are tuned below. The center frequency of these stages from the front end to the output is 25.4, 25.4, 36.8, 36.8, and 30.0. This arrangement provides the necessary overall 15-mc bandwidth at the center frequency of 30 mc.



(B) Output stage modified for low-impedance rf output.



(C) Output stage modified for using amplifier as an f-m limiter stage.

Courtesy Amperex Electronic Corp.

30-mc amplifier (cont'd)

TRANSISTOR AF and RF CIRCUITS

by Allan Lytel

Here is an assemblage of more than 100 practical transistorized circuits for use in transmitters, receivers, oscillators, converters, r-f amplifiers, i-f amplifiers, code-practice oscillators, audio amplifiers, preamplifiers, power amplifiers, etc. Schematic diagrams and parts lists are included for each circuit.

Although pnp and npn transistors are used extensively in the circuits, some of the circuits use special semiconductor devices. These devices include PADT transistors, dual transistors, Darling-ton semiconductors, varactors, etc.

An introductory section gives helpful information on certain precautions to be taken when constructing the various circuits.

This book is a handy source of information on the design, operation, and application of transistor circuits. Engineers, technicians, experimenters, students, and hobbyists will all find the circuits of interest and the material of value in research, development, experiment, and general studies of circuitry.



ABOUT THE AUTHOR

Allan Lytel has taught mathematics and electronics at the Technical Institute of Temple University and radar maintenance in the Army Signal Corps. He has prepared and conducted a course on digital computers. Mr. Lytel is currently manager of U.S. Electronics Publications, Inc. His other SAMS books include: *Handbook of Transistor Circuits*, *Transistor Circuit Manual*, *ABC's of Computer Programming*, *Fundamentals of Computer Math*, *Handbook of Algebraic and Trigonometric Functions*, *Calculus for the Electronics Technician*, *ABC's of Model Radio Control*, *Industrial X-Ray Handbook*, *Handbook of Electronic Charts & Nomographs*, *ABC's of Electric Motors & Generators*, *Microwave Test & Measurement Techniques*, *Fundamentals of Data Processing*.



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