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CIRCLE NO. 1 ON PAGE 17
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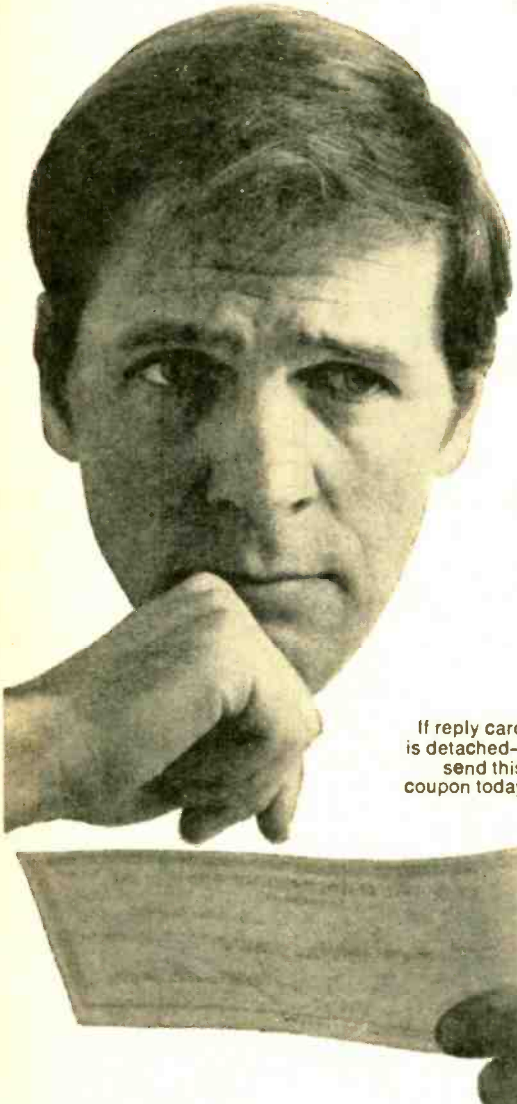
Your paycheck says a lot about you



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• March/April 1971 • Vol. 11 No. 1

e/e elementary Electronics

Dedicated to America's Electronics Hobbyists

KIT-BUILDER'S CORNER

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Cover Photo by Leonard Heicklen

AUTHORS IN THIS ISSUE

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elementary Electronics

INCLUDING SCIENCE AND ELECTRONICS

March/April 1971 Vol. 11/No. 1

Dedicated to America's Electronics Hobbyists

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random noise

The Editor talks up!

Julian M. Sienkiewicz, WA2CQL
EDITOR-IN-CHIEF

The public's attitude toward foreign products in the U.S. marketplace during the past ten years has seen increased acceptance. For the most part, more than half the American buyers believe that Japanese products are vastly superior to those made in Japan ten years ago. I have singled out Japan because they have made the greatest inroads in the American consumer electronics marketplace during the past ten years; more so than German or English products.

Today, among the best consumer buys in the photographic market are the Japanese products. The same value-oriented philosophy is rapidly coming true, if not already true, in the hi-fi marketplace. This is evidenced by brand names such as Kenwood, Sansui, Nikko, Pioneer, Sony, and many more. So, to discover for myself why this trend has come about, I visited the Pioneer offices and warehouse located a few miles outside of New York City.

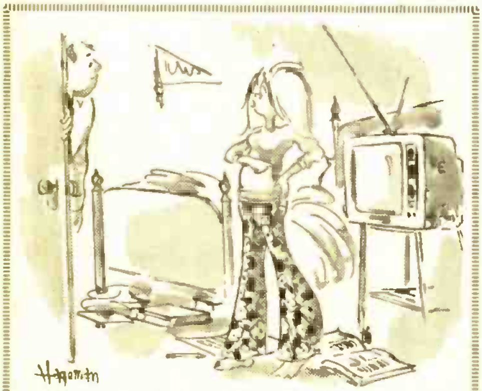
Pioneer gave me complete run of their facilities to inspect anything and everything I wanted without reservation. A quick tour of the office showed that Pioneer was just like any other American outfit—mini-skirted gals racing around with orders and coffee cups. Then I stepped into Pioneer's warehouse. Everything was as to be expected—they had an incoming area, a Quality Control area, and a shipping area. It was the QC area that raised my eyelids. For Pioneer, QC really stands for Workbench Business. There is no relying on the parent company in Japan to certify that the product is in good operating order. Each and every hi-fi component is removed from its case and made to perform under lab conditions to an engineer's satisfaction. (All it takes is one carton dropped by a shipper to damage a component's panel light or fuse element.) Although many defects are not serious, Joe Consumer wants his shiny, new unit to work perfectly when he opens the carton. Pioneer's QC sees to this!

In this Nader age of consumer product rejection, Pioneer and other Japanese companies are making inroads into the American home because they seek to deliver a quality product. You can be sure that the general consumer would not plunk down $350.00 for a stereo receiver if he knew the product was inferior in manufacture or design. Japanese products have come of age. Quality control, both here and abroad, have given Japanese hi-fi products acceptance in our audio marketplace.

Let's not get petty in our approach to foreign products. We prefer mostly Scotch whiskey, French lace, Irish linen, Colombian coffee and Italian shoes. We buy the best because we somehow manage to make more money than anyone else. And the reason we make the most money is because we export products resulting from our superior technology. If we were to stop trading with the world, the world would stop trading with us. The next time you make a purchase, do not think about country of origin, think about getting the best possible product for your dollar!

It's His Move! With heavy heart I announce the parting of Mr. John Collins from our staff of expert columnists and the end of En Passant, our chess column. Recently, we surveyed our readers through several avenues only to discover that En Passant was the least read column in ELEMENTARY ELECTRONICS. No, I'm not saying John's column was the worst of the lot, in fact, it was great. As a chess player I enjoyed it and so did a select few of my readers. However, my duty is to serve all of my readers. Hence, En Passant must go its own way without assistance from our magazine.

John Collins is man of many hats and he writes for other chess magazines. Why not write to him, care of this magazine and tell him how much you enjoyed his column. If you care to ask, he will tout you on some other publications that may be just as rewarding to your chess habit. ■



"This old black-n-white TV doesn't throw enough light to see my homework!"

CIRCLE NO. 8 ON PAGE 17

Hey, look me over

Showcase of New Products

Pop Light

Edmund Scientific Co. offers a whimsical selection of Kinetic Art Form Action Lamps to add zestful change to your home atmosphere. If you are minus the joys of a comfortable fireplace, you can select an Action Lamp that will soothe and delight you with its changing light and color. Or if you need to add a new sparkle to your old decor an Action Lamp can turn

Edmund Kinetic Art Form Action Lights

the trick. And if you have restless teenagers eager for ideas and challenge get an Action Lamp kit to absorb them. The cool looking "AtmoSpheres" are globe-type models available as tablelanps in 8", 12", 16" and 24" diameters with chrome bases. The two largest sizes which have plastic globes and are motor driven are also available as hanging models while the 8" and 12" diameter globes feature glass globes and are heat driven. They retail from $31 to $115 depending on size. More info is available from Edmund Scientific Co., 380 Edscorp Bldg., Barrington NJ 08007.

Circle No. 32 on Page 17

Fast Count

The new Heathkit IB-101 frequency counter uses computer-type integrated circuitry to provide accurate counting from 1 Hz to over 15 MHz without any special test gear adjustment. An overrange indicator and Hz/kHz switch give the IB-101's five cold-cathode display tubes the same capability as a much more expensive *eight-digit counter*. Readings to the nearest kHz are made with the range switch

Heathkit IB-101 Frequency Counter

in the kHz position. Pushing the range switch to the Hz position allows reading figures down to the last Hz. The overrange & Hz/kHz indicators light up to give error-free frequency measurement and correct range at all times. And it's only $199.95 in kit form. Get all the dope from The Heath Co., Benton Harbor MI 49022.

Circle No. 33 on Page 17

This Beep is Clean

Two head cleaners that signal "enough" when they have done their work, and a versatile five-way test-and-clean unit are available for the increasingly popular eight-track cartridge players. All three products by Robins are actually housed in standard eight-track cartridges to make it easy to get the best possible results. Model THC-9, listing at $2.50, is a head-and-capstan cleaner cartridge, with pre-recorded "beep" tones. Its specially formulated cleaning tape is permitted to run, removing accumulated oxide, grime anjd dust particles, until four beeps are heard. The recommended usage frequency is every 20 hours of player operation. Model THC-10, listing at $3.00, employs a special non-abrasive polyester tape to clean cartridge player heads for optimum sound fidelity. It talks with clicks, and is permitted to run until four clicks are heard. Then the cleaning job is done. The five-way "Test-N-Clean" cartridge is Model THC-11, listing at $5.30. To

Robins New Cartridge Head Cleaners

Hey, look me over ************

help keep equipment trouble-free, it performs these vital functions: testing track selector, testing stereo channel balance, testing speaker phasing and testing head alignment to assure full fidelity playback without crosstalk. THC-11's fifth task is to clean player heads while it is testing. Robins, whose home office plant is in College Point NY 11356, is a major single-source manufacturer of cassettes, cartridges, reel-to-reel tape and cassette, cartridge and phon accessories. Look for them on racks at your favorite hi-fi dealer.

Circle No. 34 on Page 17

Zap—Your Clean

Formulated especially for difficult TV tuner problems, new Magic Vista golden foam tuner cleaner from GC Electronics Division of Hydrometals, Inc., is packaged in a handy, versa-

GC Electronics Magic Vista Tuner Cleaner

tile, 8-ounce aerosol can. Included with the dispenser is a plastic spray extension tube to help reach into tight places. The aerosol can features a new, any-angle constant discharge valve that lets the technician use the spray regardless of the can's position—even *upside down!* The special golden foam formulation cleans, polishes and lubricates TV tuner contacts without running off or evaporating. The chemical is completely safe for plastics. Retail price of the 8-ounce aerosol can (Catalog No. 10-800) is $3.85. GC Electronics manufactures a full line of electronic components, accessories and hardware for use by hobbyists, consumers, service technicians and industry. Available at most electronic parts store.

Circle No. 35 on Page 17

Cassette Player with Dolby

Fisher Radio has added the RC-80 cassette

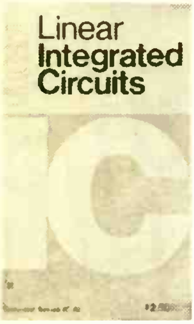
(Continued on page 97)

CIRCLE NO. 21 ON PAGE 17

BOOKMARK
BY BOOKWORM

RCA Did It Again

RCA's Linear Integrated Circuits manual (IC-42) has been extensively revised and expanded to cover the latest innovations in IC technology and applications. The jumbo 416-page manual may be used as a guide for circuit design. It is also helpful to educators, technicians and hobbyists who have a basic understanding of solid state divices and circuits. The basic fabrication, packaging, mounting, and interconnection techniques are explained and the fundamental building-block elements for linear monolithic integrated circuits are analyzed. The *RCA Linear Integrated Circuit* manual is available from RCA distributors and electronic parts stores or write to RCA Commercial Engineering, Harrison, N.J. 07029.



Soft cover
416 pages
$2.50

Circle No. 42 on Page 17

Who's That Breaking in My Door?

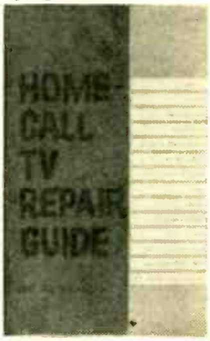
Electronics in hi-fi, TV and radio are no mystery to us. However, the operating principles of electronic devices and systems used to provide security against crime are practically unknown to most hobbyists. That's why John E. Cunningham wrote his latest title *Security Electronics*. The text describes intrusion alarms and intrusion-detection devices. Included are chapters on detection of hidden metal objects, announcement of detected intrusion, bugging, debugging and speech-scrambling systems, and future developments. The appendix describes one of the more recent developments in electronic components, the integrated circuit, or IC, whose microminiature size may make possible further advances in electronics security. Published by Howard W. Sams & Co., Inc., 4300 W. 62nd Street, Indianapolis, IN 46268.

Soft cover
160 pages
$4.50

Circle No. 43 on Page 17

Fast TV Servicing

Every pro service man and do it yourselfer can use an on-the-spot repair guide with quick-reference charts specifically designed as a trouble guide for the outside technician. That's exactly what you get with *Home-Call TV Repair Guide* by Jay Shane. With this handy, quick-reference home-call trouble guide, any technician will be able to increase his ability to complete more service calls per day. The book is arranged in logical reference sections—covering raster, video, chrominance, and other circuit troubles—to guide the reader right to the cause. By simply comparing the symptoms in each case with the handy charts in the guide, the technician is guided, step by step, through quick checks for the most logical causes of any malfunction. In minutes he can tell whether the set can be repaired on the spot or if it's a bench job. Published by Tab Books, Blue Summit, PA 17214.

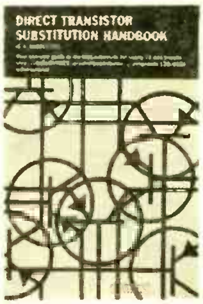


Soft cover
144 pages
$2.95

Circle No. 44 on Page 17

For the Want of a Transistor

You almost never have the transistor specified for a project, but you may have its replacement in your spare parts box. You can find out quickly by thumbing through *Direct Transistor Substitution Handbook*, by H. A. Middleton. A complete, up-to-date reference for technicians, hobbyists and circuit designers, the guide provides computer-selected substitutes for transistors used in entertainment, industrial, and commercial equipment. Close, conservative tolerances yield almost 130,000 substitutions, each graded from "good" to "best." All substitutions are *di-*



Soft cover
224 pages
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(Continued on page 100)

DX central reporting

A world of SWL info!

BY DON JENSEN

Are QSL's harder to get these days? Opinion seems to be divided. There are those DXers who claim that stations are slower to answer correct reception reports than they used to be. They theorize that foreign shortwave broadcasters are receiving more reports of reception than they used to and as a result, find it harder to come up with the manpower, time and money needed to verify them. And, they argue, apparently with some merit, that many poor reports received by these stations tends to turn them off, make them reluctant to QSL!

On the other hand, there is evidence that many shortwave stations, even some of the real toughies when it comes to verifying, do appreciate good reception reports and will reply with QSLs.

A good report, of course, will include all the important details, date, time and frequency, plus a useful description of conditions of reception and, most importantly, a list of items logged which will prove to the station you actually heard them. And, a good report will include your own personal reactions, your comments on programming heard, some background about yourself, your interests in the hobby and anything else that will give the station the idea that there is a real human being out there who is interested. In short, a good report will be correct, useful and, hopefully will stand out from the rest of the listener mail received.

In practice, it pays off. Here are some of the raries that have QSLed good DX reports recently.

Remember Chicom I, the first Red Chinese space satellite that was launched last April and circled the earth for about a month, broadcasting telemetric signals and the revolutionary tune, "The East is Red?" A number of U.S. SWL's managed to hear these broadcasts on 20.009 kHz. as the satellite passed over the States. But, many wondered, was it possible to get a QSL for reception of this signal from outer space?

A few thought it was, and using the suggested address given in this column some months back, sent their reports to the Chinese Academy of Science in Peking, the governmental agency that is responsible for scientific development behind the Bamboo Curtain.

It worked! At least eight DXers, from whom we've heard, including Alvin Sizer of Connecticut and Rhode Islander, Hank Michalenka, received verification letters, in both English and Chinese, from the academy, confirming their loggings of Chicom I.

The verification letters, in typical revolutionary style, called the satellite "a fruitful result achieved by the Chinese people under the guidance of Mao Tsetung thought and after being tempered in the great proletarian cultural revolution."

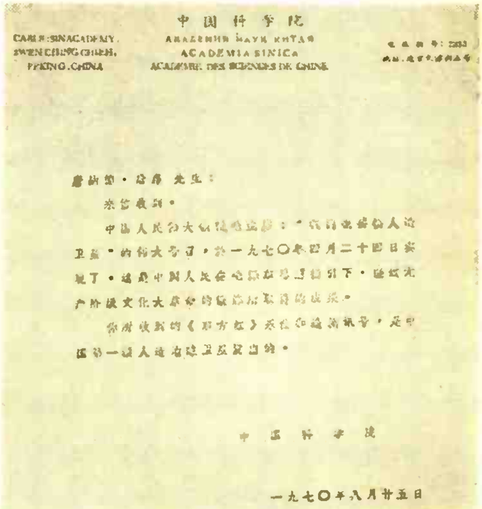
Propaganda aside, these rare QSLs are real treasures to the happy recipients.

And, Radio Espana Independente, a longtime communist voice of the Spanish Communist Party, which presumably broadcasts from Russia, has verified some reports recently. Like most clandestine operations, this one for years seemed to be a dyed-in-the-wool non-verifier, but now it has been replying with a very attractive card designed by Pablo Picasso.

REI uses a number of different frequencies, but 14.478 kHz., has been reported by Wisconsin SWL Gerry Dexter around 2000 GMT, recently. Programs are, of course, in Spanish, and reports should be sent to Radio Espana Independente, Box 359, Prague, Czechoslovakia. But don't be surprised if your QSL comes back from a postal drop in France. Confusing? Sure, but that's the way these secret stations operate.

Bandsweep. (Times in GMT and frequencies in kHz)—**900**—Radio Barbados has shifted

(Continued on page 99)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Letter from Chinese Academy of Science verifies reception of China's 1st. broadcasting earth satellite. Letter in English also sent.

ELEMENTARY ELECTRONICS

READER SERVICE PAGE

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CIRCLE NO. 15 ON PAGE 17

stamp shack

Philatronics Today!

BY ERNEST E. KEHR

● ● We've become so accustomed to radio—in cars, at the office, at home and even in elevators o fhigh-rise urban buildings that it hardly seems credible that this form of communications is a mere 50 years old.

● As far as we know, the world's first public broadcasting transmission took place down in Buenos Aires, half a world away. A stamp, issued by Argentina on August 29, 1970, recalls that memorable night with a special 20 centavo stamp multicolor. It depicts an antiquated horn receiver and a series of arcs to suggest radio waves as lithographed at the Casa da Moneda or state mint.

● Marconi had been pioneering and experimenting with wireless for a number of years before the scientific invention was put into commercial use. The instruments were primitive: the transmissions, weak.

It was on the night of Aug. 27, 1920, that Hams Drs. Enrique Telemaco Susini, Miguel Mugica, Cesar Jose Guerrico and Luis Romero Carranza joined forces to give Argentinians a chance to hear a program sent through the South American ether.

● In cooperation with the Buenos Aires Opera Company—which used the old Coliseum Theater before the Teatro Colon was erected—they brought their primitive equipment onto the stage. Felix Weingartner was on the podium and a stellar cast of European and South American artists sang the roles of Richard Wagner's "Parsifal." Just how many people heard the crackling, static-filled music never will be known. But that a good many amateurs who owned crystal sets and other wireless receivers were tuned in, listening to the impressive prelude, with its "Last Supper" theme; Amfortas', Kundry's and Gurnemanz' arias and the final "Grail" notes, is certain.

● The following day, more broadcasts were transmitted by the pioneering quartet.

Rep. of Argentina 50th Radio Anniversary

● It wasn't until just about three months later that the first radio broadcasting was accomplished in the United States, when the elections of 1920 were described through the air waves to announce the victory of Warren Harding as president of the nation.

● The pioneers were eventually given national recognition when, in 1939, they received medals and plaudits of the Argentine Chamber of Deputies.

● ● Back in 1969, the British Post Office decided to publicize its advances in technological handling of its mail service. Four stamps were designed, printed and released, each intended to symbolize one of four systems which had been automated by electronic facilities.

● Two of the stamps which most clearly suggest their intentions are identified: the other two, whose designs leave one wondering what they're all about are simply inscribed, "telecommunications" and definitely require an explanation—which the British GPO sent along with its official announcement of the set.

● The five-pence denomination shows a huge "G," emblem of the National Giro, part of an intricate kind of money order system which

Great Britain 5d National Giro

had been introduced in many parts of Europe some years ago. Giro is an inexpensive, fast and easily accessible fund-transferring system based on a computer's ability to do in a fraction of a second what ordinary manpower could do only in hours. To avail itself of its facilities, the public can open accounts with the Post Office and by using an individual account number, make payments or receive funds without having to fill out cumbersome money order forms, waiting in lines and having to prove identity when cashing them.

● The nine-pence has a lined globe surrounded by a series of circular blobs. This one according to the GPO explanation, is intended to publi-

Great Britain 9d Telecommunications

cize international subscriber dialling telephone service that was begun in 1963, when such facilities were opened between London and Paris. Although Europe is smaller than the United States, where such dialling has been in operation for many years the necessity of crossing borders of lands which have their own, inde-

(Continued on page 102)

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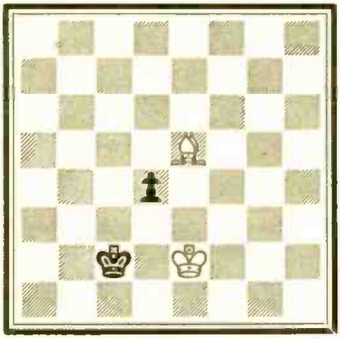
It's your move!

The Bishop is worth about three Pawns, as is the Knight, according to the table of relative values of the chess pieces. But most masters prefer to it the Knight, except in obstructed positions, because of its greater range and aggressive characteristics in open positions. And, in the ending, two Bishops all but constitute a winning advantage against two Knights.

Ordinarily, a Bishop draws against one or two Pawns, unless they are too far advanced. But in the following exceptional case a check breaks the rule.

Black



White

1	P-Q6#	3 B-B4	P-Q8=Q(#)
2 K any	P-Q7		

And Black wins with King and Queen against King and Bishop. Normally, White would have been able to sacrifice his Bishop for the Pawn or new Queen and thereby draw the game.

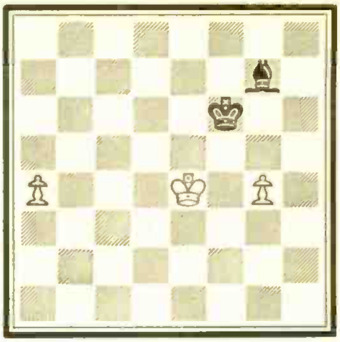
In the next example the Black King cannot avoid getting in the way of his own Bishop.

See game top of next column.

1 P-R5	B-B1	5 K-B3!	B-K8
2 K-Q5	B-R3	6 P-R6	B-R4
3 P-N5#!!	BxP	7 P-R7	B-N3
4 K-K4	B-R5	8 P-R8=Q	. . . .

And White wins with King and Queen against King and Bishop. It is interesting to see how the White King denies the Bishop the vital squares. If 3. . . . KxP (instead of 3. . . . BxP) 4 P-R6 and the Black King obstructs the Bishop

Black

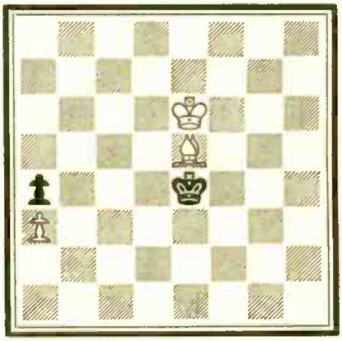


White

from reaching K6, where it would control QR2. This was composed by H. Otten.

It is well known that a King, Bishop and Rook Pawn do not win against a lone King if the lone King can reach the queening square of the Pawn and if the Bishop does not control that square. Sometimes, however, as in this study by Rauser, 1928, the Black King can be kept away from the Rook file and side with the extra material wins.

Black



White

1 B-R2	K-Q5	6 K-N5	K-B6
2 K-Q6	K-B5	7 KxP	K-B5
3 K-B6	K-N6	8 B-N4	K-Q4
4 B-Q6	K-B5	9 K-N4	K-K3
5 B-B5!	K-N6	10 K-B6	. . . .

And the Pawn goes on to queen and win.

With Black to move, in the original position, White's winning solution is: 1. . . . K-B6 2 K-B5, K-K6 3 B-N2! K-Q6 4 K-K5, K-K6 5 B-B1# K-B6 6 K-B5, K-N6 7 B-N5, K-B6 8 B-B4 and White wins, as shown in a great study by Kling and Horowitz, 1851. But it takes another 18 precise moves to prove it!

Game of the Issue. Vassily Smyslov, former world champion, was born in Moscow on March 24, 1921. His father, a strong player, taught him the rudiments of chess at the age of six. He entered his first tournament in 1935, rose rapidly during the next few years, and earned the title of master when he was seventeen. Embarked on an active tournament career, which is still in full swing, he scored firsts, or ties for first and second, at Moscow, 1938, Moscow, 1942, Moscow, 1944, USSR, 1949, Moscow, 1951 (Tchigorin Memorial), Zurich, 1953, Hastings, 1954/5, Zagreb 1955, USSR, 1955, Amsterdam, 1956 Moscow, 1956 (Alekhine Memorial), and others in the last decade and a half. In 1954, he drew a match with M. M. Botvinnik, 7 wins, 7 losses, and 10 draws for the world title, which left Botvinnik champion. But three years later he captured the title himself by defeating the same opponent in a return match with 6 wins, 3 losses, and 13 draws.

Smyslov has written that he "would like to emphasize that the title, world champion, is not merely a sporting term, but something more which correlates the ideas of creation and scientific achievement in chess.' And 'it would seem that chessplayers, masters and grandmasters, who remain faithful to the best tradition of the game should try not only to win, but also to create artistic work and at the same time improve the general quality of play by their respective innovations.' In our Game of the Issue, played at Moscow, 1955, as White against Botvinnik in a Kings Indian Reversed, Smyslov embodies these thoughts and foreshadows his future success.

See game top of next column.

1	N-KB3	N-KB3	15	R-N1	P-QR4
2	P-KN3	P-KN3	16	B-QR3	N-B2
3	B-N2	B-N2	17	BxN	PxB
4	O-O	O-O	18	RxP	B-R3
5	P-Q3	P-B4	19	R-N6!	BxN
6	P-K4	N-B3	20	PxB	B-B5
7	QN-Q2	P-Q3	21	RxQP	Q-K1
8	P-QR4	N-K1	22	R-K1	R-B2
9	N-B4	P-K4	23	N-N5	R-K2
10	P-B3	P-B4	24	B-B1!	BxB
11	P-QN4!	PxNP	25	RxB	QxP
12	PxNP	PxP	26	R-Q8#	R-K1
13	PxP	B-K3	27	Q-B3	Q-B5
14	N-K3	NxP	28	R-Q7	Resigns

Why did Black resign? Because he is faced with mate or prohibitive material loss. Here is the analysis—

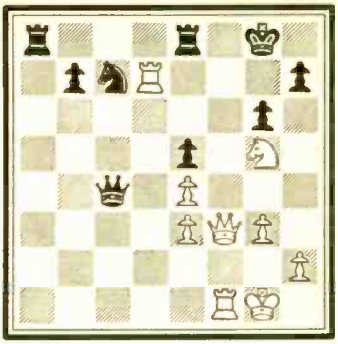
A. If 28. . . . K-R1 29 Q-B6# K-N1 30 Q-N7 mate.

B. If 28. . . . Q-B3 29 Q-B7# K-R1 QxP

C. If 28. . . . R-KB1 29 RxN (29 N-B7 wins easily too) QxR 30 QxR# RxQ 31 RxR# KxR 32 N-K6# K-K-2 33 NxQ and extra Knight is more than enough to win.

A typical Smyslov game—positional, technically accurate, culminating in combinative play and a King-hunt.

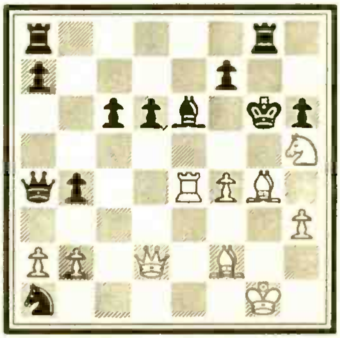
Position after 28 R-Q7



Solution to Problem 28: 1 B-Q4.
If 1. . . . K-Q3 2 Q-Q8 mate. If 1. . . . K-N1 2 B-K5 mate. If 1. . . . N-K2 2 B-K5 mate. If 1. . . . N-Q3 2 B-N6 mate. And if 1. . . . N-N3 (or 1. . . . N-R2) 2 B-K5 mate.

Stranger than Fiction. James H. Blackburne (1841-1924), the great British master who was lugubriously nicknamed "the Black Death," reached the position below with White against Mr. Scott. Thereupon he announced mate in 16 moves—that is called off the remaining moves. Remarkable enough. But wait!

Black



White

1	RxB#	K-R2	9	RxRP#	K-N1
2	Q-Q3#	R-N3	10	N-Q7#	K-B1
3	QxR#!	PxQ	11	N-B5#	K-Q1
4	R-K7#	K-N1	12	R-Q7#	K-B1
5	B-K6#	K-B1	13	R-KB7#	K-Q1
6	R-B7#	K-K1	14	N-N7#	K-K1
7	N-B6#	K-Q1	15	NxP#	K-Q1
8	R-Q7#	K-B1	16	B-N6	mate!

Blackburne did all of this blindfold—without

(Continued on page 103)

elementary Electronics MAR-APRIL 1971

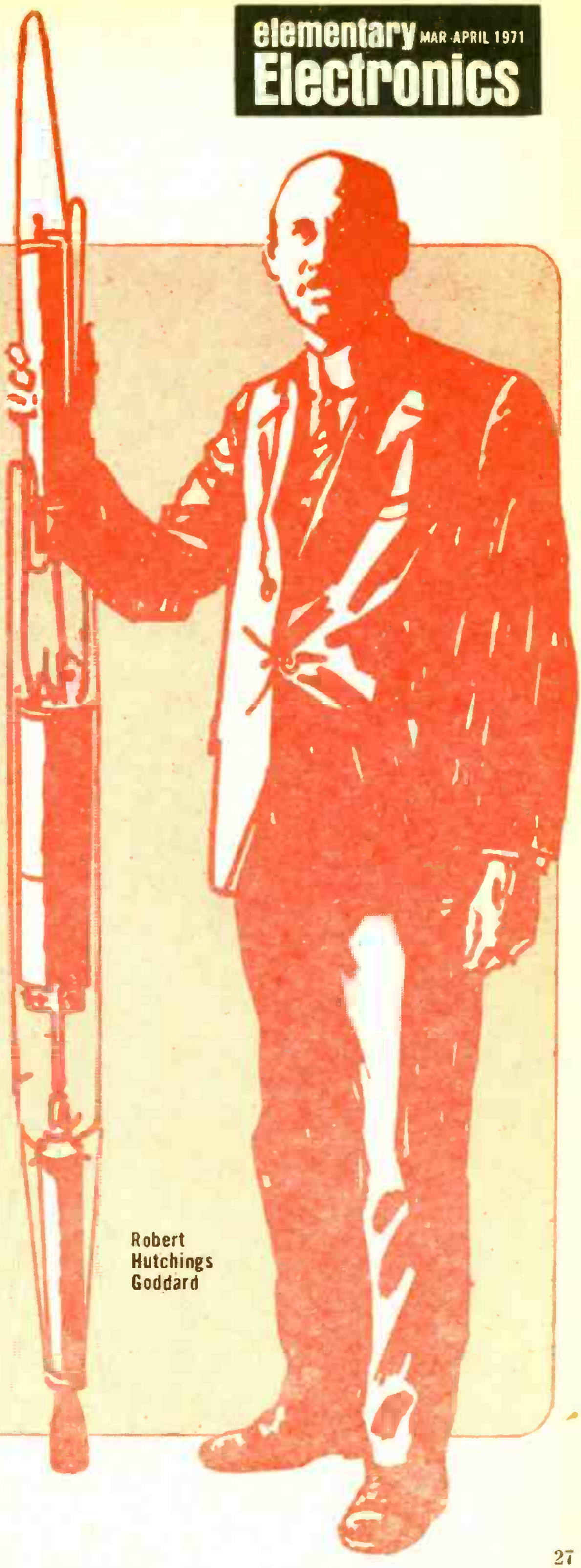
PROPHET OF THE SPACE AGE

Robert Hutchings Goddard, whose work laid a technical basis for the Apollo flights, predicted intergalactic travel, human migration from earth, and the harnessing of solar energy.

by Arnold C. Bailey

Man will journey to Mars and other planets, using the moon as his jumping-off point. Neptune will become his launching base for explorations to other solar systems, other galaxies. He will allow his body to be reduced by freezing to granular protoplasm and travel in sleep on voyages lasting thousands of years, to be awakened automatically at journey's end.

Then, one day, man will find his own planet no longer able to support life. He will begin his final voyage from earth, a lonely migration in search of a distant home. He will carry with him, in condensed form, the best of all human knowledge so a new civilization can begin where the old one ended. This glimpse of man's destiny in space (Turn page)



Robert Hutchings Goddard

Facts and photos courtesy Electronic Age, Radio Corp. of America

e/e PROPHET OF THE SPACE AGE

could be a fantasy by Jules Verne or a Buck Rogers thriller, exciting to consider but easy to dismiss. It is neither. Instead, these predictions are found in the private papers of Dr. Robert Hutchings Goddard, the pioneer American rocketry scientist whose work laid the technological foundation for many of this nation's prodigious accomplishments in space. The recognition Goddard has received as father of the space age makes his view of the future doubly exciting. And, because the Apollo moon landings have demonstrated the soundness of his historic research and testing, his predictions are uniquely difficult to dismiss.

Aviator Charles A. Lindbergh, one of Goddard's earliest and most consistent supporters, summed up the scientist's visionary legacy in the foreword to *This High Man*, a biography of Goddard by Milton Lehman. His ideas "must be considered as belonging to an open volume, with a preface of fact on one side and thick chapters of fiction on the other. Year by year, time keeps turning the pages of fiction over into the preface of fact."

As the Pages Turn. Goddard can be seen as a mixture of the conservative, matter-of-fact scientist and the adventurous, imaginative visionary. During most of his lifetime, Goddard kept a tight rein on his imagination—a reaction to public skepticism and ridicule of his work. It must have been like trying to hold back a Saturn rocket with a kite string. On the night of January 14, 1918, he completed the writing of *The Last Migration*, a 12-year compilation of notes concerning interplanetary travel and the work that he himself called his "most extreme speculation." Typically, Goddard sealed the manuscript in a folder deliberately mistitled "Special Formulae for Silvering Mirrors" and had it locked in a friend's safe.

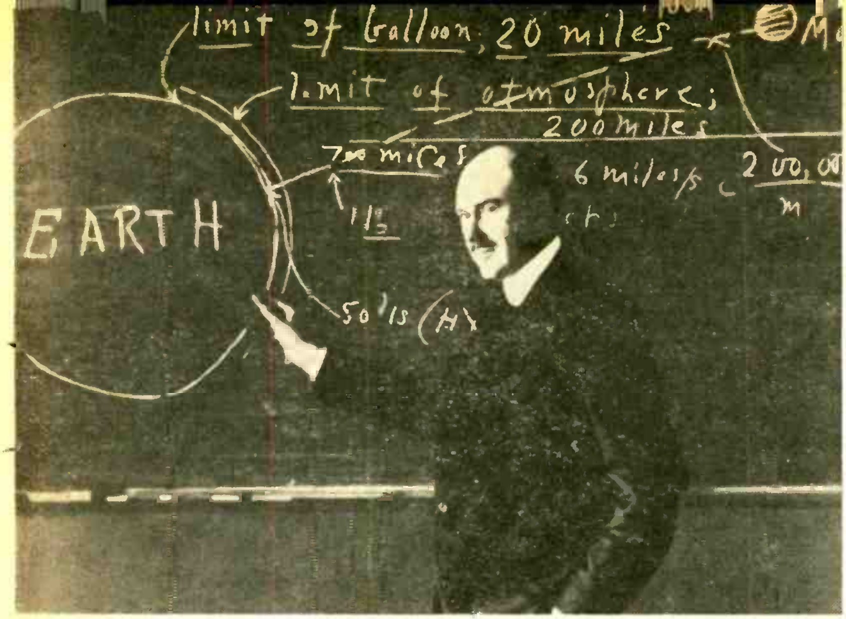
Early in his work, Goddard had been marked publicly, perhaps indelibly, as "the moon rocket man." And, to be sure, reaching the moon was Goddard's persistent dream. But it was just one of his dreams. He clearly envisioned the lunar surface as the stepping stone to the other planets in our solar system. In *The Ultimate in Jet Propulsion*, a summary of his ideas written in 1943, he suggested the possibility of establishing a self-contained moon station where both propellants and constructional materials could be produced for use in expeditions sent out from the surface of the moon. He theorized that hydrogen and oxygen could be made on the lunar surface with the same 500,000-watt solar plant that would have propelled the spacecraft (which was converted into the moon station) during its journey to the moon. The power plant would be capable of electrolyzing one ton of water in slightly more than two-and-one-half hours. The moon station would have a protective covering with movable ports to counter possible dangers from meteorites.

"The station could be made a veritable astronomer's paradise," Goddard wrote. "Since there would be no atmospheric disturbances, telescopes and other moving instruments would be of small weight and would move slowly, and observations could be made in any direction for as long as desired. In addition, extreme ultraviolet light and electrified particles from the sun and even similar rays from the stars could be studied. A station in which sunlight was used to grow vegetation could be, in effect, self-supporting. A start from such a station using jet propulsion, would require much less initial mass than that required for a start from the earth. Moreover, sending mass to a craft in space suggests a means of reducing still more the mass of propellant required."

Always the physicist, Goddard did not neglect opportunities for lunar-based research. "An interesting investigation, made possible by the absence of air, would be a study of impacts of very-high-velocity ions," he wrote.

A Pioneer with Vision. Travel to other planets was frequently on Goddard's mind, although he became increasingly cautious about mentioning it in public. However, one of his former students at Clark University in Worcester, Mass., where Goddard served on the faculty for 29 years, recalls a moment of boldness when the professor flatly predicted to his class: "Gentlemen, I can assure you that during your lifetime men will be traveling to other planets in our solar system."

Mars and Jupiter seemed especially likely destinations to Goddard. Mars could be reached, he theorized, directly from earth without using the moon as a jump-off station. As early as 1918, he worked out the



Top—At Clark University in 1924, Goddard lectures on how man eventually might reach Moon. Right—Goddard with his liquid-fueled rocket: motor is at base, fuel tanks are above it.

Top, Bottom Right—Auburn, Mass. rocket launch test site. Right—Demonstration of sun-motor apparatus for rocket.

Top—Centrifugal pump, turbine tested at Clark University.

specifics of such a journey, basing his calculations on the use of solar energy. "A rough calculation," he wrote, "shows that for a journey from Earth to Mars the average velocity should be about three miles per second, the mirror surface per 500 pounds being 680 square feet." The journey's duration, he suggested, would be 14.26 weeks. Two years later, he revised his figures, calculating that an average speed of seven miles a second might be possible. Earth to Mars, he said, was a seven-week trip.

The Count-down Begins. Rocket propulsion, of course, had always been one of Goddard's special interests. His initial work had been conducted with traditional powder rockets, but as early as 1907 he began considering liquid propulsion to increase efficiency. Goddard tested the first liquid-fueled rocket that ever flew on March 16, 1926, at Auburn, Mass. His initial reasoning behind the use of liquid hydrogen and oxygen was that the liquid type of propellant would be more likely to make interplanetary travel possible than any other known fuel. Goddard theorized that, whatever the makeup of interplanetary bodies, some surely would contain hydrogen and oxygen that could be collected electrolytically. Such reasoning led him to suggest the establishment of the previously described moon station.

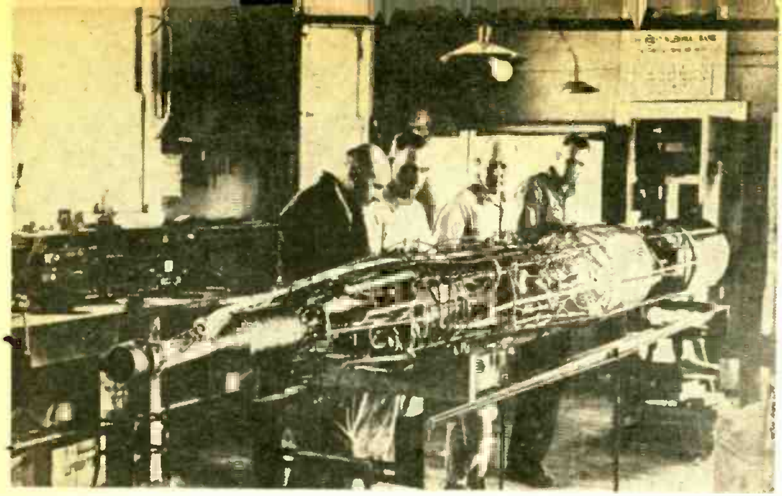
However, Goddard looked to other forms of propulsion—nuclear, ion, or solar energy—as the ultimate solution to space travel. In fact, Goddard thought enough of solar and ion motor concepts to take out patents on these two methods. Today, both are in the research and development stage.

He Splits the Atom. His interest in the possible use of atomic energy as a propellant illustrates how far ahead of his time Goddard was. In 1907, Goddard put it this way. "The navigation of interplanetary space depends for its solution on the problem of atomic disintegration"—his concluding statement in a paper written as an undergraduate for a senior physics course at Worcester Polytechnic Institute. Nine years later, he collected his fragmentary ideas on the subject in a paper entitled *Atomic Disintegration*. Interestingly, this paper predates by almost three years the first actual disintegration achieved with alpha particles from natural decay by Ernest Rutherford in England, and by 15 years the first disintegration by artificial means by J. D. Cockcroft and E. T. S. Walton.

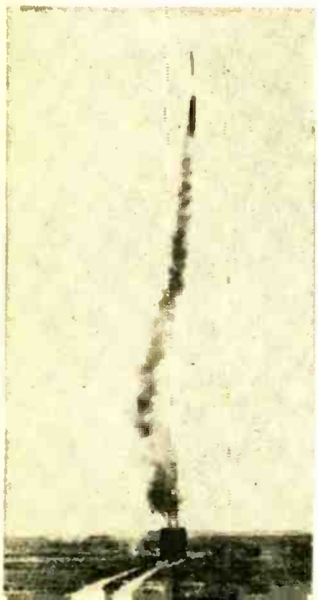
Goddard wrote: "If it is possible to obtain intra-atomic energy, the matter of transportation in space would be comparatively simple, and a large body could be sent from the solar system, thus affording protection from meteors to the contents. In this case, living beings might be carried, the necessary light and heat being furnished by radioactivity. If atomic disintegration is solved, the way may be open to the creation of what might be called artificial atoms in which energy might be stored by many high-speed particles. This tremendous amount of energy could be liberated when these artificial atoms were broken up or the particles were removed gradually."

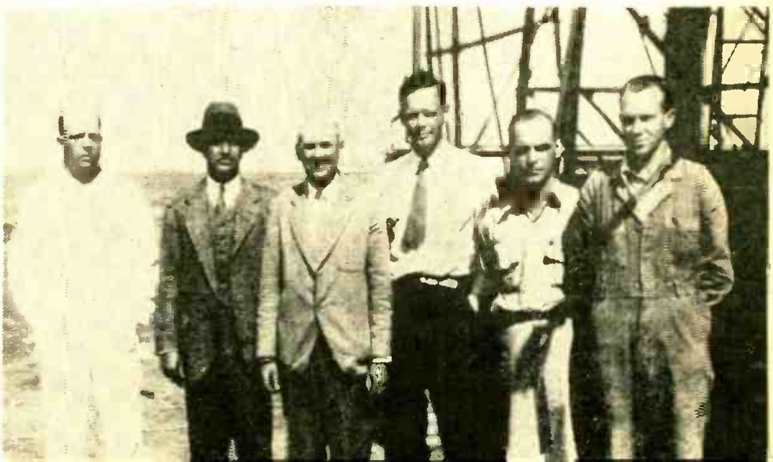
A early as 1906, Goddard began considering the possibilities of ion propulsion. In essence, his concept of an ion motor resembled today's electric light bulb. It required a filament or foil and, for ejection, virtually any substance that could be incandesced or broken down electrically. A number of tests were conducted under Goddard's direction by graduate students in the laboratories at Clark University—their work helping Goddard draw conclusions on ways that man might reach the stars.

He Looks to the Sun. However, Goddard saw solar energy as perhaps the most efficient and feasible method of propulsion, employed either alone or combined with other systems. His method made use of a solar sail, lightweight collapsible, mirror-like apparatus of metal foil, about 600 feet square. Like a parasol, it would be unfurled in the vacuum of space. He theorized that such a sail could be used to push a spaceship outward from the sun or some other star with pressure from the light of these bodies acting much as the wind that drives sailing ships. The sail could be furled or tilted on edge to permit a return to the sun or star through the pull of gravity. The power plant would be a shell or boiler into which the radiant energy could be directed, its outside highly polished and inside blackened. This was one of three possible methods of absorbing solar energy considered by Goddard; the others were based on combining fluid with absorbent materials. In all three methods, a turbo-generator would be used with the boiler, employing electromagnets near individual turbine blades. The



Top Left—Rocket is checked out by Goddard team at his workshop.
Top Right—Rocket launch tower at Roswell, N.M.
Left—Goddard enjoyed painting during his leisure time. Here, he works in oils near his rocketry workshop at Roswell, N.M.
Bottom Left—Successful launch of rocket from Roswell, N.M. tower shown in top right photo.
Bottom Right—Goddard (third from left), his crew were visited at their workshop near Roswell by philanthropist Harry Guggenheim (second from left), aviator Charles A. Lindberg (third from right).





generator would be designed for small current and high potential in order to give high velocity to a small amount of matter. The boiler would produce a jet or stream, and the ship would sail effortlessly.

During the 1930s, Goddard developed a prototype of a solar motor in his shop at Roswell, N.M., where he conducted his later research and tests. His autobiographical notes indicate his belief that it was only a matter of time before solar energy could be harnessed. "The main ideas regarding the absorption of solar energy and the directing of the mirrors appear to have been conceived."

Beyond Pluto. Goddard pictured man traveling not only in interplanetary space but through what he called "superspace" into other solar systems and other galaxies. Neptune, he believed, would serve ideally as a space base. In 1927, Goddard proposed: "To leave the solar system with a fairly high residual velocity, using hydrogen and oxygen and solar energy, the final start should be made from or near the planet Neptune, such materials as are needed being stored on this satellite, on which solar energy could be employed. . . . Of course, the satellite could be a halfway station, and the final start could be beyond the orbit of Neptune . . ."

Goddard doggedly believed that man was at his best as a curious, exploring creature who inevitably would benefit from learning the ways of the universe. The vastness of space, he theorized, might someday be man's only hope for survival. He suggested that in the future the sun and its planets might grow cold or lack sufficient oxygen and that mankind might be forced to seek a more hospitable environment.

In the final pages of "The Last Migration," in a section cautiously entitled "A Glimpse into the Future," Goddard paints a striking, almost frightening, picture. "If passage is possible from planet to planet within the solar system, it can be seen that, as the solar system cools down, migration can take place to the planets near the sun and finally to the sun itself. It may, however, be possible to migrate to the planets that are around the fixed stars after the solar system has cooled to such an extent that life within it is difficult or impossible.

"The most desirable destination would be a planet near a large sun or suns . . . preferably hydrogen, or new stars . . . so situated that the temperature would be like that of earth but on which the cooling process would be slower. The destination should be in a part of the sky where the stars are thickly clustered so that any further migration would be comparatively easy. Because of the danger from meteoric matter, expeditions should be sent to all parts of the Milky Way where new stars are thickly clustered."

His Dreams! It is at this point that Goddard, the outwardly cold-facts scientist, stretched his imagination to limits that even today are breathtaking. Fifty years ago, when Goddard evolved his plans in the privacy of his research laboratory, they were not to be whispered. He realized that, because of the distances involved in explorations of other solar systems, the pioneer travelers might find their greatest personal adversary in time itself. The voyages would entail enormous self-discipline. The space pilgrims might marry, give birth, grow old, and die long before their journey was over. Their sons might follow the same course and so might their grandsons and great-grandsons. Generations might pass before journey's end.

Surely there must be a way to postpone death, Goddard thought. As far back as 1905, he had conceived of a state of granular protoplasm for these space passengers, allowing man to travel for centuries in a dormant state, waking in a new part of the universe. In his early notes, he groped for the answer. "If there was some substance like formaline that would permeate every tissue and kill all bacteria life except the spores, and besides, if the body were placed in a sealed glass containing nitrogen and the temperature remained constant and a little above freezing, there seems no reason why the body might not remain in this passive condition indefinitely since decay is absolutely arrested from the moment the passivity is assumed, although the same amount of moisture is present as when the body is active . . ."

The pilot would be awakened or animated at intervals to steer the apparatus, if this were necessary. The intervals could be 10,000 years for near stellar systems and 1 million years for very distant systems. "The awakening could be accomplished," he suggested, "by a radium clock, the pressure of

(Continued on page 101)

e/e builds the finest COLOR TV KIT you can buy

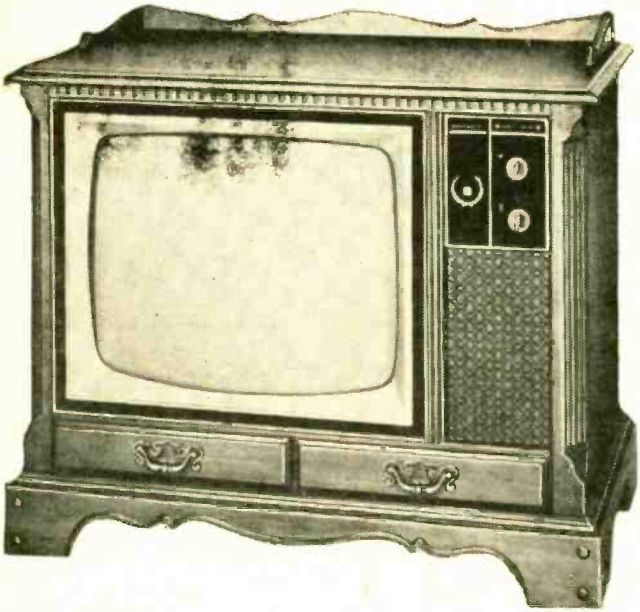
Versatile performance and excellent serviceability highlight Heathkit's Model GR-370

Manufacturers of "commercially-built" color TVs spend millions for advertising their wares every year. One claims *modular construction* for lower repair bills. Another claims *highest brightness*; a third claims *automatic fine tuning* and yet another claims *perfect flesh tones*, or even *remote color control*. The list of special features to insure optimum color reception is almost endless. Here's the lowdown on the one receiver that truly gives you *all these features in one package*—the new Heathkit solid-state Model GR-370 Color TV.

The GR-370, with 295 square inches of viewing area, has a list of functional features for a color television that reads like a guide book on "how to do it right." For example, you can order an optional wireless remote control that turns the receiver on or off, changes the channel, and adjusts color and tint. Heathkit's exclusive FET front end means your picture will have less snow or noise present and reduced strong-signal, cross-modulation for better AGC action. Heathkit's GR-370 also includes automatic fine tuning (AFT), automatic picture tube degaussing, automatic color control and gated AGC.

There's also provision for adjustable video peaking, instant on, and an audio tone control for both front-facing speaker and hi-fi audio output. The GR-370 also gives you a choice of either 300 or 75-ohm VHF antenna inputs.

But most important in terms of reliable performance, this kit television's end-all

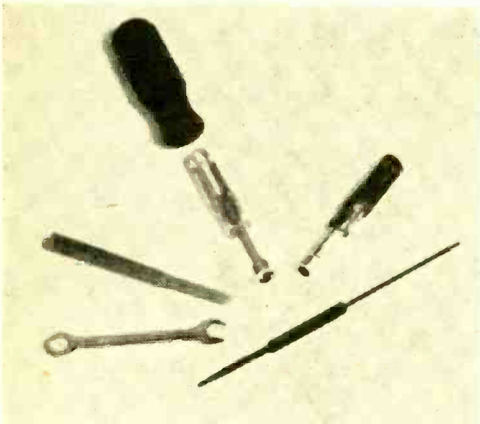


Although e/e whipped together Heathkit's Model GR-370, you can bet your sweet purity adjuster that Heath has more color TV kits for you to choose from. Model GR-270, for instance, utilizes same chassis but smaller, 227 sq. in. CRT. Price of GR-270 is less, too; it costs $489.95. You're also presented with choice of four factory-assembled cabinets to house kits. Early American cabinet, shown to left, is maple finished, costs $114.95. Other cabinet styles include Mediterranean, Contemporary, roll-around cart/cabinet combination. If portability's your bag, Heathkit's Model GR-169 is for you. This 102 incher's really mini GR-370 in disguise! Model GR-371MX, Heath's next TV kit, will have 313 sq. in. CRT. Look for it!

feature is the plug-in circuit boards and wiring harnesses especially designed for the home constructor. If you can think of a feature that will enhance color reception, chances are the Heathkit GR-370 already has it built in!

Naturally, some of the best features of earlier Heathkit color TVs have been retained. For example, the push-button, motor-driven channel selector means wireless remote control can be easily added at a later date. We suggest though, that you install the remote control as you build the kit. Heathkit also retained the swing-out, front-mounted color convergence feature allowing the user to easily "trim" the convergence.

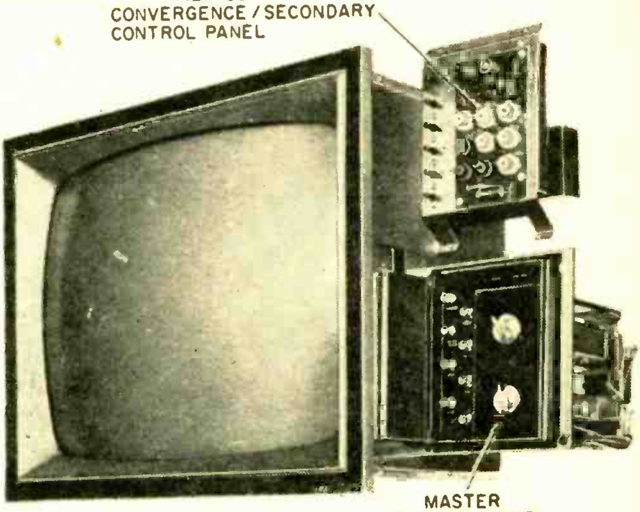
When you first open the Heathkit GR-370, it appears to be a chassis made of jacks and plugs. But the two really outstanding features of this kit are the plug-in circuit boards, and the instruction manual. We'll get to the manual later.



Board Banter. Except for the tilt convergence panel, the factory-wired UHF and VHF tuners, the IF amplifier, the AFT (for Automatic Fine Tuning), and the high voltage power supply, all your wiring chores consist of assembling small printed circuits which plug into chassis-mounted jacks. There are 9 plug-in boards. Each contains a homogenous circuit; for instance, the entire sound circuit is on its own board, and the vertical oscillator lives on its own board. If a defect occurs, it is only necessary to repair that particular board. But if you're really stymied by the electronics, Heath provides a low cost board repair service for a nominal fee once you're beyond the two year warrantee.

The chassis is actually the hinged rear cover of the CRT shield. All the builder installs are the power supply components, IF amplifier, and high voltage power supply. Then, pre-formed wiring harnesses are connected to the PC board plugs; other harnesses have connecting jacks that are already preconnected. Interconnection between circuits is automatic when the PC boards are plugged in. Similarly, external circuits such as the tuners, panel controls and convergence panel plug into chassis mounted connectors.

The Instruction Manual is a Classic. It surpasses even the manuals for Heathkit's GR-681 and AR-29, which were formerly the recognized standards of "instruction manual perfection." The GR-370's manual actually consists of a series of six separate



Heath not only supplies all needed parts to build GR-370, they even include tool kit to help speed construction, alignment time. Tilt-out Convergence, Secondary Control panel, Master Control panel are easy to wire. Convergence/Secondary Control panel location will prove its convenience when you adjust TV for proper color rendition. Note portion of shield visible in picture; it's wrapped around entire chassis, effectively preventing set-generated signals from being radiated into viewing area.

instruction manuals.

Book 1 has only the introduction and assembly for the circuit boards.

Book 2 contains the instructions for the chassis assembly, with separate instructions for the remote control. depending on whether it will be installed during construction, or at a later time.

Book 3 details construction of the front panel assembly.

Book 4 details the final assembly, adjustments and operation.

And Book 5 is 160 pages of the most detailed troubleshooting and circuit data we've seen outside of an aerospace industry "tech manual." Fact is, every resistance and voltage check possible on every pin and terminal is detailed, as well as every possible transistor configuration.

All circuits are broken down into both function and normal operation, and every PC board has both foil and "topside" views. There are even PC board pictorials pinpointing just the voltage check points. What about waveforms, you ask? Our answer: you'll see fifty-five of them! Finally, there is a price list for what appears to be every component except for the CRT shield equipment. That's given in a separate picture tube and shield assembly booklet.

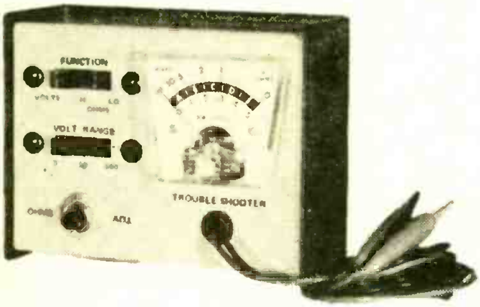
The detail in the individual construction manuals is absolutely astounding. Nothing is left to chance or guesswork. For example, all transistors plug into sockets and four—that's correct, four—pictorial steps are used just to illustrate how to *plug a transistor into a socket*.

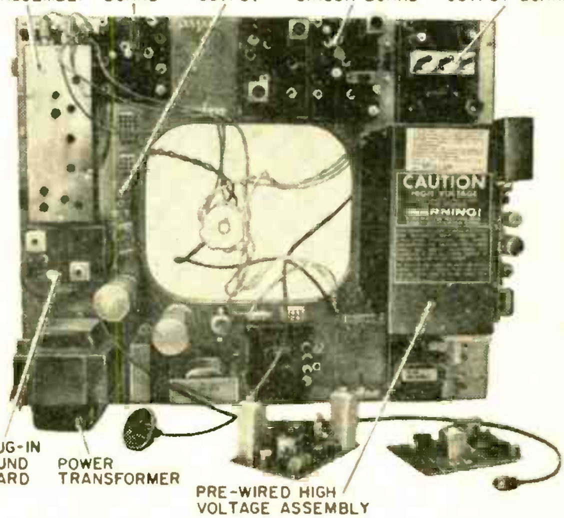
That's really step-by-step instruction! The chassis itself is broken down into 8 parts. That's how a small pictorial section can be placed on the same page with the wiring steps. And there's no pictorial crowding; if the pictorial is large, there might be just 5 steps on the entire page.

A new Heathkit construction feature consists of color callouts on the instruction manual pictorial. To avoid having the builder's eye lose its place in the wiring diagrams, each step is positioned near the actual wiring position. A red number indicates the step sequence, while red numbers in the pictorial indicate the number of wires to be soldered at that location. You have really got to try hard to make an error.

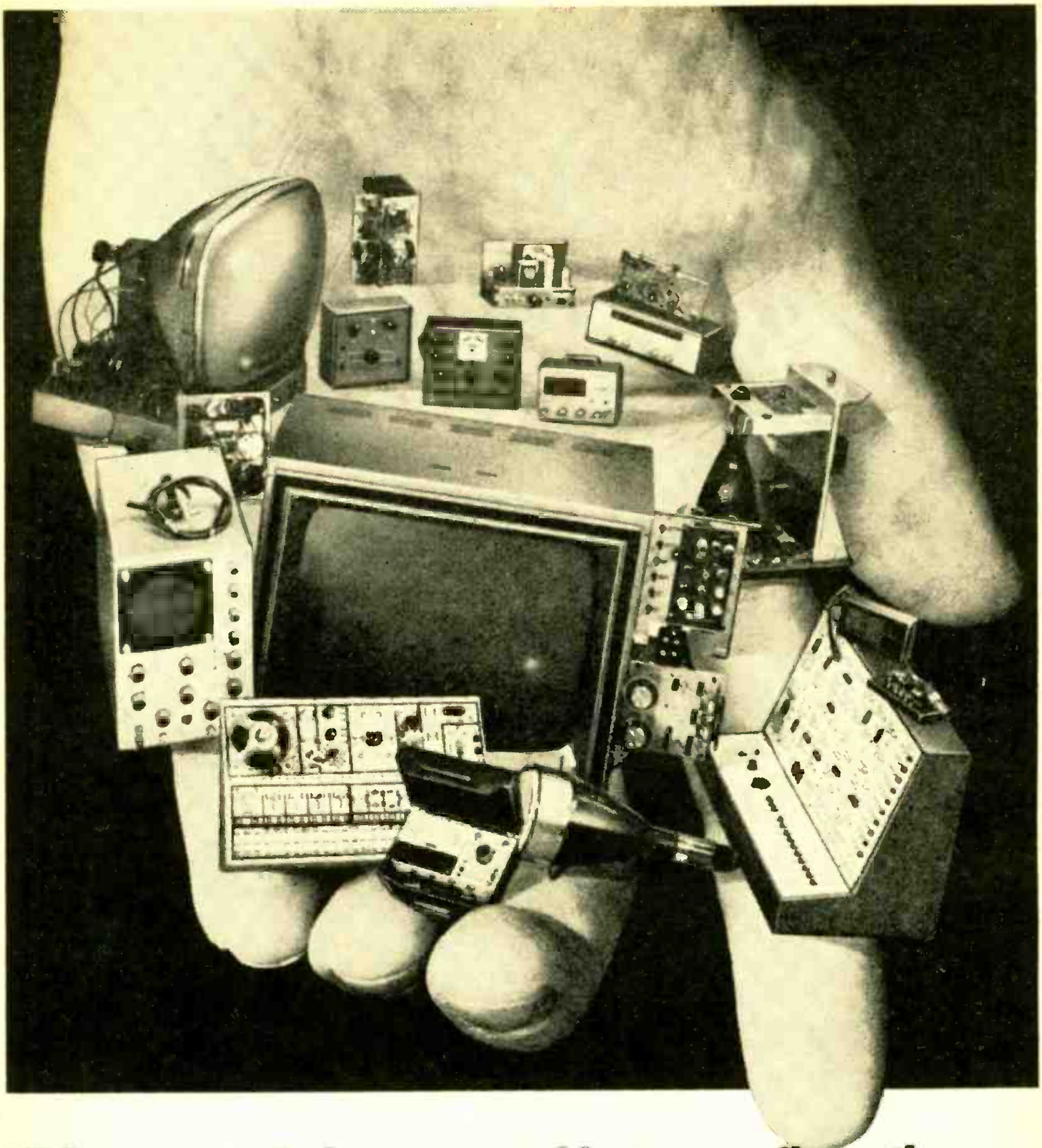
Built-in Super Sleuth, too. Now let's look at the built-in Volt-Ohmmeter turned troubleshooter. To insure that everything possible is checked out before power is applied, the GR-370 includes a volt-ohmmeter kit

(Continued on page 40)





Built-in volt-ohmmeter, called "Troubleshooter" by Heath, is included in kit. It's purpose is to not only help you make final adjustments, point-to-point wiring checks, but also to enable you to pinpoint circuit malfunctions—if any ever crop up. Picture to right gives you some idea of what your final efforts will look like. Note how each PC board mates to sockets located at opposite ends of PC board. This feature insures good electrical contact, removes all chances of plugging PC boards in wrong way.



CIRCLE NO. 16 ON PAGE 17

e/e COLOR TV KIT

(Continued from page 35)

Heath terms a "Troubleshooter." Throughout the checkout and adjustment procedure, there are instructions utilizing this instrument. Similarly, the Troubleshooting and Data Manual lists the meter readings for every transistor and test terminal in the set. Before power is ever applied, virtually every connection and most of the components are checked out with the Troubleshooter. By the time you are ready to fire up the receiver, you are an expert on the innards of the Heath color TV.

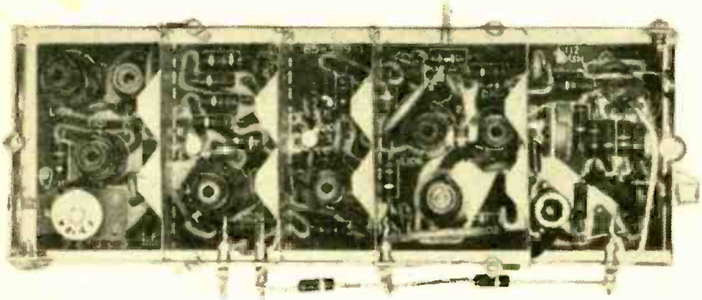
Naturally, final alignment is the last step. Since all the critical circuits are factory wired and aligned, most of the final alignment is the color tube convergence. As with other Heath color sets, the dynamic convergence panel is up front where it's easy to see the results of the adjustments. All you need do is follow the instructions using the built-in dot generator. And you get *perfect* color alignment.

We say *perfect*—because unlike a factory wired receiver which gets a fast assembly line alignment—you can spend as much time as you like to insure optimum color convergence. Considered as a fringe benefit, once you have performed the convergence you're an expert (no joke, it just takes practice). And periodically, say monthly, you can trim up the color in a few minutes. Remember, your neighbor down the block has to put up with deteriorating color until he can afford a serviceman.

Performance With a Punch. With all of the aids that Heathkit builds into the GR-370, it's only fair to ask about color performance. As with any color TV, your first questions should be: how good is the picture? And what's the final result available from a consumer set. With all the talk about "special color circuits," the most a consumer set can do is come close to Heathkit color. Heath color is soft (natural), not garish as is common to many consumer sets.

Normal brightness level is very high, and good color saturation is obtained even in a brightly lit room. Fact is, the standard tube produces the maximum brightness level that can be accommodated by the eye. There is no reason to go to the extra-cost, extra-brightness RCA Matrix CRT unless sunlight will be falling directly on the tube's face.

As expected, this Heathkit traditionally reaps long-term low cost for the kit builder. While the cost of the Heathkit GR-370 in kit form compares with wired color TVs, it is important to keep in mind that color sets do eventually break down. The savings made by being able to do your own service will be considerable, particularly when you consider the cost of TV service is approaching $20 per hour. Best of all, after you finish building and adjusting the Heathkit you will know a lot more about the color set than the average technician. And, of course, you will be able to obtain exact replacement parts within days, rather than weeks or months.



Interior view of pre-wired, 3-stage IF assembly. Unit's aligned at factory. Solder three wires to appropriate lugs, then connect three cables into their jacks—your IF's now wired into circuit!

Summing up. The Heathkit GR-370 color TV offers the kit builder two prime advantages: 1) excellent initial color performance, and 2) the knowledge, ability and experience to keep the overall level of color performance great year after year.

The basic GR-370 color TV kit is priced at $539.95. With the RCA Matrix-type CRT the price is $549.95. The remote control kit, Model GRA-70-6 is $64.95. Three factory-assembled cabinets are available for the GR-370, with prices ranging from $74.95 to $129.95. (Custom mounting templates are supplied with the kit.)

For additional information describing the Heathkit GR-370 color TV, circle number 30 on the Reader Service Coupon on page 17. ■

LEARNING NEW TRICKS FROM AN ANCIENT RIG

GRANDPA'S LOOSE COUPLER IS ALIVE AND WELL AND STORMING OUT OF WIRELESS' GOLDEN PAST/by Art Trauffer

MANY Americans could vividly remember Lee's surrender of Appomattox when the Age of Wireless was born. As an infant industry, it was weaned by some of the foremost scientists of the day—and countless home-bound experimenters all eager to stretch their ears across the cold, blue Atlantic.

But unlocking the mysteries surrounding this electric infant proved to be a difficult task. It was comparatively easy for scientists to theoretically prove the existence of radio waves in their laboratory. But extracting RF energy from a noisy, spark-belching transmitter was a task beyond most experimenters' abilities.

And receiving gear fared no better on the home-brew front, either. Most rigs depended heavily upon the vagaries of nature to bring man-made ethereal energy down to mile-long antennae. Fact is, much of radio's earliest experimental work was the result of sheer dumb luck! But theory would soon outpace the rabbit's foot with the introduction of a deceptively simple radio frequency tuning device.

The loose coupler is radio's classic tuning device from the heyday of wireless. We don't know exactly who invented it, but we do know that it was one of the most commonly used pieces of gear found in any well-stocked radio lab—or living room—between the years 1900 and 1922. Perhaps the loose coupler evolved from the combined efforts of several pioneer experimenters. Yet nobody really seems to know for sure; records tell us that the device was manufactured commercially, and home-brewed by most of radio's earliest enthusiasts.

Loose couplers, or receiving-type transformers, as they were also called, are now considered by most collectors of antique radio gear to be in the most-sought-after category. The few remaining models are in museums and painstakingly-assembled private collections.

But unlike other equally-extinct relics from the Wireless Age, you can easily build a replica of the loose coupler. Here's the best way you can recreate for yourself the earliest radio-frequency experiments of the pioneers of wireless. And, as a conversation piece harking back to the dawn's early light of radio's history, the loose coupler is an attention-getter from both Aquarian audiophile and micro-circuit oriented amateur alike!

Grandpa's Energy Grabber. Arizona was still a decade away from statehood when syntony (radio's earliest term describing coil tuning) was stumbled upon. But Grandpa e/e LOOSE COUPLER

didn't know about coils and capacitors as we know of these tuning components today. He lashed together various forms of brass tubing, Leyden jars and even variable resistors, in an effort to vary the frequency of cumbersome, spark-spitting transmitters and yard-long receivers.

Finally, gramps hit upon the idea of winding a continuous copper wire around a shellacked cylinder, and tapping the coil's wire every ten turns or so. The wire taps were sent to a variable switch; this method was used until someone figured they could build a better radio frequency trap. By winding the same coil on the same cylinder, but substituting a sliding tap for the fixed taps, radio's earliest experimenters found they could wring even more selectivity from the coil. Some of the more intricate slide tuners boasted up to three sliders, but the slider would wear out the coil wire, depositing copper between the turns.

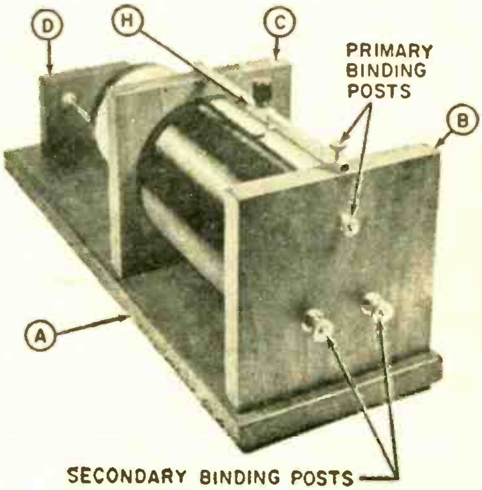
Perfection—as radio's early experimenters thought of it—arrived on the spark-gap-galena-detector scene as the two-circuit, or "loose coupler." No longer was it completely necessary to rely solely upon the vagaries of insulating-today, shorted-tomorrow copper wire insulation. Here was a tuning device that transferred received energy from the antenna circuit to a secondary circuit without actual electrical contact. As you can see by our photos, this device has two cylindrically shaped coils of wire, each wound on tubes of insulating material.

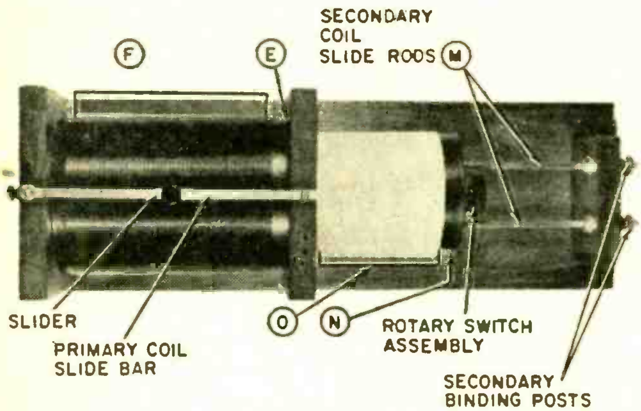
The secondary coil is mounted so it can slide in or out of the primary coil with just enough clearance between the two coils.

The chief advantage of the loose coupler over fixed, tapped inductances was that the inside coil (in this case, the secondary coil) could be moved with respect to the stationary coil, or primary coil. This effect was first called "coupling" and the name stuck. When the secondary coil was pulled away from the primary coil, it was "loosely coupled." When the experimenter pushed both coils together, the device was then "tightly coupled." By altering the relative positions of the coils within one another, the overall receiver selectivity could be increased or decreased at will.

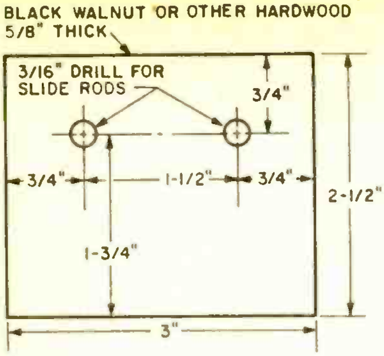
Slide Bars and White Shellac. The loose coupler described is very similar to the typical couplers of way back when. But, as you build the coupler, you might want to make some minor changes according to the materials you are able to beg, borrow or make.

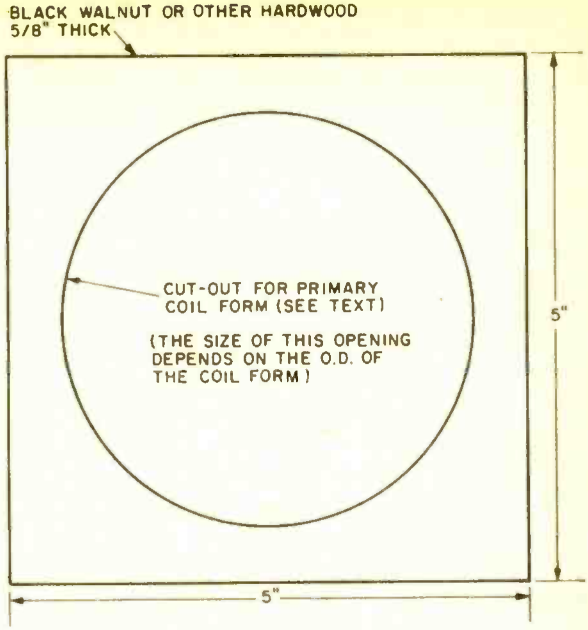
Let's start with the coupler's foundation, or baseboard, first. The author found a piece





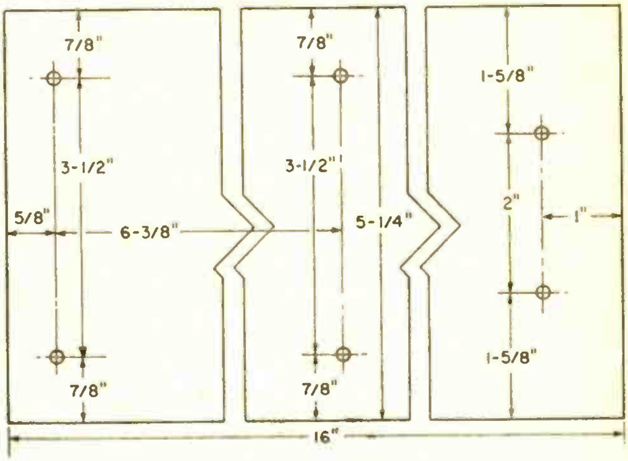
Circled letters in both pictures refer to parts described in Bill of Materials. Comparing loose coupler in both pictures, you'll note that secondary coil binding posts are located on both front, rear end supports. If you don't need second set of binding posts, omit posts on front end support; substitute hex nuts of proper size in their place.





FRONT END SUPPORT
Correct spacing is vital for secondary tube alignment with primary tube form. Best bet is to place front end support block in C-clamp wood vise; temporarily fasten vise to flat bed of drill press before proceeding to bore holes.

CENTER SUPPORT
You'll need hole saw, electric drill in order to accurately cut out hole for primary coil form. First bore starter hole in wood with 1/16-in. drill, then proceed to cut hole in wood with hole saw.



BASEBOARD
Dimensions given in picture to right are for baseboard. As with other wood supports, accurate hole location is extremely important. We suggest you treat baseboard, other wood supports with liberal coats of varnish to prevent warping.

of ⅝-in. solid black walnut for this part, as well as for the three upright supports.

As our drawings show, all visible surfaces of the wood were sanded smooth. Sharp corners and edges were slightly rounded off with a mill file and finished with a medium grade of sandpaper. As a final fillip, all walnut pieces were stained and hand rubbed with facial tissues to bring out the wood grain.

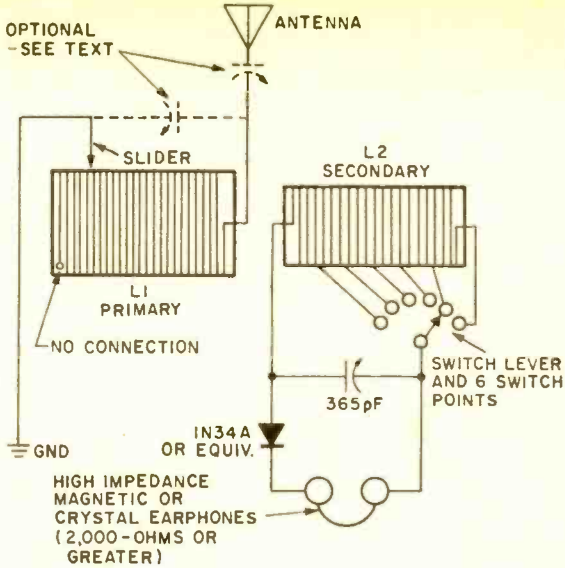
After you've cut the wood base and upright pieces, and finished them to your liking, you'll probably want to make both primary and secondary coils next. The author found a cardboard container with an outside dimension of four inches. Try art supply companies or drafting firms in your search for a similar coil form.

The secondary coil form is a piece of 3⅛-in. cardboard tube originally used to ship large sheets of photo paper. After the tube was cut to size, it was given a coat of white shellac, and allowed to dry before winding the secondary coil onto it. If you can obtain Bakelite or plastic tubes of these sizes, go ahead and use them.

Starting with a half pound of #22 enamelled magnet wire, you'll *closely* wind 175 turns of the wire onto the primary form. It doesn't make any difference which direction you wind the coil; the important point to remember is that the coil must be e/e

LOOSE COUPLER

You can't tell how well this rig performs just by gawking at its schematic! Although substitution of 1N34A germanium diode for galena detector detracts in eyes of home-brew-or-bust purists, improved performance gained from solid-state diode more than makes up for this seemingly modern "oversight."



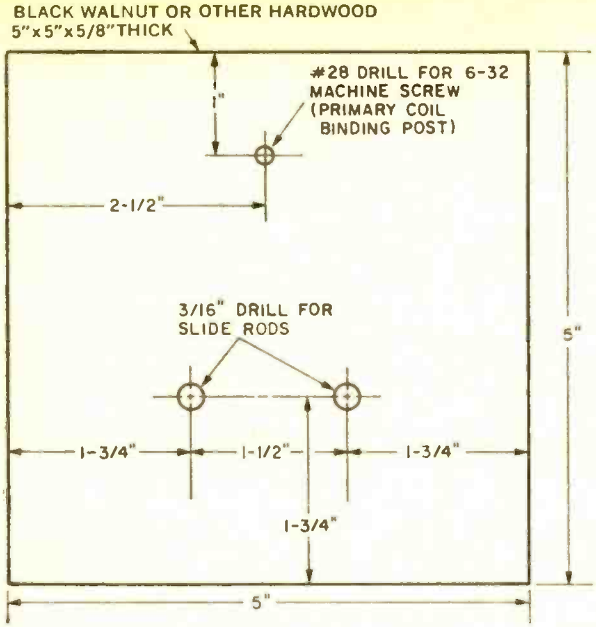
BILL OF MATERIALS FOR LOOSE COUPLER

A—16-in. x 5¼-in. x ⅝-in. black walnut or other hardwood (baseboard).
B—5-in. x 5-in. x ⅝-in. rear end support for primary coil.
C—5-in. x 5-in. x ⅝-in. center support for primary coil.
D—3-in. x 2½-in. x ⅝-in. front end support for slide rods.
E—Primary coil form about 6⅜-in. long and about 4-in. O.D. Cardboard, fiber, bakelite, plastic, etc.
F—½-lb. #22 enamelled magnet wire for primary coil.
G—¼-in. thick wood or composition-board disc (fits in end of primary coil).
H—Springy brass band ⅜-in. wide and about 1½-in. long; 6-32 brass machine screw about ⅜-in. long; small insulated knob to fit 6-32 screw (primary coil slider).
I—Binding post for primary coil slide bar: 6-32 rh brass machine screw 1¼-in. long; brass hex nut to fit; round knurled brass nut to fit.
J—⅝-in. rh steel wood screw (holds slide bar to wood center support).
K—Binding post for primary coil: 6-32 rh brass machine screw 1½-in. long; soldering lug to fit; two brass washers to fit; brass hex nut to fit; round knurled brass nut to fit.
L—6 rh wood screws about 1¼-in. long; 6 washers to fit (hold wood upright to baseboard).
M—Slide rods for secondary coil: two pairs of 3/16-in. dia. brass curtain rods cut 16½-in. long; eight lock-washers to fit; eight brass hex nuts to fit 10-24 threads; four round knurled brass nuts to fit 10-24 threads.
N—6-in. L x 3⅛-in. O.D. secondary coil form (cardboard, fiber, bakelite, plastic, etc.).
O—½-lb. #26 cotton-covered enamelled magnet wire for secondary coil.
P—2 end discs for secondary coil form (see drawing).
Q—Brass tubing to fit over 3/16-in. dia. brass rod (sleeves for secondary coil slide rods).
R—Switch lever: 5/16-in. dia. brass rod ¾-in. long; 6-32 rh brass machine screw about 1¾-in. long; three brass washers to fit; small compression spring; springy brass band for making switch lever blade; insulated knob to fit 6-32 screw.
S—6 switch points for switch lever (make from 6-32 rh brass machine screws ¾-in. long, with brass hex nuts to fit). Four rubber tack bumpers for bottom of baseboard.

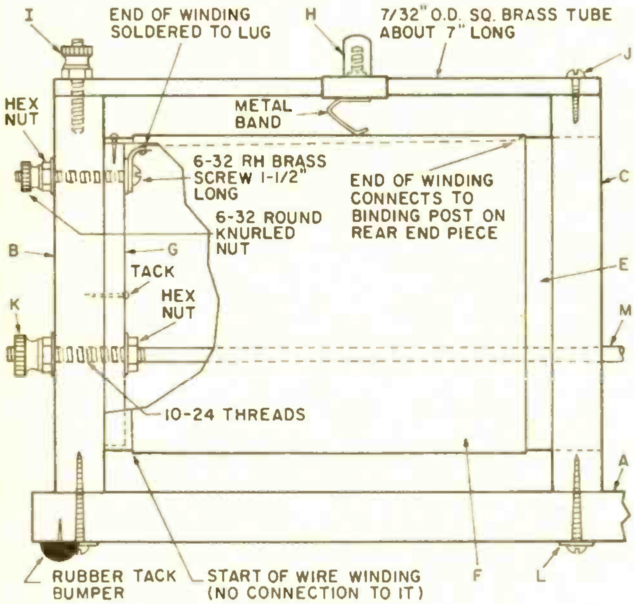
close wound with *no spaces* between the wires.

The secondary coil will need a bit more finagling. After the coil form's been shellacked, start by winding the secondary with #26 single-cotton-covered enamelled magnet wire. As with the primary coil, you'll need about a half pound of wire for the secondary coil.

Note, however, that the secondary coil is tapped once every 46 turns. Each tap terminates at a separate rotary switch position. Noting our drawing, you'll find this home-brew rotary switch located on the secondary



Rear end support for primary coil, slide rods is bored, finished with same methods described for other wood pieces. Black walnut stock, while not necessary for loose coupler's performance, adds to unit's good looks—especially when wood's hand rubbed with many coats of stain, then finished off with elbow-grease-furniture-polish treatment. But if one piece of wood looks like any other to you, then by all means hack up plywood stock. We promise not to snitch.



Detailed cutaway of primary coil mounting technique. Note square brass tube in picture—it's what author used for his loose coupler. If you can't find similar brass tubing, cut up third curtain rod as instructed in text, construct primary coil brass band (part H) to wrap snugly around it.

coil's front plate. Be sure to leave a sufficient length of wire at the beginning of the secondary winding so you can solder it to a brass slider sleeve. The end of this winding is soldered to position 6 on the rotary switch.

Homebrew Twister. Don't be frightened away from this project merely because you've never built your own switch assembly before. After, all grandpa didn't have mail-order-catalog parts ordering convenience in his day. If he could make a rotary switch, well, by jiminy, so can you.

First step's rounding up the parts you'll need; then look at our rotary switch diagram for the sequence construction. The most difficult part of this build-it switch is making the actual switch points.

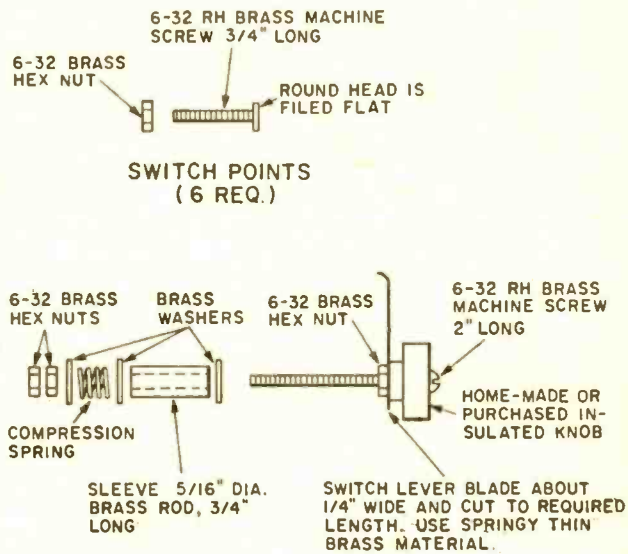
Start by putting half a dozen hex nuts onto each 6-32 x ¾-in. Round Head brass machine screw. Holding the nut/screw assembly in a machine vise, you file the screw top parallel to the screw's body with a mill file. The nuts serve to hold the screw firmly in place in the vise. After each screw head has been filed flat, smooth them with a sheet of fine emery cloth.

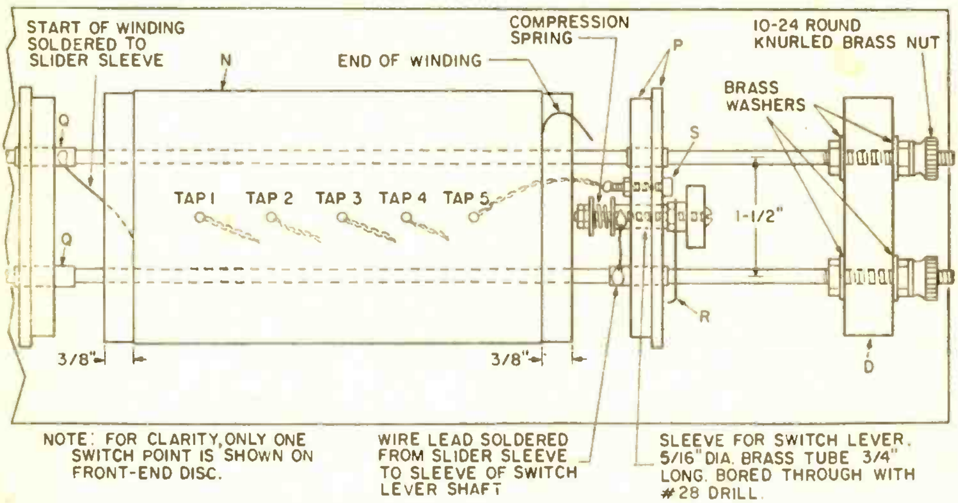
Now cut out two secondary coil end discs: one's for the front and the other sits on the coil's rear. A piece of composition board or ¼-in. plywood does the job material-wise. Drill six ⅛-in. holes for each switch point as our front-end disc layout shows. Using a #28 drill, you bore a hole in the center of the disc for the remainder of the switch assembly. Following our diagrams, mount the entire rotary switch kit 'n kaboodle on the front-end disc. Finish this part of the project by soldering each secondary coil tap to its switch point.

Brass Rails. Buy the secondary coil slide rods from the least likely of all possible electronic construction project sources—a

(Continued on page 104)

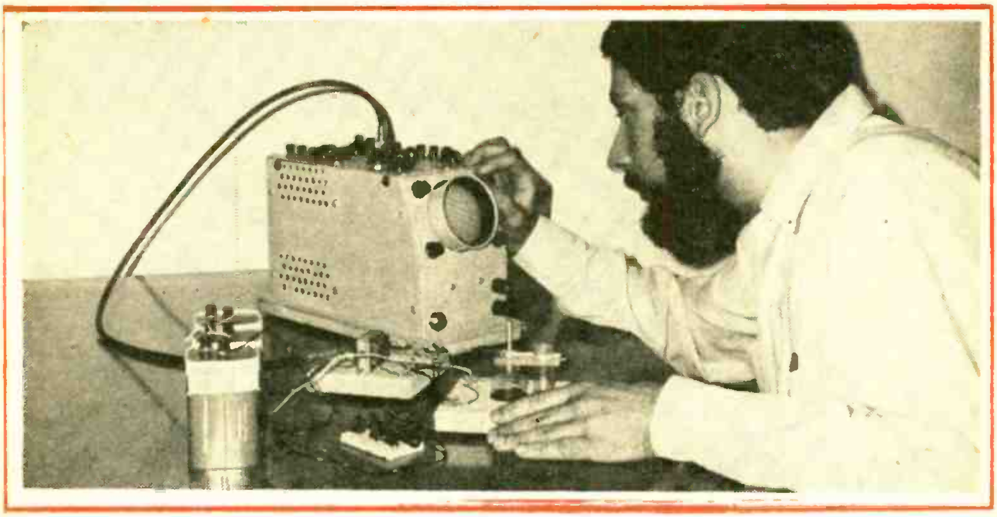
Picture to right shows sample switch point, exploded view of rotary switch. While this phase of loose coupler's construction isn't difficult, it separates do-it-yourself men from store-bought boys. All parts required for home brewed switch can be bought in any well-stocked hardware store; any non-shorting rotary job intended for radio frequency switching'll do if you want to take easy way out. Bottom pix shows secondary coil's method of mounting. Note end of winding; it doesn't terminate at any rotary switch point.





LIQUID NOISE GENERATOR

Join the old timers, experiment with an electrolytic interrupter



by Charles Green, W6FFQ

In the early days of radio, at the beginning of the 20th century, experimenters tried weird and wonderful ways to solve their problems. Before the electron tube was discovered by DeForest, most radio transmissions were generated by spark coils. These spark coils required an interrupted DC input which was usually achieved by mechanical interrupters.

Another method of interrupting DC was the electrolytic interrupter. The electrolytic interrupter used lead and platinum electrodes immersed in dilute sulphuric acid. Electric current flowing through the circuit caused bubbles of gas to form on the platinum electrode that temporarily interrupted the circuit.

You can experiment with the electrolytic interrupter by using our Liquid Pulse Generator, a modified unit that employs salt water as an electrolyte, and lead wire solder and a sewing machine needle as the electrodes. We have included information for the construction of an experiment board that can enable you to observe generated pulses on your oscillosope.

How-It-Works. Pure water is a poor conductor of electricity. When ordinary table salt is dissolved in water, some of its molecules are split up and the resultant ions of chlorine and sodium cause the water to become a good conductor of electricity.

When electric current flows between the lead wire-solder electrode immersed in the salt water electrolyte and the point of sewing machine needle (serving as the other electrode), gas bubbles are created. These gas bubbles form at the junction of the needle point and the electrolyte. Since at these low voltages gas is an insulator, the DC current flow through the circuit is interrupted by the bubble. When the DC current flow stops, the gas bubbles no longer form and they are dissipated. When the gas bubbles are gone, electrical contact between the needle point and the electrolyte is remade, and the process is repeated indefinitely.

Construction. The Liquid Pulse Generator unit and the Experiment Board unit are both built on 5-in. squares of ¾-in. thick white pine. Begin construction by cutting these pieces to size.

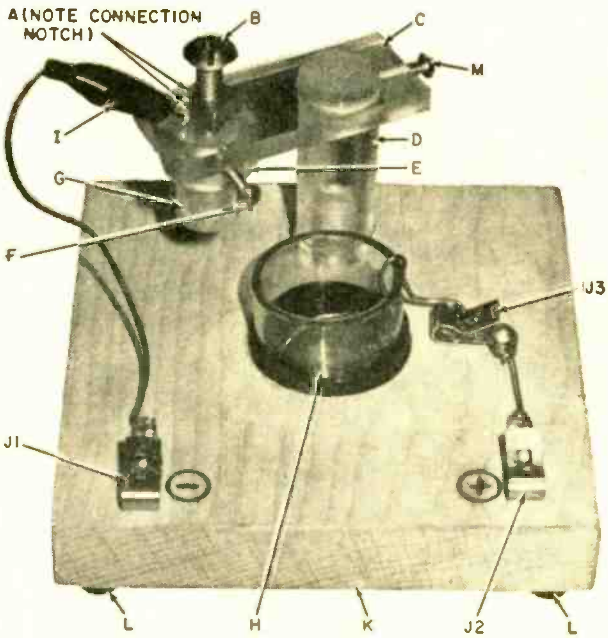
Pulse Generator. The Liquid Pulse Generator is an assembly of units made of clear plastic cut to the sizes shown in the drawing. This assembly is mounted on a 2-in. length of ¾-in. diameter clear plastic rod (*D*). After cutting support *C* to size, carefully drill a hole at one end so that *C* will fit over *D* and can be moved up and down. Mount a small set screw in a tapped hole on this end of *C* so that it can be locked in position on *D*.

Cut and drill *G* to size shown in the drawing and then cut collar *E* so that *G* can fit inside *E*. Mount a small set screw in a tapped hole in *E* to lock *G* in place. Cement *E* to the end of *C* as shown, and carefully drill and tap hole in *C*, to fit the ¼-20 threaded rod of *B* in the exact center of the space within *E*.

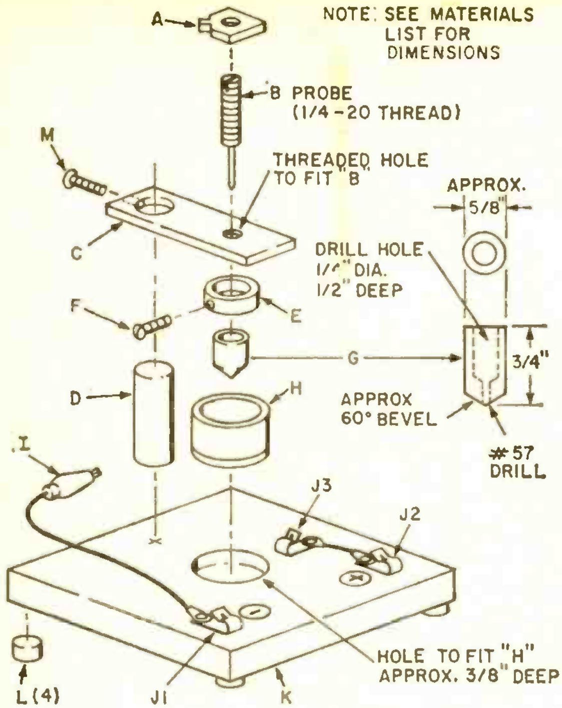
Feed screw *B* is a 2-in. piece of ¼-20 threaded rod cut from a longer piece. Solder a sewing machine needle to the exact center of *B* at one end and cut a slot for a screwdriver at the opposite end of the threaded rod. Insert the threaded rod into the hole in section *C*, making sure that the sewing machine needle tip passes freely through the small hole drilled in the end of *G*, as *B* is turned with a screwdriver. Notch one corner of machine nut *A* so that clip *I* can be fastened to it. Install *A* on *B*.

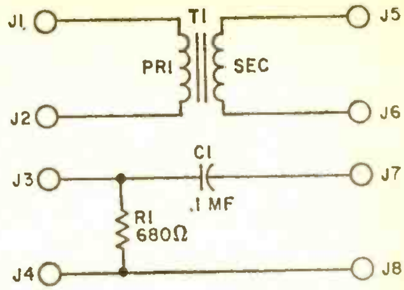
Cut the plastic cup *H* to size specified in parts list. Mount it in the hole in the center of the wood, base *K*. We used a plastic coin tube cut to the size needed for our unit and wrapped several layers of plastic tape around the base of *H* so that the cup will fit snugly in the hole.

Position the needle holding assembly so that *G* is directly over the center of *H* and fasten it permanently by cementing *D* to the wood base *K*. In our model we threaded a hole in the base of *D* and bolted *D* to the wood base *K*. Connect the clip lead *I* to Fahnestock connector *J1*, and wire leads to *J2*, and *J3* using solder lugs, wood screws



This neat, easy-to-make Pulse Generator is the heart of your experiments with Liquid Noise Generator. All materials should be readily available; they are easy to work with so with a little patience and care you should come up with a perfect duplicate of our model shown here. Full dimensions and a description of material required for each piece is given in Materials and Parts List. Each part identified by letter in photo can be found in Parts List.





Schematic above makes an interesting experiment board, which, when added to Liquid Pulse Generator, batteries and your oscilloscope, provides a means of experimenting by changing circuits and/or components and then observing their effects on the scope. Full dimensions and instructions for the critical parts of the Liquid Pulse Generator are included on this exploded diagram shown to the left.

MATERIALS AND PARTS LIST FOR LIQUID NOISE GENERATOR

(1) LIQUID PULSE GENERATOR UNIT (See Dwg.)
- **A**—¼-20 nut to fit threaded rod(B).
- **B**—¼-20 threaded rod, approx. 2-in. long.
- **C**—2½ x 1 x ¼-in. clear plastic sheet.
- **D**—2-in. long x ¾-in. diameter clear plastic rod.
- **E**—¼-in. long, ⅞-in. diameter clear plastic tube. (See drawing for drilling details.)
- **F**—6-32 x ⅝-in. set screw for E.
- **G**—¾-in. x ⅝-in. diameter clear plastic rod (shaped and drilled as in drawing.)
- **H**—Clear plastic cup, approx. 1½ x 1-in. high (see text).
- **I**—Insulated alligator clip with 4-in. lead.
- **J1, J2, J3**—Fahnestock clips. (Lafayette 33F71028 or equiv.)
- **K**—¾-in. white pine 5-in. square.
- **L**—Small rubber bumpers.
- **M**—6-32 x ⅝-in. set screw for C.

(2) EXPERIMENT BOARD UNIT (See Dwg.)
- **C1**—.1 µf, 600V ceramic disc capacitor (Centralab DF-104 or equiv.)
- **J1, J2, J3, J4, J5, J6, J7, J8**—Fahnestock clips (Lafayette 33F71028 or equiv.)
- **R1**—680 ohms, ½ watt, 10% resistor.
- **T1**—Audio transformer, single plate to single grid, turns ratio 1:3 (Allied 54D2062 or equiv.)
- **MISC.**—¾ in. white pine 5-in. squares, small rubber bumpers, solder lugs and hookup wire, pure lead wire-solder.
- Oscilloscope
- Spst Knife Switch
- Batteries (approx. 18 volts—see text)
- Table Salt (see text)
- Wire Solder (see text)

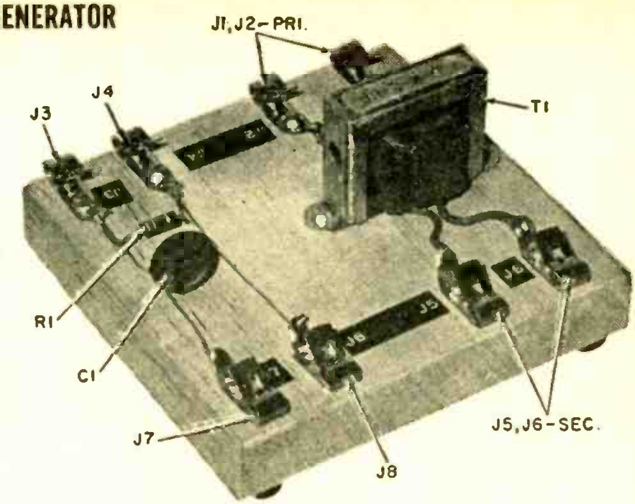
as shown in schematic and drawing. Position the components as shown in the drawing and photo.

Experiment Board. Next mount the components on the wood base as shown in the photo and schematic of the Experiment Board. Mark the fahnestock clips with their respective designations of *J1* to *J8*. We mounted small rubber bumpers on the four corners of the bottom of both wood bases.

Experiment No. 1. Connect the Pulse Generator unit, Experiment Board, batter-

e/e LIQUID NOISE GENERATOR

We're all familiar with that old cry of the usher—you can't tell the players without a program. Well, we claim you can't experiment without the proper setup—so—we made the experiment board for you eager beavers to make your experimenting meaningful. It's simple to build and worth the effort.



ies, knife switch and on oscilloscope as shown in Block Diagram No. 1. We used three 6-volt lantern batteries for an 18-volt supply, but any voltage from 12 to 24-volts will be adequate for the experiments.

Place a length of wire-solder (preferably plain, pure lead solder—*do not* use acid core solder) coiled inside the bottom of the plastic cup of the pulse generator, and connect the end of the wire solder to *J3*.

Mix approximately ¼ teaspoon of table salt (sodium chloride—NaCl) with enough water to fill the plastic cup to about ¼-in. from the top. Remove plastic shell *G* from the assembly and adjust the probe so that the needle point just touches the surface of the salt water electrolyte. Finger tighten nut *A* on this probe to prevent movement of the needle and attach the alligator clip lead from *J1* to the nut.

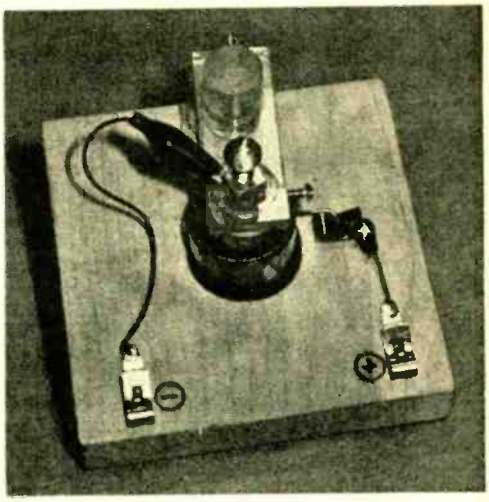
Close the knife switch (*ON*) and adjust the probe for maximum pulse amplitude as seen on an oscilloscope. Adjust the oscilloscope's vertical sensitivity for a convenient display height on the CRT. Adjust the oscilloscope's time base for a slow sweep for best display of the pulses. Observe that the pulse display is comprised of many small spikes and few large pulses. This indicates a high noise output.

Experiment No. 2. Open the knife switch *(OFF)* and disconnect the pulse generator lead and oscilloscope leads from the experiment board. Reconnect them as shown in Block Diagram No. 2.

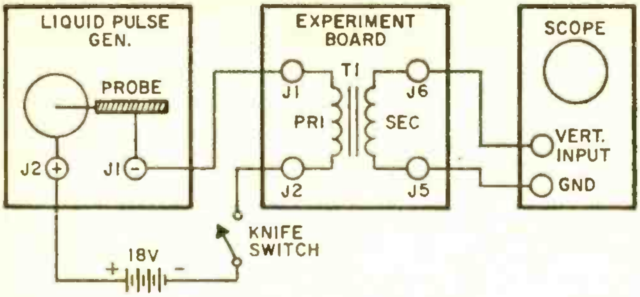
Close the knife switch *(ON)* and again adjust the probe for maximum pulse display on the oscilloscope CRT. Observe that the pulses are much sharper, and have greater amplitude. This is because the pulse from the liquid generator DC circuit is increased in voltage due to the inductive kick from the primary of *T1*.

Experiment No. 3. Open the knife switch *(OFF)* and remove the probe from the liquid generator assembly. Install the plastic nozzle *G*. Adjust position of *C* until the nozzle tip just touches the surface of the salt water electrolyte.

Insert the probe *B* into the assembly, and adjust it so that the needle tip is protruding



Here's an uncluttered view of our Liquid Pulse Generator. It's versatility shows through its neat design.



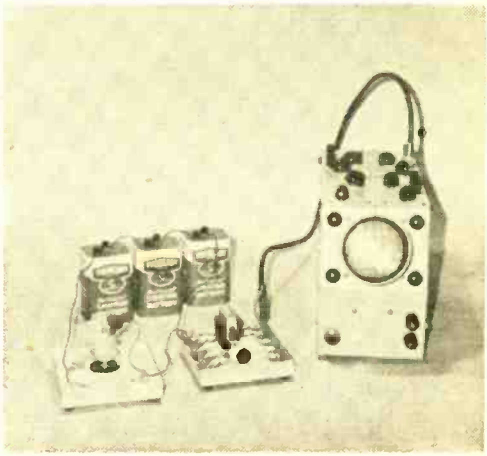
Here are connections for a basic experiment using various units constructed from directions in text. Once it's mastered go to other experiments using same units, but develop your own interconnections. Just take care not to harm any of the units that are interconnected.

into the small hole in the nozzle. Connect the clip to the nut and close the knife switch *(ON)*.

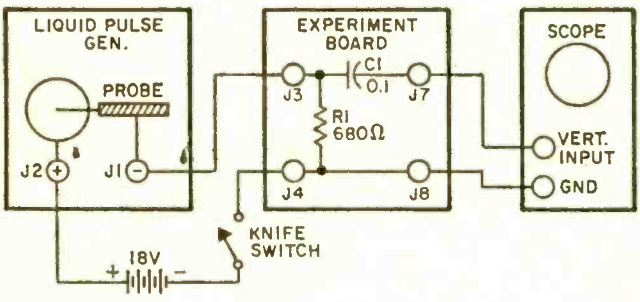
Adjust the probe *B* for maximum pulse amplitude on the oscilloscope. Also adjust the nozzle assembly *G* at the point where it touches the electrolyte. Observe that the pulse display has a much sharper waveform, at a lower display rate, than without the plastic nozzle in the previous experiments.

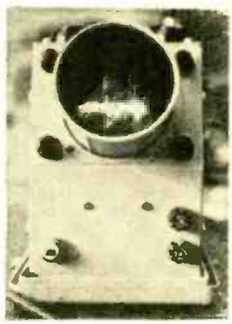
Reason for this is that in Experiments 1 and 2, although the needle was adjusted so that its tip was just touching the electrolyte, the shank of the needle was exposed so that bubbles of gas surrounded by a thin film of electrolyte produced a profusion of interruptions. Whereas in Experiment 3, the plastic nozzle prevents this build-up of bubles on the needle shank. Just one bubble forms at one time; therefore, it takes longer to form and it will be larger in size.

You can make further experiments with the Liquid Noise Generator by substituting plastic nozzles with different sized holes, and probes with broader points in place of the needle point. ■



Here's how schematic shown in above basic experiment looks in the flesh.

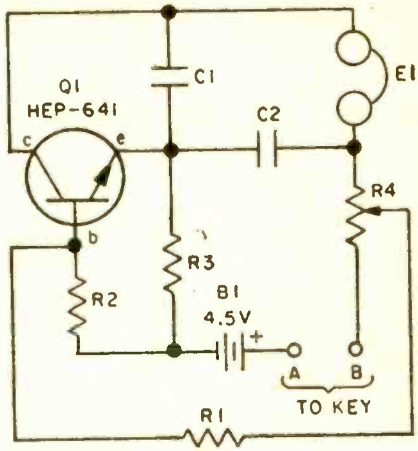




To improve on clarity and definition of pulse displayed on your scope try hookup shown in this schematic. It's easy to see on actual scope photo that pulse is more sharply defined and much cleaner with lots less noise in this experiment than in the basic one shown in photo above this one.

Clip Book Circuits

ECONOMY CPO

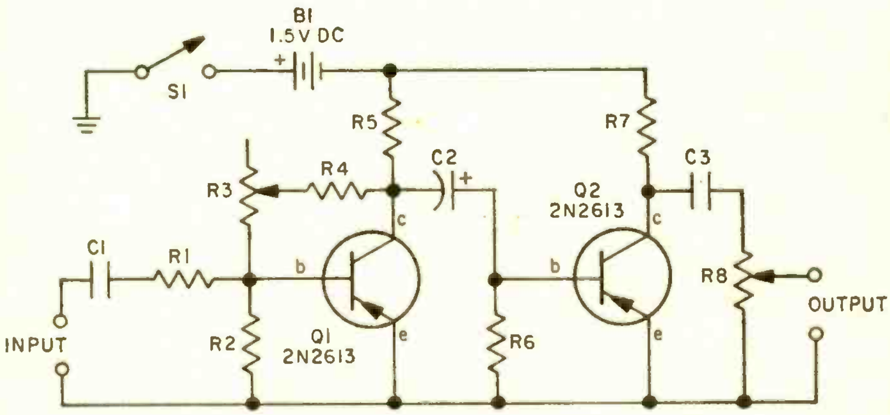


PARTS LIST

B1—4.5-V battery
C1—0.02-uF, 10-VDC capacitor
C2—0.22-uF, 10-VDC capacitor
E1—2000-ohm magnetic earphone
Q1—HEP-641 npn transistor (Motorola)
R1—2700-ohm, ½-watt resistor
R2—1500-ohm, ½-watt resistor
R3—27,000-ohm, ½-watt resistor
R4—50,000-ohm potentiometer

Components you have lying about might make this simple, budget CPO (code practice oscillator). Using component values given, the tone frequency is approximately 800 Hz. It can be changed by substituting different values for C1 and C2, but maintain the same capacity ratio. That is, C2 should always be about 10 times larger than C1. Battery current drain is only about 1 milliampere.

FANTASTIC FUZZBOX



Add that 'way-out NOW sound to any electric guitar by connecting the Fuzzbox between your guitar and amplifier. Potentiometer R3 sets the degree of fuzz, R8 the output level.

Since the fuzz effect cannot be completely eliminated by R3, fuzzy-free sound requires a bypass switch from the input to output terminals. The switch should completely disconnect the fuzzbox output; the input can remain in parallel with the bypass switch.

PARTS LIST

B1—1.5V AA battery
C1, C3—0.1-uF, 3-VDC capacitor
C2—5-uF, 3-VDC electrolytic capacitor
Q1, Q2—2N2613 pnp transistor
R1, R6—22,000-ohm, ½-watt resistor
R2—18,000-ohm, ½-watt resistor
R3—1-megohm potentiometer
R4—100,000-ohm, ½-watt resistor
R5, R7—10,000-ohm, ½-watt resistor
R8—50,000-ohm, audio-taper potentiometer
S1—Spst switch

Quad-Mix

Mix-up the boys in the band

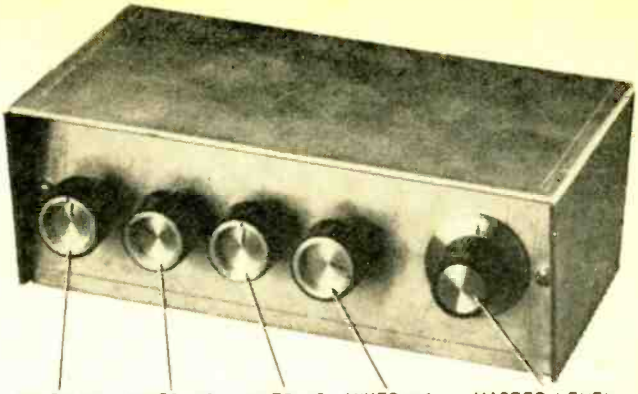
by Joseph J. Carr

No, we're not in the genetics business! We've got an interesting four position audio mixer, designed around an RCA integrated circuit (IC), that can be built for just a few dollars worth of parts and about one evening's worth of your leisure time.

What can you do with it? It's an excellent pre-amplifier/mixer that will let you feed four different audio signals into a single input of your power amplifier and individually adjust their volume levels. You may have organized a new rock group that owns up to four guitars that you want amplified to get that solid sound the group is capable of producing. Easy to do with Quad-Mix. Just feed the outputs from the electrical pickups on the guitars to the individual input jacks of Quad-Mix and feed the output of Quad-Mix to the input of the PA amplifier. If your group doesn't use four guitars, you can connect one or more microphones to the unused inputs on Quad-Mix and blend the volume level of instruments and/or voices for the specific effects you want. Quad-Mix has sufficient gain to raise the low level output of musical instrument pick-ups and most microphones to drive the average PA to full power and perhaps, even beyond into distortion.

How It Works. Input jacks J1 and J2 are connected through potentiometers R1 and R2, which serve as series mixers, to feed one of the two pairs of Darlington connected

e/e QUAD-MIX



This handy, portable, self powered four position mixer lets your group sound its best over any PA. Each of four instruments or vocalists can be individually blended and the overall level adjusted and fed to a simple amplifier input via the master level control

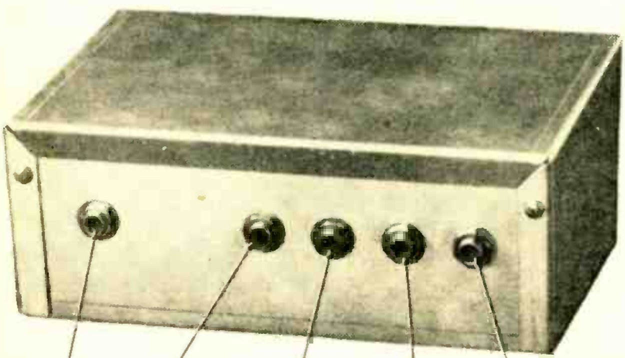
transistors that make up the IC. Input jacks J3 and J4 are similarly connected through potentiometers R3 and R4, which serve as series mixers, that feed the second pair of Darlington connected transistors of the IC.

Resistors R5, R6, R7 and R8 were purposely made fairly high in resistance to assure freedom from interaction between the potentiometers or affecting overall gain due to variations in setting of any of the controls. If they were not a fairly high resistance, it is possible that differences in settings of the two potentiometers associated with their common amplifier would be effected. This would be particularly true in the event one of the potentiometers in the pair should be set at minimum gain (near or at ground).

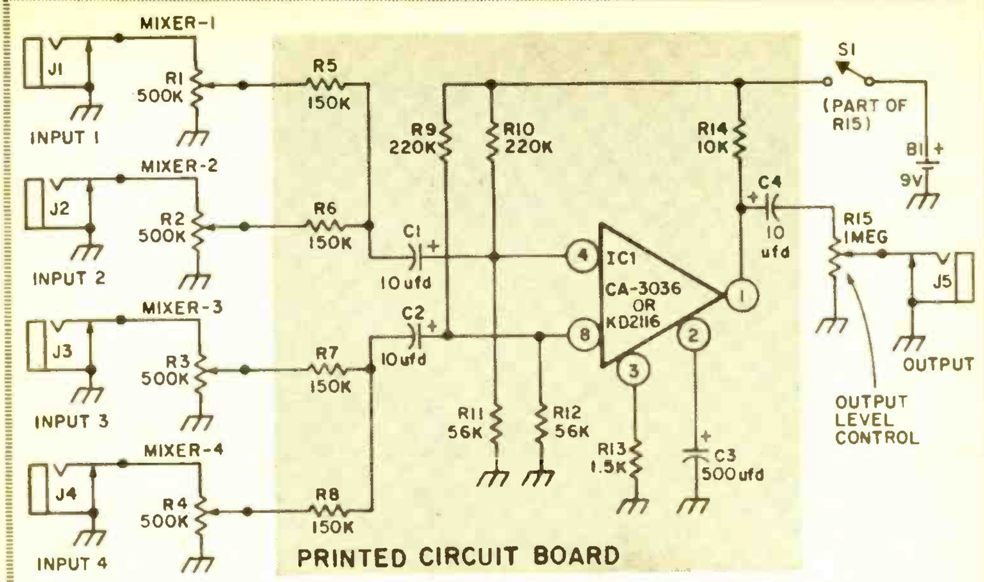
The RCA KD-2116/CA3036 integrated circuit (IC) contains two low-noise, wide band amplifier circuits in one package. It has two isolated inputs and a common output connection. Each of the amplifiers is comprised of Darlington connected transistor pairs arranged in a differential amplifier configuration. The IC is housed in a standard 10 lead TO-5 package.

When used as an audio mixer in our Quad-Mix, the IC is employed as a dual input active mixer. By combining two passive mixer circuits, one dual passive for each of the active sections of the IC, the unit can mix, and individually adjust, the level of a total of four different transducers (pickups) or microphones. Since total current drain of the IC is only 50 mA, we power Quad-Mix from a 9 V transistor radio battery mounted in Quad-Mix's cabinet. Another advantage of the battery supply is that it makes Quad-Mix portable and independent of the 117 VAC power lines. This also results in a much quieter hum free operating mixer.

Making A Quad-Mix. Since the mixer is small and designed for portable use, we housed it in an attractive hooded front alu-



Connections from microphones and/or pickups are easily and quickly made to Quad-Mix by regular easily available phone plugs as is output lead to PA amp. Input and output jacks neatly arranged on rear apron.

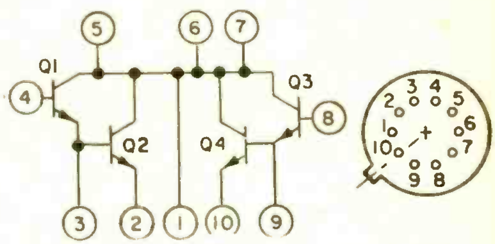


PARTS LIST FOR QUAD-MIX

B1—9V transistor radio battery (Eveready 216 or equiv.)
C1, C2, C4—10 µF, 12 VDC electrolytic capacitor. (Calectro A-1-10A or equiv.)
C3—500 µF, 25 VDC electrolytic capacitor (Calectro A1-132 or equiv.)
IC1—RCA KD2116 or CA3036 dual darlington array, monolithic silicon integrated circuit.
***J1, J2, J3, J4, J5**—Standard closed circuit jack (Switchcraft 112A or equiv.)
P1—Standard 2-conductor flat phone plug (Calectro F2-819 or equiv.) (As many as needed for input and output —maximum of 6)
R1, R2, R3, R4—500,000 ohm, audio taper, potentiometer (Calectro B1-688 or equiv.)
R5, R6, R7, R8—150,000 ohm, ½-watt resistor
R9, R10—220,000 ohm, ½ watt resistor
R11, R12—56,000 ohm, ½ watt resistor
R13—1,500 ohm, ½ watt resistor
R14—10,000 ohm, ½ watt resistor
R15—1,000,000 ohm, audio taper, potentiometer with s.p.s.t. switch (Calectro B1-692 or equiv.)
1—Battery Connector (Calectro F3-052 or equiv.)
1—Battery Holder, (Keystone 203P or equiv.) (See text)
1—Hooded aluminum metal cabinet 3 x 5 x 8-in. (Lafayette 12F85956 or equiv.)
4—Knobs black with silver trim, 1-in. diameter, (Calectro E2-720 or equiv.)
1—Knob black with silver skirt and silver trim, 1⁷⁄₁₆-in. diameter (Calectro E2-717 or equiv.)
1—3 x 6-in. piece copper clad, phenolic printed circuit board (Calectro J4-605)
Misc. Hookup wire, bolts, nuts, solder lugs, solder, spacers, printed circuit material (See text) etc.
*Note: You can get a 6 or 12 ft. shielded lead fitted with standard phone plug on one end and pig tails on other end (6 ft. Calectro 30-450S 12 ft., Calectro 30-451-S or equiv.) to use for an output lead. If either of these cables are purchased one less plug may be all that are required.)

minum cabinet that's only 3-in. high, 8-in. wide, and 5-in. deep overall. Although we haven't finished the aluminum cabinet of our model, you can, if you have a more artistic nature, paint yours an appropriate attractive color or you can cover it with pressure sensitive plastic sheeting (CONTAC or equiv.) that comes in either in woodgrains, solid colors or patterned prints.

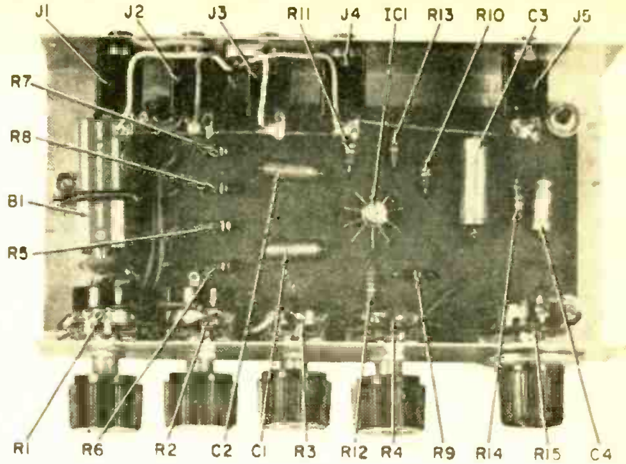
We suggest you identify each of the controls and input jacks by applying transfer letters and digits (Datak or equiv.) once the



Ever wonder what's crammed into the TO-5 case of an IC? Here's a schematic, base pin arrangement of CA3036.

e/e QUAD-MIX

You can appreciate how well planned Quad-Mix has been conceived from this view showing what's inside its attractive housing. Each component is identified to help you in laying out your own unit. Just follow our suggestions for wiring and you'll wind up with surprizing success.



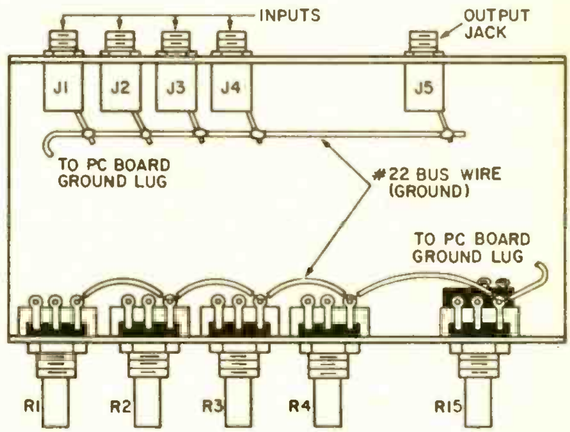
newly applied spray paint or plastic sheeting has thoroughly dried. You should spray the letters and digits with a very light coat of clear plastic to protect them from scratches etc.

First step in fabricating your Quad-Mix is to make the printed circuit board. We have included a full sized pattern to assist you. Rather than repeat instructions on how to make printed circuit boards we refer you to the construction article titled *Touchdown Twinhaler* in the September-October issue of *ELEMENTARY ELECTRONICS*. Detailed steps for making *printed circuit boards* are outlined on pages 32 and 33 of that issue. Or, you may prefer the more simplified method made available in the kit reported on in the *November-December 1970* issue of *ELEMENTARY ELECTRONICS*. . .

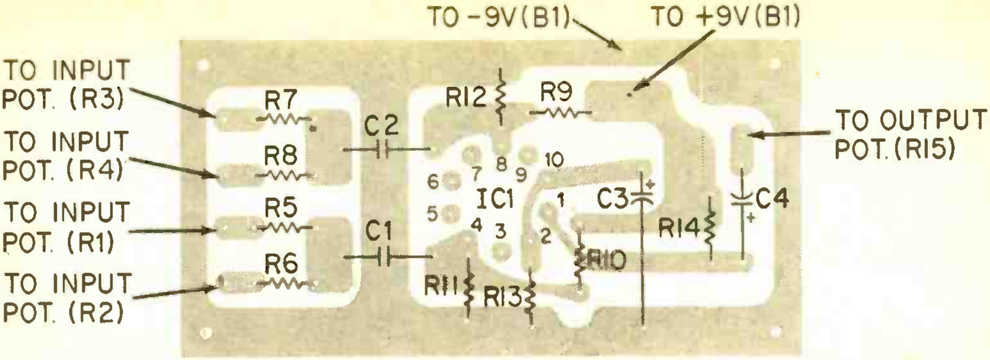
While the etching process for the printed circuit board is in progress you can spend this time in laying out and drilling the chassis. Since you are dealing with very high gain units, we suggest that you follow our layout. A great amount of thought has been put into it to reduce, to a minimum, input-output coupling. With this layout you are assured of maximum separation of input and output leads, which makes for a stable amplifier.

By the time the holes have been located and at least partially drilled, the etching of the PC board will have been completed. If, by chance, layout and drilling takes longer than the recommended etching time, follow those etching timing instructions explicitly in preference to completing the drilling which can be completed after the etching. Once etching is completed rinse the board thoroughly, dry it, and put it aside.

Finish the drilling and de-burring of all holes then apply either the vinyl covering or the spray paint to the cabinet and front panel. During the time the finish is setting thoroughly, mount all components to the PC board and the chassis. Save the mounting of the IC on to the PC board for the last task. Double check to be sure that you have it properly oriented before applying heat from the soldering iron. Use a small, low wattage



Because actual photo of Quad-Mix doesn't show ground buss details too clearly we had this pictorial layout drawing made. From it you can readily determine just where and how to run grounding leads between components.



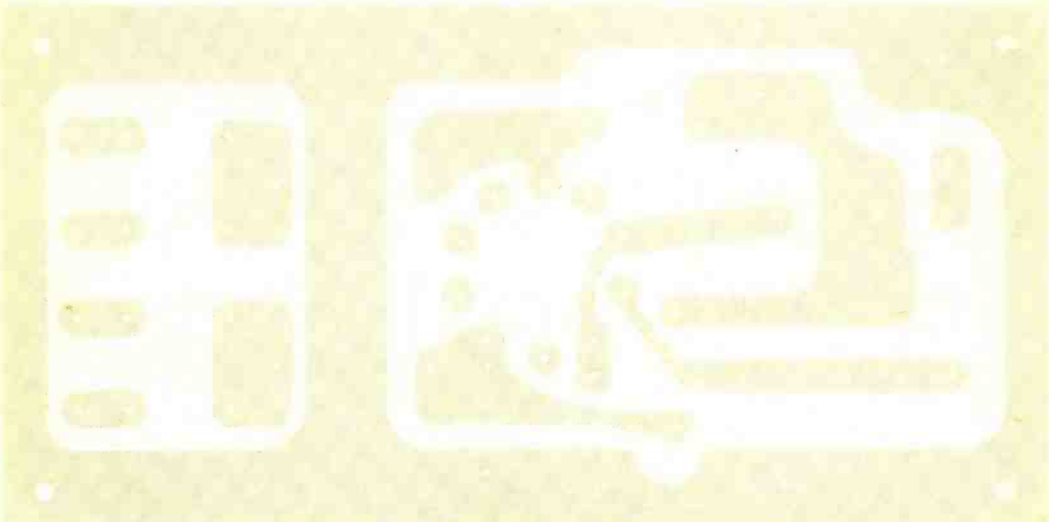
Here's a foil side view of printed circuit board showing where each component is located. Components mounted on top side of board and are soldered to foil on bottom.

iron to avoid damage to the IC, the capacitors and the PC board from excess heat. Make certain too that electrolytic capacitors are properly polarized before soldering them into the circuit.

A short scrap of coiled spring, extended between two solder lugs makes up the battery holder on the inside of the chassis. You may prefer to buy a standard battery holder since they are inexpensive and do a good job of holding the battery in place. We've listed one in the parts list along with a standard battery connector.

Bond the ground side of the four input jacks to a common ground point on the PC board. Do the same for the ground point of the five potentiometers. Easiest way to do this is to loop a bus wire from ground lug to ground lug of each of the components involved and terminate the loop on a ground point of the PC board. Use separate loops for the jacks and potentiometers and make each loop as short and direct as possible.

A bundle, or harness, made of four different colors of insulated hookup wire connects the high side of each jack to the high side of its respective potentiometer. Clamp one end of four lengths of different colored wire, each about 2-ft. long, in the jaws of your bench vise. Clamp the other ends into the chuck of your hand drill. Twist them together to make a neat tightly twisted bundle: once removed from the vise and chuck they'll hold together. To assure their holding together you may wrap the bundle at several points with 1/8-in. wide strips of insulat-



Easy way out is to order completely etched printed circuit board by filling in coupon on opposite page. If you're a brave or venturesome soul you may want to roll your own. There've been several articles in previous issues of this magazine telling you how.

ing tape. Locate the harness with one end centered between pots 2 and 3, fan out two leads to the right and two to the left of this center position and solder them to the high side of each potentiometer. Neatly fold the bundle to conform with the bends in the chassis, crossing under the PC board and comming inside up the rear apron of the chassis between input jacks 2 and 3. Following the color scheme used in connecting the pots match the fan out and connection to high side of the jacks so that the same color used for a potentiometer is used for the corresponding numbered jack. (i.e. Jack 1 to pot 1 etc.) Center contact of each input pot is connected to its respective resistor, mounted on the PC board, through connecting pods on the left hand side of the board (see photo). The output lead from the center of the master control potentiometer to the outjut jack is dressed under the PC board's right edge, close to the chassis. The lead to the high side of this pot is connected to a pod on the PC board near the right edge.

Once the four input, one output and the battery connector leads are soldered to the PC board it can be fastened to the chassis. Use ¼-in. spacers or extra 8-32 nuts to raise the board above the bottom of the chassis to avoid shorting any of the PC board ribbons or solder mounds. Before tightening down the board check out the circuit to be sure you've not made any mistakes. If all checks out mount and connect the battery.

You've Done It. Now you are ready for *The Big Thrill*—checking the mixing action and actually putting Quad-Mix into use. You'll need a shielded lead between the output jack of Quad-Mix and the input con-

We made battery holder from old spring. If you'd rather, buy one per Parts List.

nector of your amplifier. In all probability the plugs for both the Quad-Mix output and the amplifier input jack will be the same, standard tip-sleeve phone plugs. Before purchasing parts to hold Quad-Mix check for the correct input plug so you can add this to your parts purchase and have everything available at the same time. It is best to keep the interconnecting lead between Quad-Mix and the main power amplifier as short as possible; in any event never longer than 25-ft. The shorter this lead is the less chance there will be for picking up electrical interference. Also, by keeping the lead short capacity between ground (shield) and the hot side (center conductor) will be small to reduce high frequency attenuation. After all you want to get the widest band of frequencies from the instruments to the amplifier.

You might also check the connectors on the leads from the guitars and/or microphones you're going to use with Quad-Mix. You do want to be able to plug them into Quad-Mix after doing such a fine job of building it. If they don't match the input jacks buy suitable plugs for them as specified in the parts list when purchasing all of the other parts. So now that you've completed the construction and tested out your Quad-Mix—go ahead and surprise everyone—use it on your next performance. ■

DXing Russia's Other Voices

Russia is a riddle inside a mystery wrapped in an enigma!

Sir Winston Churchill

Winston could—like a prime minister should—turn a catchy phrase when he chose. But few Churchillisms hit the mark as accurately as his definition of the Soviet Union, rasped out during a BBC speech one night in October 1939. In Russia, things seldom are what they seem and Winnie's words now seem particularly apt in describing the shortwave scene. For, contrary to popular notion, there's much more detail in the DX picture than just Radio Moscow.

In Amharic and Zulu, and dozens of languages between, the Kremlin weaves its propaganda thread around the globe. English programming, for instance, is heard **(Turn page)**

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from no less than five different overseas services beside Radio Moscow. At home in the USSR, domestic networks span a sixth of the inhabited world, programming in 60 different Soviet languages to the peoples from the Baltic and Black Seas to the Pacific.

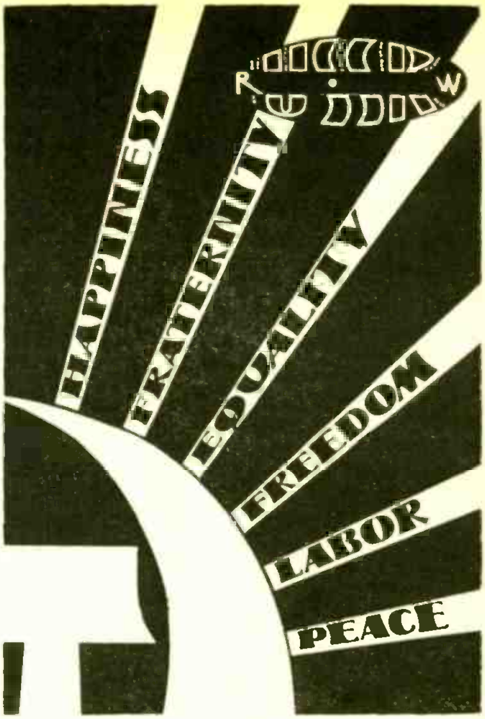
Russian shortwave transmitters are located in some 100 cities. Many of these are used interchangeably by the various foreign and home services, depending on the time of day and the audience. Station identifications often aren't much help. Programs produced in Moscow, or in other regional capitals, actually may be radiated from transmitters thousands of miles away.

The announcer says, "This is Radio Moscow." But the signal really may be coming from a transmitter in the Ukraine, or the Far Eastern Kamchatka Peninsula.

Other Voices. Ditto for most of the other English language programs. Radio Kiev, best known of Russia's other voices, has a popular DX program Mondays, Tuesdays and Fridays at 0030 GMT. Though tape recorded in the Kiev studios, it's transmitted on various frequencies by stations outside the Ukraine. Armenia's Radio Yerevan has some English around 0300 GMT, during the first portion of a transmission to the western United States. But these programs really come from outlets in Asiatic Russia, not Armenia. And English may be heard during Radio Vilnius' overseas service for Lithuanians abroad. Recorded at Vilnius, usually it is aired by a number of different stations elsewhere in the USSR.

It isn't that the Kremlin's masters are trying to be tricky. Idea is that with so many

View of Tashkent. City is the home of Radio Tashkent, one of Russia's other voices. Rodina cinema house is seen in this picture.



One of the many Radio Moscow QSL's that have been issued over the years. If you request, staff'll show on QSL transmitter site.

different audiences to reach and with so many stations and programs to operate, the situation is complex and confusing. Though it is never quite admitted, what is clear is that sometimes the left hand doesn't know what the right is doing. For instance, Radio Moscow, while verifying reports for its own programs, tells SWLs that it is unable to issue QSL cards for the other foreign or home services. Having made the point that it's usually tough to keep track of which Soviet tramsmitters broadcast which programs, on which frequencies, and when, let's take a look at some of the other Russian shortwave voices.

Touring the Borscht Belt. From a political standpoint, one of the most interesting stations on a SWLs DX agenda is Radio Peace and Progress. It shouldn't surprise you to learn that it uses the same series of transmitters as Radio Moscow. But its programs present another image of the Soviet Union.

Sovietologists maintain that Radio Peace and Progress speaks for the international Communist movement and reflects covert Russian foreign policy. Radio Moscow, on the other hand, skips the vitriolic, anti-American blasts and carefully polishes the

QSL card issued by Radio Tallinn, located in Tallinn, Estonia, SSR. Note that one freq-listed—1034 kHz—is on Broadcast Band!

Kremlin's "nice guy" public posture.

Not so, says Moscow. Radio Peace and Progress is a private radio station belonging to Soviet public organizations. Its broadcast targets are Europe, Asia, Australia, Africa, the Near and Middle East, and Latin America. The claim is that the station presents Russian public opinion—the collective views of Ivan Q. Public—and not necessarily those of the government. Because of its alleged "private" status, Russian authorities maintain there is no governmental control of program content.

Radio Peace and Progress began operations in 1964 with Spanish programs to Latin America. Today it uses a dozen different languages and dialects. English programs to Africa can be heard at 1430 GMT. Other English language programs for Asia are aired at 1030 and 1530 GMT on various common Radio Moscow channels. These broadcasts clearly are not intended for American audiences. But, they are readily heard Stateside, and present an interesting contrast to Radio Moscow's programs.

If you're game to tackle some of the many non-English shortwave transmissions from the USSR, the field is wide open. There are all sorts of domestic programs in Russian and the other national lingos that are interesting DX. With a little experience you can learn to pick out identifications, despite the fact they're not in English.

National nyet-works. Among the national networks, the First, or "All Union" Program is intended chiefly for European Russia. Its schedule is heavy on classical music, lectures and newscasts. Similar are the so-called Fourth and Fifth Programs, but they are timed for audiences in the Far Eastern and Siberian regions. Still another service is aimed at the more cosmopolitan Muscovites.

An identification often noted by SWL's is "Radiostantsiya Yunost." This is a special daily broadcast for members of Komsomol, the Communist youth organization. Another frequently heard is the "Majak," or lighthouse, program. This is aired on a 24-hour-a-day basis throughout the nation by transmitters in many cities. Majak programs are lighter and brighter than the rest, featuring more popular music. Its interval signal—an old Russian folk tune popularized in the U.S. as "Midnight in Moscow"—makes it a cinch to spot.

Not forgotten are those who, for one reason or another, have left the homeland. "Radiostantsiya Rodina" is a service for Russian—and Armenian, Latvian and Estonian—citizens abroad. Soviet fishermen are kept in touch with home by "Radiostantsiya Atlantika," transmitted by stations in Latvia and European Russia. Radio Leningrad has a similar program for Baltic Sea trawler crews that operate out of its port. Still another maritime service is "Radiostantsiya Tikhiy Okeahn," Radio Pacific Ocean, broadcast by stations at Patropalovsk-Kamchatskiy and Vladivostok. This one may be heard during the morning hours when Asian signals are coming through.

With all of these, a pair of sharp ears will help you pick out the announcements. Figuring out actual transmitter location is another matter. But, then, who cares about that anyway? Hide and seek is kidstuff.

Hear one Ruskie and you've heard 'em all, right? Uh-uh, and you can bet your sweet samovar on that. True, the Soviet Union is the most highly unified political monolith around today. But for DXing purposes, most shortwave listeners consider each of Russia's

Probably the most famous photo of Moscow, this picture of Kremlin in known worldwide. Red star is on top of foreground tower.

e/e DXING RUSSIA'S OTHER VOICE

internal "republics" a separate country to be logged. Tuning broadcasts from stations in each of these regions included in DX country lists is a real challenge. And to do this you need to know if a particular signal is coming from Kursk, Kiev or Khabarovsk!

The DXer's World-Wide Poop Sheet. One way to do it is to invest in "Tentative High Frequency Broadcasting Schedules," published regularly by the Swiss-based International Telecommunications Union. These lists will tell you what you need to know, frequency, transmitter location, current operating schedule, and much more, about stations in the international shortwave bands. They'll help you not only with the Russians, but with all your DXing.

"Tentative High Frequency Broadcasting Schedules" are issued four times a year and cost about five bucks each, or $20, more or less, for a year's worth of up-to-date DX data. The latest list is available by mail from the ITU, Geneva, Switzerland. They have other useful publications too and a price list is free for the asking. Admittedly the ITU lists are a bit steep for the average guy on a budget. And, while useful, they're not essential for DXing some of the regional Russian outlets.

Luckily, some of the stations in the Soviet "republics" operate on predictable schedules and frequencies. For example, though Radio Kiev's English programs generally are aired by transmitters outside the Ukraine, you'll find the real thing can be logged on 4,940 kHz., around 0330 GMT. No English, of course, but the Ukrainian identification, "Hoverit Kiyiv" is the tipoff.

And the real Radio Yerevan, its transmitters actually in Armenia, can be heard occasionally in Russian and Armenian on 5,740 and 7,270 kHz. Try for "Erevan Khosum" on 7,270 kHz. around 0430 GMT.

An English language program intended for foreign audiences is broadcast by Radio Tashkent each day from 1200 to 1230 GMT on 9,600 and 11,925 kHz. It's easily heard and will give you another "country" to count since its transmitters are within the Uzbek "republic." Home service programs in Estonian, from Radio Tallinn, 6,085 khz., are normally blocked by a powerful Radio Nederland on the same wavelength. But the Dutch station takes a brief break about 2120 GMT. So, while difficult to log, Radio Tallinn sometimes slips through for a few minutes. Okay, that's the Soviet DX lowdown for now. As you can readily see, Russian SWLing is not really a riddle inside a mystery wrapped in an enigma. ■

View of Khreshchatik Street, one of many modern thoroughfares in city of Kiev. City is Ukranian capital, one of the major broadcasting centers of USSR. Try tuning in Radio Kiev on 4940 kHz about 0330 GMT. Listen for Ukrainian identification "Hoverit Kiyiv" as tipoff.

SOVIET DX

	Station (Radio—)	kHz.	Best Listening Time (GMT)
Armenia	Yerevan	5740, 7270	About 0430
Asiatic USSR	Vladivostok	5015	Early mornings
Estonia	Tallinn	6085	2120 (see text)
Georgia	Tblisi	5040	Evenings
Kazakh	Alma Ata	9250, 9380, 10530	0130 to 0300
Kirghiz	Frunze	4008	Early evenings
Tadzik	Dushanbe	4635	Early evenings
Turkmen	Ashkhabad	4825	About 0215
Ukraine	Kiev	4940	About 0330
Uzbek	Tashkent	9600, 11925	1200 to 1230

Ten timely tips for resistance measurement

By Marchall Lincoln, W7DQX

Resistance measurements must be one of the most misunderstood tasks undertaken by electronic's buffs. Why? Because a good many of us don't really understand how resistance is actually measured.

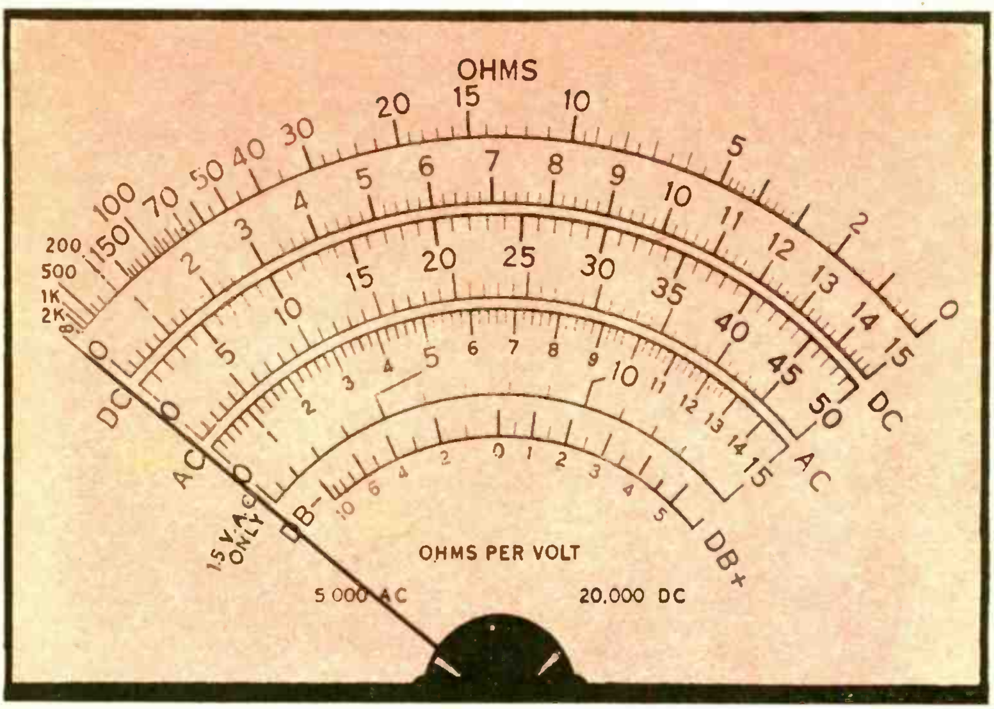
Since the meter we use can't think for itself, we must use it properly to obtain the correct results. Like all electrical instruments, of course, a meter performs according to electrical laws which cannot be violated. But it may not give us the results we want, or the results *we think we're getting,* unless we use it properly.

1 For our first tip, all we need do is look at the ohmmeter scale on the face of our handy VOM. Notice how the numbers indicating resistance are squeezed together near the high end of the scale? Down at the low end, the numbers are spread out where we can easily read them—the number 1 is a fair distance from 2, and 2 is almost as far from 3 and so on.

But up at the high end, we see that 200 is about as close to 500 as 1 is to 2. And 1k and 2k are practically on top of each other.

This compression at the high end of the scale is normal for an ohmmeter, and there's nothing we can do about it. But what we can do is make use of this situation so it works to our advantage.

How? Very simple—just remember to use the right two-thirds or so of the scale, where the numbers are spread out the most, whenever possible. This will allow you to read much more clearly just exactly what calibration is being indicated by the meter needle. If the pointer stops far to the left, where the



scale calibration is greatly compressed, the thing to do is switch the meter's range switch to a higher resistance range so the needle will drop to a more usable part of the scale. And don't forget to re-check the zero-set adjustment when you do this, since it may need re-setting for the new range.

If you're already using the highest resistance range, then to achieve a more accurate reading you'll have to use a different method for measuring high resistance, as explained in *Tips 8* and *9 which* follow.

2 Our second tip is another simple item often overlooked. Did you ever notice, when holding ohmmeter prods tightly against the leads of a resistor, that the ohmmeter needle couldn't seem to make up its mind just where to stop? Then you probably discovered that as you pressed the test prods tighter against the resistor leads, you got an indication of lower resistance on the meter.

Ah ha, you thought, *there's some corrosion on the resistor leads and I'm pressing the test prod through it and getting better contact with the wire.* This may have been true. But there more probably was another reason for this occurence, or for the major part of the effect.

It's simply that the meter was measuring not only the resistance of the little resistor you held against the prods, but the resistance of your body as well! When you pressed harder on the prods, you also brought more skin area into contact with them.

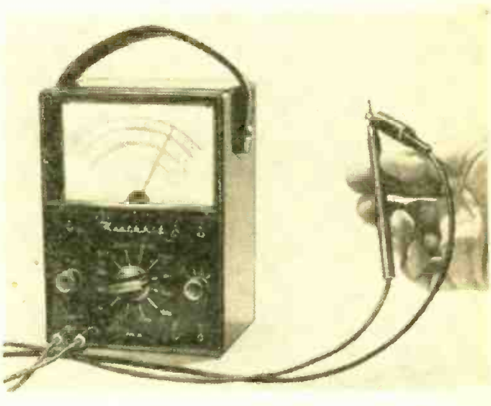
So, you should be sure, especially when using a high-resistance range, that you don't touch the metal tip of the test prods. Or if you do touch a prod, touch only one—never both. Use an alligator clip on one lead so you don't have to hold it in contact with the resistor lead.

On low-resistance ranges, the effect won't be noticeable, since your body resistance is rather high. For this reason, connecting it in parallel with the resistor you're measuring will have little effect.

3 Another often-overlooked item that can have a large effect on the accuracy of an ohmmeter is the condition of its battery. Every ohmmeter has a small battery inside its case to supply the small current which passes through the resistance being measured. The amount of current which flows gives us the ohmmeter indication.

However, if the battery is weak, the indication may become false if we hold the test prods on the resistor for any length of time. Reason is that the battery voltage may drop during this time. And if the battery voltage changes after we set the meter to zero, we'll get a false meter indication.

There's a simple way to check the battery condition without opening up the meter case and removing the battery. When you touch the prods together and adjust the zero-set knob to prepare to make resistance measurement, hold the prods together for several seconds longer and watch the meter



Above—Be sure battery in your VOM is putting out enough voltage if you want accurate resistance readings. Keep test leads together for a few seconds to be sure zero setting remains constant. Left—Never hold both test probes in your hand when checking resistance, your body resistance in parallel with resistor being measured affects reading.

needle closely. If it stays at zero, the battery voltage is holding steady. But if the needle begins to slowly move upscale, the battery voltage is dropping, and the battery should be replaced.

Make a habit of performing this test each time you use your ohmmeter. This way, you'll always know for sure if the battery is in condition to give you accurate measurements.

4 An ohmmeter can be put to handy use in checking for one of the peskiest of all troubles that may occur in a vacuum tube—an intermittent short between elements. This is a condition that may not show up on a conventional check in a tube tester.

This test is made with the tube plugged into its regular socket in radio or amplifier or whatever. The heater should be lit, but there should be no voltage on either plate or screen. After the tube is thoroughly warmed up, use the ohmmeter to check for continuity between each pair of tube socket terminals in all possible combinations. Be careful, though—don't connect the ohmmeter across the heater pins!

Tap the tube firmly with the rubber eraser on the end of a pencil while making each of these checks, and watch the ohmmeter closely. If there's a momentary flicker of the ohmmeter needle, there is contact between tube elements, and the tube should be scrapped. A stable resistance reading between two tube pins could indicate a resistive short between two tube elements. Then, too, it could merely be caused by a resistor, capacitor, or coil in the circuit. Check the stage's wiring to be sure.

5 Got a box full of battered and scraggly-looking diodes—and you don't know which ones are good and which ones are open or shorted? Fortunately, there's a quick way to tell. And while you're at it, you can find out the correct polarity of those that have the cathode marking band rubbed off.

To make this simple test, you'll need to know which ohmmeter lead goes to the positive terminal of the ohmmeter battery and which goes to the negative battery terminal. Generally, the ohmmeter in a VOM is wired so that positive (+ or red) jack on the meter case goes to the negative battery terminal, and the common or negative (– or black) jack goes to the positive battery terminal.

If you have the wiring diagram for the meter, or care to open the case and trace the wiring, you can find out for sure. Or, you can make this check: switch the ohmmeter to a medium range and touch the prods to the leads of a rectifier which you know is good. You'll get the lowest resistance indication when you have the positive lead touching the anode and the negative lead touching the cathode.

To test unknown diodes, connect the ohmmeter to their leads first one way, then the reverse. The two resistance indications you obtain should be considerably different—one should be quite high and the other rather low. If this occurs, you have reasonable assurance the rectifier is good, since it passes current much more readily in one direction than it does in the opposite direction. If you get resistance indications that are nearly the same, the diode is shorted. And should you get indications of a high resistance in both directions, the diode is open. When you get the lower resistance reading, you have the positive ohmmeter lead connected to the anode and the negative lead connected to the cathode.

6 Transistors also can be checked with an ohmmeter . . . or can they? Yes, they can . . . sometimes. (How's that for a straight-forward answer?)

The reason it's impossible to give an absolute *yes* or *no* is that there are so many types of transistors in the world today. Many of them can be safely checked with an ohmmeter; others, being on the delicate side, can't be. Assuming you want to be perfectly safe, you should never touch an ohmmeter lead to a transistor. But if you follow this precaution, you'll be passing up many golden opportunities to check transistors which can be safely tested with an ohmmeter—if you do it properly.

To determine whether or not to even try it, you'll have to refer to a transistor manual for the particular type of transistor you want to check, then do a few calculations. Always use the lowest ohmmeter range available for the test. This will assure minimum current flowing through the transistor as you make the check.

By knowing the polarity of your ohmmeter battery, as explained in *Tip 5*, you

e/e TEN TIMELY TIPS

can determine if each section of the transistor has the proper relationship of low resistance in one direction and high in another. Which way is which will of course be determined by whether you're checking a *pnp* or *npn* transistor, and which leads you're touching with the ohmmeter prods.

For example, with the positive ohmmeter lead connected to an *n* lead and the negative ohmmeter lead connected to a *p* lead, you'll get a higher resistance indication than with the leads reversed, if all is normal. As with a diode, equal readings would indicate a short, and excessively high readings would indicate an open.

7 Some rudimentary checks of capacitors can also be made with an ohmmeter. Most common of these is checking an electrolytic capacitor. Even so, you can learn at least a little about the health and well-being of coupling and bypass capacitors as well.

A capacitor, unless shorted or leaking shouldn't conduct current. When a ohmmeter is connected across a capacitor, the battery in the ohmmeter supplies current which charges the capacitor. As this is done, the meter seems to indicate that the capacitor is conducting current. But once the charge begins to build up on the capacitor plates, this charging current drops off.

In the case of an electrolytic capacitor, which has a fairly large capacity, enough current flows when you first connect the ohmmeter prods to the capacitor leads that you will get an indication of very low resistance. This is normal, as long as this resistance indication quickly increases, within a few seconds, to a value of several hundred thousand ohms.

However, if the apparent resistance remains rather low, then the capacitor has excessive leakage and probably should be discarded.

Other types of capacitors, such as coupling capacitors, have much lower capacity. This means that usually you'll get no indication on the meter that the capacitor is charging. Reason is that the capacitor requires so little current to take on a full charge that the ohmmeter battery supplies this current very quickly. The meter movement barely flickers—if it budges at all.

With such capacitors, you should get an indication of infinite resistance with the ohmmeter. If you do get an indication of low or medium resistance, then the capacitor is leaking or shorted, and should be discarded.

8 By adding a simple external modification to your ohmmeter, you can extend its range upward to accurately measure resistances much higher than what you normally can read on the meter scale.

Fig. 1 shows how this is done. What you do is add a battery and resistor in series with one ohmmeter lead. The positive battery terminal is connected to the negative ohmmeter lead, so that the internal and external battery voltages add. The external battery voltage should be nine times the voltage of the ohmmeter battery; similarly, the external resistor, R, should be nine times the total resistance of the ohmmeter high resistance range circuit.

The result of this external range extender will be to multiply the ohmmeter's high range by 10 times. With this hookup, for instance, a resistance which produces an indication on the meter of 2 megohms would actually be 20 megohms.

The exact external battery voltage and resistance needed will vary, depending on the meter you're using. For the Simpson 260 VOM, for instance, the manufacturer gives the values as 67.5 Volts and 1.08 megohms. But keep in mind that other meters may require different values.

To determine what you must add to your meter to use this range extension method, consult the operating manual for the meter. If this fails to cover the matter, write the manufacturer, enclose a copy of the dia-

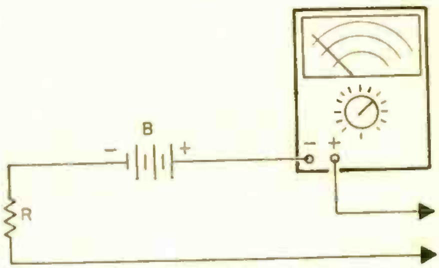


Fig. 1—External battery and resistor are used in this manner to extend range of your VOM for resistance measurements beyond normal range of your test set.

gram in *Fig. 1*, and explain what you want to do.

In case you find you need a rather peculiar external battery voltage, such as 54 or 13.5 Volts, remember that this doesn't have to be just one battery—you can connect a series of flashlight cells together to add up to the required voltage.

9 There's an alternate method of accomplishing high-resistance measurements which, unlike *Tip 8* just given, doesn't even involve using an ohmmeter. The circuit for this method is shown in *Fig. 2*.

For clarity, the diagram shows two meters. However, you can use a single VOM to make the two measurements required. The unknown resistance is connected in series with the VOM and with a DC power supply of several hundred volts.

Start with the highest current range your meter offers so as to guard against the possibility of throwing the meter off scale, then switch down to lower ranges until you obtain a usable reading.

After measuring the current flowing through the unknown resistor, you now need to measure the voltage across the resistor. If you use the same VOM to make this voltage measurement, remember to close the circuit where the current meter is shown in the diagram when you remove this meter to connect it across the resistor.

With these two measurements made, apply Ohm's law to determine the value of the unknown resistance. If, for example, you measured 700 volts across the unknown resistor and 10 microamps flowing through it, your calculations would be:

$$R = \frac{E}{I} = \frac{700}{.00001} = 70 \text{ megohms}$$

Before trying this method, be sure you are really dealing with a large amount of DC resistance. With the voltages you'll have to use, you could easily damage your meter or burn out the unknown component if it turned out to actually have only a medium amount of resistance.

10 A technique very similar to that illustrated in *Tip 9* can be used to measure very low values of resistance using a low voltage. A pair of dry cells connected in series will be fine, though you may get by with a single dry cell if your VOM has a millivolt range.

The test hookup is shown in Fig. 3. In addition to having the unknown resistance connected in series with the current meter and the flashlight cell, there's also a second resistor, about 5 to 10 ohms, in the series loop to limit the current flow. The value of this resistor isn't critical. However, if it's too large, you'll have difficulty getting meter readings large enough to be usable.

First, measure the current in the circuit. Then remove the meter, close the circuit again, and measure the voltage across the unknown resistance. Again, a simple calculation with Ohm's Law gives the value of the unknown resistance.

For example, suppose you got a current indication of 160 milliamperes and measured 0.08 volts across the unknown resistor. The calculation would be:

$$R = \frac{E}{I} = \frac{0.08}{0.16} = 0.5 \text{ ohm.}$$

Since you'll be measuring a pretty small voltage across a tiny resistance, a VOM with a millivolt scale would be handy. However, if your meter doesn't have such a scale, try using two or three dry cells instead of one. This will cause more current to flow, which will increase the voltage drop across the unknown resistance to the point where it should be easier to measure. ■

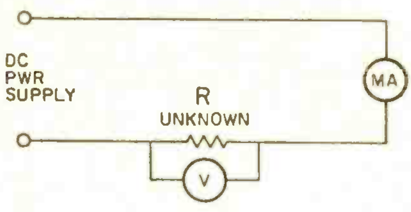


Fig. 2—Here's how to measure high resistance. Using a high voltage source, measure current and voltage and then apply Ohms Law to calculate resistance value.

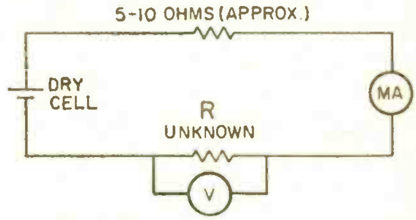


Fig. 3—Very low resistance values require higher current than available from VOM cell; with external source as shown in Fig. 2 read V and A and apply Ohms Law.

KATHI'S CB CAROUSEL

"STEE-RIKE THREE!" barked the ump, as the player dropped his bat, and sauntered back to the dugout. Sitting in front of my TV, I was watching the season's first ball game. Slowly, it dawned upon me why the Citizens Band was loosing a goodly portion of its regulars. For, it is said by the fairer sex, that a young man's fancy turns in the springtime to—darn it!—baseball.

All you have to do is tune through the CB channels to hear the evidence. Almost every call heard is a plea for relief players at the town's ball field. Why, the other day as I was band hopping, I heard a Bush League batter's wife-turned-baseball-widow practically crying on Channel 9. Seems her Little League-filled station wagon broke down on the way to practice, and the players were thinking of warming up—on the highway's grass divider!

But not everyone's struck with baseball fever. Some of the latest rigs were shown off while at the local CB club the other evening. Seems the transceiver copping most favorable comment from the other YLs was the *Courier Citation*. And for good reason, too. Every YL who cast her eye shadow toward the *Courier Citation* found it the dreamiest rig she's ever seen.

Homey-Run Rig. More than one male CBer has slept on the living room couch after a spat with his wife over his "ugly CB trans-something-or-other." Okay, Fellows, your CB dog days are over. *Courier's Citation* transceiver ends the CB shack decorating doldrums forever. Cast your orbs toward their highly-styled, solid wood cabinet surrounding the set. Then add the gorgeous chrome bars accenting this rig. But the real topper's a built-in digital clock!

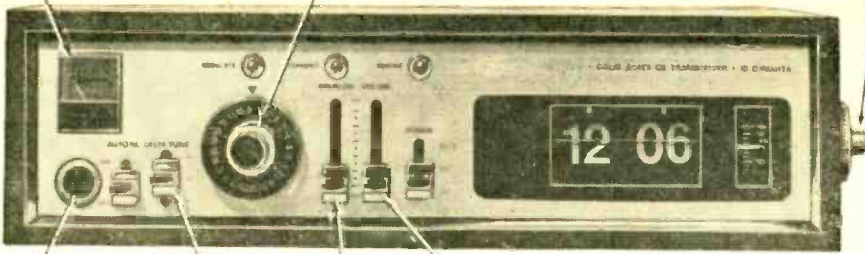
Not only is the *Courier Citation* a super looker: it's scrunched into the 14½x9⅜x4-in. bikini-sized cabinet—and with room to spare. While I'm on the subject of space, take a gander at the *Citation's* front panel control layout.

Of course, there's the digital-styled clock staring back at you. The clock turns this rig on at any pre-set time. The transceiver sports five look-alike knobs; two of which are linear controls. These're for *Squelch* and *Volume*. To the right of these slider-type controls is *Power* on/off/auto. In the "auto" position the digital clock turns the rig on, or off, at any pre-set time. And, as your blinkers sashay leftward, both the three-position *Delta Tune* and *Auto Noise Limit* control functions are ready to do your bidding.

Tucked into the lower left corner's a standard 3-prong *microphone* socket; above it is the *S/RF Meter*. *Courier* has also seen fit to include three jewelled lamps into their rig; these are for the *Modulate*, *Transmit*, and *Receive* modes. The only rig-related dial you can twist on the *Citation* is the *Channel Selector*. It spins you through all 23 channels. The rig's external *Public Address* (PA) function is also selected by this teensy, chromed knob.

If you thought the front panel was super simplicity, just do a 180 and look at the rear panel. Seems all I did to become CB-borne was twist my antenna lead onto the SO-239 coax connector, hit the mike transmit switch—and start gabbing! The transceiver also sports both *External speaker* and *PA speaker* jacks on the rear panel. You've also got

Functional styling, superior performance combine to make Courier's Citation centerfield attraction. To receive scorecard from Courier describing their rig, circle number 31 on Reader Service Coupon located on page 17.



Courier Citation front panel layout is very clean, making it easy to work with. Noise limiter switch's next to mic connector; power switch sits to clock's left.

access to the *Television Interference Filter* (TVI Adj.)—but don't bet on using it too often. Adjust the TVI filter only if one of your tee-veed neighbors tells you that you're competing with the Tube.

A Beauty With a Brain. I wondered if *Courier's Citation* was merely a walnut-finished beauty. But lo and behold—this rig not only has looks; it's got performance worthy of the most avid CBer. The receiver portion of the *Citation* is double conversion and frequency synthesized. You'll find a crystal filter in the second IF amplifier. This filter effectively squashes adjacent channel interference. Our lab cranked out 45 dBs worth from the *Citation*.

The high selectivity available from the receiver made Delta Tuning a mandatory feature for the *Citation*. That's how you can receive off-channel CB transmitters.

The transmitter portion of the transceiver is a 5-stage affair. It, like the receiver half of the rig, is crystal-controlled over all 23 channels. As you can imagine, all adjustments for the transmitter are buried within the rig's metal case. You won't ever need to fiddle with them anyhow; there's very little that can go flooey with the *Citation* rig.

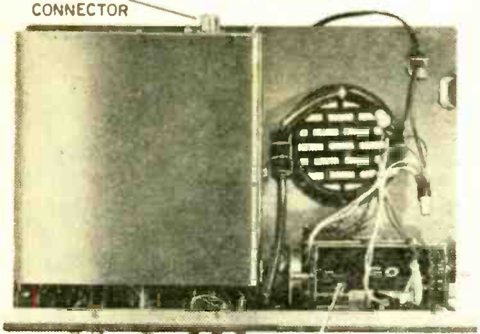
Another feature putting the *Courier Citation* into the major league is a voltage-regulated power supply. That's *Courier's* way of keeping critical voltages where they belong.

Pop-fly Performance. The *Citation* has all the receiver sensitivity that any CBer can ask for. Fact is, the rig logged a high 0.6 μV for a 10 dB S+N/N ratio before I lost the received signal. And receiver image rejection was an excellent 50 dB.

The AGC action didn't exactly slouch on the job, either. For a test input signal of 1 to 50,000 μV, the lab recorded a very good reading of 5dB.

Looking at the S-meter's performance, I saw that it took 50 μV to pin the meter over to S9. But there was no other relationship between the S-meter calibrations and the input signal. So, the meter simply indicates relative signal strength. The *Citation's* transmitter put out in major league fashion, too. Three watts pumped into a good whip should give you all the talk-range you need. Of course, the output load's a standard 50-ohms; no need to worry about antenna matching problems. *Courier's* modulator sopped up my vocal output as relative sensitivity for 90% modulation was

(Continued on page 101)



Top view of rig. We suspect that while YLs like Courier's rig mostly for its snazzy looks, OMs look at gobs of interior space with eyes toward future built-in accessories like RF amp or antenna matchbox.

1 New Heathkit solid-state 25" ultra-rectangular Color TV with exclusive MTX-5 Matrix picture tube

This is the world's finest color TV . . . and you can prove it to yourself. Compare the standard features of the new "371" to any color TV at any price . . . and you'll agree.

MTX-5 picture tube . . . standard. Developed by Heath engineers in conjunction with leading domestic picture tube manufacturers to provide optimum picture quality. Specially formulated etched glass face plate cuts out unwanted glare . . . gives increased contrast without sacrificing brightness . . . delivers the sharpest, purest, most natural 315 sq. in. of color you'll ever see.

Unique solid-state design . . . under development for over 5 years: 45 transistors, 55 diodes, 2 SCR's; 4 advanced Integrated Circuits containing another 46 transistors and 21 diodes; and just two tubes (picture & high voltage rectifier) combine to deliver performance and reliability unmatched in the industry. Modular plug-in circuit boards permit easier assembly & service.

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Exclusive design solid-state VHF tuner . . . MOSFET design for greater sensitivity, lower noise & lower cross-modulation. Delivers visibly superior color reception. Assembled & aligned.

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15 manual voices, 4 pedal voices . . . any or all at the flip of a tab. SOLO: Diapason 16', Bass Clarinet 16', Trumpet 16', English Horn 8', Oboe 8', Violin 8', Tibia 16', Tibia 8', Tibia 4', Tibia 2'. ACCOMPANIMENT: Diapason 8', Saxophone 8', French Horn 8', Oboe Horn 8', Cello 8'. PEDAL: Diapason 16', Major Flute 8', Bass Clarinet 8', String Bass 8'.

200 watts peak power from two separate solid-state amplifiers . . . one for the Leslie system, one for the main system.

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Put a universe of sound in your home today . . . order your new TO-101 now. **Kit TO-101,** 299 lbs. . . **$1495*.** Playmate & Band Box accessories also available.

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Now . . . frequency measurement at a price you can afford. Delivers stable, accurate counting from 1 Hz to over 15 MHz. All integrated circuitry for top performance, high reliability. Automatic trigger level for wide range input without adjustment. Five digit cold-cathode readout with Hz/kHz ranges and overrange indicators give 8-digit capability. Input Z 1 megohm shunted by less than 20 pF for low circuit loading. Order your new IB-101 today. **Kit IB-101,** 7 lbs. **$199.95***

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CIRCLE NO. 17 ON PAGE 17

ELEMENTARY ELECTRONICS ETYMOLOGY

By Webb Garrison

RUBY

▲ Numerous ancient civilizations, notably those of Egypt, Greece, and Rome, placed a premium upon the color red. Indicated in Latin by the term *rubeus* or *ruber*, the color name entered many European languages virtually unchanged.

From it, *ruby* appeared in fourteenth-century English as the title for a red precious stone. The gem comes from a common mineral, corundum, which is a simple oxide of aluminum.

Murder, theft, pillage, and war are closely associated with the story of the ruby—long considered the most valuable of gems. Today a large crimson faceted ruby is worth more than $10,000 a carat, wholesale.

The stone over which queens wept and for which conquerors have given their lives led to a major scientific breakthrough in 1960. For by use of a small crystal of ruby experimenters managed to generate intermittent but very pure and concentrated beams of infra-red light.

Having led man to techniques that made the laser a reality, the ruby was promptly challenged by a mixture of helium and neon. Many kinds of gas lasers have been produced in the last decade. For a variety of applications, however, the stone once prized chiefly for its color remains the key factor in laser technology.

STROBE

▲ Greek artisans made frequent use of little plugs of lint twisted so that they resembled fir cones. Romans who adopted the use of these rounded masses described their shape as *strobilus*.

Dormant for centuries, the old word was revived when artisans invented a scientific toy that produces the illusion of motion by means of a series of pictures viewed through opening of a revolving disc. This instrument, dubbed the stroboscope, came into vogue during the 1830's.

Later the toy was adapted and put to scientific use. By means of light periodically interrupted it proved possible to observe the successive phase of periodic movement.

This type stroboscope was known only to specialists. Still, it served to name an important addition to the photographer's equipment: a high-intensity light capable of yielding repeated short bursts.

With its name clipped to *strobe*, and no longer bearing the faintest resemblance to a fir cone, the stopped-motion electronic multiflash became one of the trademarks of the psychedelic age.

AMORPHOUS

▲ In classical Greek, *morphe* was used as a general term for "shape." Since vivid memories of queer shapes often linger after a dream, the poet Ovid used Morpheus to name the god of dreams, son of the god of sleep. Morpheus, in turn, inspired *morphine* as a title for the bitter narcotic that causes users to see frightful shapes.

By tacking the prefix *a-* to the front of a word, Greeks indicated "not." So to them *amorphos* signified "not shaped," or formless.

Amorphous materials include liquids and non-crystalline solids. Since to the naked eye these substances "not shaped" by nature seem chaotic in structure, their electrical properties weren't investigated until very recently.

Late in the 1950's, excited by development of crystalline semiconductors, Soviet physicist A. F. Loffe turned his attention to amorphous materials. He found that many have electrical properties, but made no practical application of these properties.

Independently, U. S. physicist Stanford R. Ovshinsky began a similar program of research. His goal was highly practical: the discovery of new switching effects.

In June, 1958, he hit pay dirt. Using the transition metal tantalum coated with an amorphous layer of tantalum oxide he produced a semiconductor with new properties. With his wife Iris, a biochemist, he set up Energy Conversion Laboratories and devoted full time to these long-neglected materials.

Numerous finds have led to more than forty patents and a wide range of functional devices.

One of them is the ovonic threshold switch. At least two electrodes are employed, separated by an amorphous semiconducting film. Such a switch may have resistance as high as 5×10^8 ohms in its blocking state. But transition time to the "on" condition is incredibly brief (less than 150 picoseconds), and the holding current needed is only 5×10^{-4} amps.

A person gripped in the arms of Morpheus or caught in fantasies induced by morphine sometimes sees very unusual shapes. None evoked in this way are so bizarre as the shapeless films of molecules that have spawned a new generation of *amorphous semiconductors* which employ non-crystalline components. ■

the ABC's of WHEATSTONE'S BRIDGE

Learning all about how it works makes it a more useful instrument in the shop or laboratory.

By Norman Crawford

Back in 1843, Charles Wheatstone had a need for a convenient way to measure unknown resistances. He solved his problem by using and publicizing a circuit devised by S. H. Christie some ten years earlier. This same circuit is still widely used today, and, despite Wheatstone's earnest attempts to ascribe the invention to its proper inventor, it is best known as the Wheatstone bridge.

The circuit Mr. Christie invented in 1833 is usually shown as a diamond-shaped cluster of resistors with a battery across two of the opposite points of the diamond, and a meter or other detector across the two remaining points. See Fig. 1. With this circuit, it is possible to determine accurately the value of one of the four resistors, provided value of other three is accurately known.

To understand this bridge, first let us consider a familiar circuit, the voltage divider. As you probably know, a voltage divider is a two-resistor circuit which can convert a given voltage to a lower voltage. For example, in this circuit shown in Fig. 2 the output voltage will be two-thirds of the input voltage. And, if you don't like such low resistor values, then look at Fig. 3. This circuit will also have an output which is two-thirds of the input.

If we apply 9 volts to the input of either circuit shown in figs. 2 and 3, the output will be 6 volts. For a 90-volt input, a 60-volt output results.

Since the outputs of the two above circuits are identical, connecting a meter between the two outputs should give no read-

Fig. 1

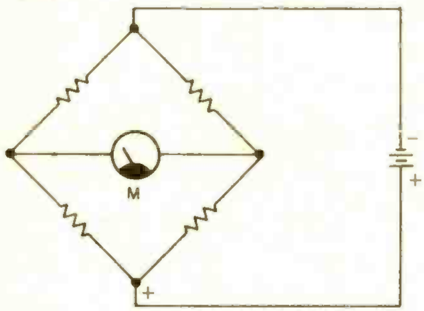


Fig. 2

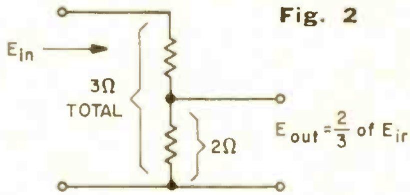
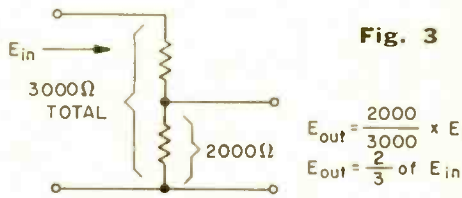


Fig. 3



e/e WHEATSTONE BRIDGE

ing at all, because the two leads of the meter are connected to identical voltages. Take a look at Fig. 4. For that matter, changing the 9-volt input to 10, or 50, or 100 volts, will still give no (zero) meter reading, because each voltage devider is providing two-thirds of the same number, be it 9 volts, 10 volts, or whatever. Therefore, both meter leads are kept at the same matched voltages, regardless of the input voltage, so the meter continues to register *zero*.

As you have probably already deduced, by combining these two voltage dividers we have produced a Wheatstone bridge. This may be more obvious if we draw the circuit as shown in Fig. 5.

When the resistor values are such that the meter reads zero, the bridge is said to be *balanced*. The reverse is also true: if the bridge is balanced, we know that the left side of the bridge and the right side of the bridge are matched voltage dividers.

To use the bridge to determine an unknown resistance, we could arrange the circuit as shown in Fig. 6.

Since the two uppermost resistors are identical (1,000 ohms each), the bridge will be balanced only if the two lower resistors are also identical to each other. Therefore, we can connect an unknown resistor to the terminals X and X′, and adjust the calibrated variable resistor until the meter reads zero. At this condition, the calibrated variable resistor is identical to the unknown, so the value on the calibration dial is the value of the unknown resistor.

Of course, if the unknown turns out to be larger than 10,000 ohms (the largest value of the calibrated variable resistor), *no* adjustment of the calibrated variable resistor will make the two lower resistors identical. Hence, the bridge cannot be balanced. How, then, can the bridge be used to determine the value of an unknown resistor greater than 10,000 ohms?

One way to measure a larger resistor with this bridge is to change one of the upper resistors from 1,000 ohms to 10,000 ohms as done in Fig. 7. Compare Fig. 7 with Fig. 6.

Since the right-hand uppermost resistor is now ten times the left-hand uppermost resistor, the bridge will be balanced only if the lower right-hand resistor (the unknown) is ten times the lower left-hand resistor (the variable one). For example, one condition of bridge balance would be as shown in Fig. 8.

On the other hand, a very *low* value of unknown resistor (for example, 69 ohms) could not be read accurately on the above bridge, because it would require that the 10,000-ohm calibrated variable resistor be set to one-tenth of 69 ohms, or 6.9 ohms. Although such a setting is physically possible, it does not result in a very accurate reading.

To measure such low-value resistors, we change the upper right-hand resistor again; this time to 10 ohms. See Fig. 9 for the balance condition.

This immediately suggests a very versatile

Fig. 4

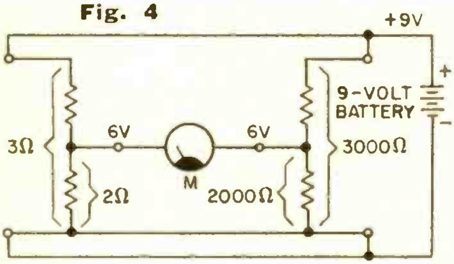


Fig. 5

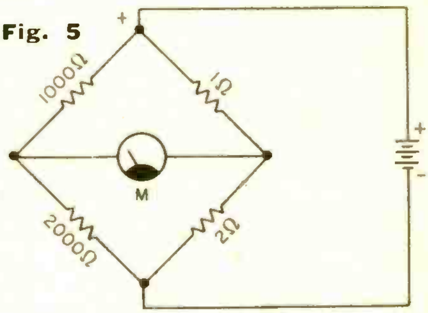


Fig. 6

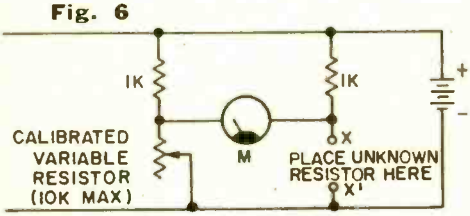
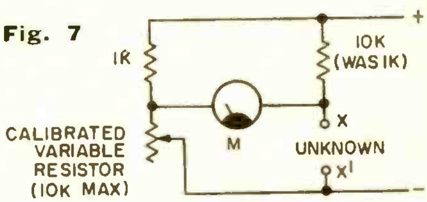


Fig. 7



bridge, which uses a multi-position selector switch to select a variety of values for the upper right-hand resistor. In addition to 1,000 ohms, 10,000 ohms, and 10 ohms, which were used in the above examples, we can choose 100 ohms and 100,000 ohms. Fig. 10 illustrates such a bridge.

To use this versatile bridge to measure low-value resistors, select the 10-ohm resistor by placing the selector switch in the "X 0.01" position, connect the unknown resistor to the terminals X and X', and adjust the calibrated resistor until the bridge is balanced, as indicated by a reading of zero on the meter. The reading on the calibrated resistor's dial is then multiplied by 0.01 to give the value of the unknown resistor. For example, if the reading is 3,700, the unknown is 37 ohms.

Similarly, setting the selector switch to "X 100" allows you to measure large resistors. If a certain unknown resistor results in a reading of 3,700 at balance, the unknown is 370,000 ohms.

Practical Considerations. Although this bridge can be built using ordinary 5 percent resistors, the errors in measurement will be as large as ± 10%. It's better to use 1% resistors everywhere.

The variable resistor, similarly, could be an ordinary potentiometer with a hand-calibrated dial. However, this also limits accuracy; it would be much better to use a resistance decade of the type sold by some of the leading electronic kit manufacturers. Calibrated multi-turn pots are also available.

The meter should be a zero-center microammeter (such as the 25-0-25 microamp type) for the best accuracy. However, even an ordinary 0-1 meter will suffice if you are willing to trade some accuracy to keep the cost down. Remember, however, the more sensitive the meter, the more accurately you can balance the bridge, especially on the high resistance ranges. Also, the more easily you can burn out the meter when the bridge is not balanced! To forestall this catastrophe, connect your meter to the bridge through a group of normally-open pushbuttons and resistors (10% type), as shown in Fig. 11.

Pressing the top button will give a reading on the meter if the bridge is far from balance, but the large value of resistance in series with the pushbutton will keep the meter from being damaged by the large unbalance. Holding this button, balance the best you are able, and then press the next pushbutton, which will further increase the

(Continued on page 100)

Fig. 8

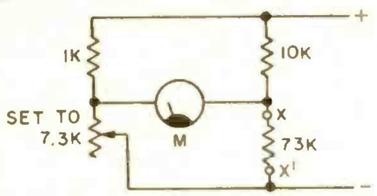


Fig. 9

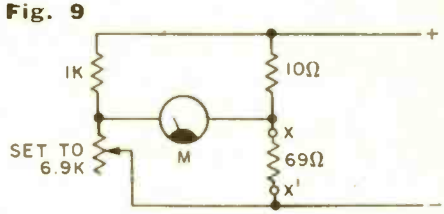


Fig. 10

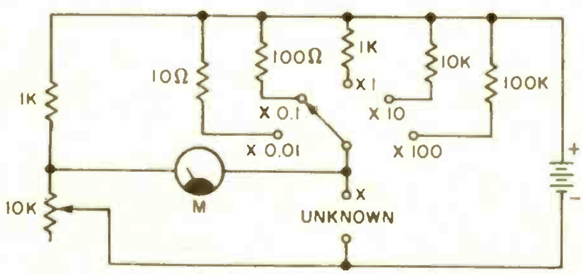
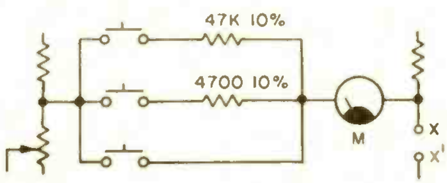
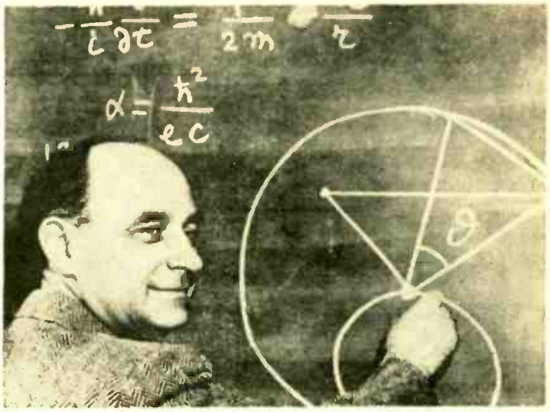


Fig. 11



Enrico Fermi—helped build the first Atomic Pile

GREAT MEN OF SCIENCE



by Webb Garrison

☐ "Yes?" inquired the receptionist at the physics laboratory, University of Rome. "Whom do you wish to see?"

"*Sua Eccellenza* Fermi, please."

"This way," directed the receptionist. "The Pope is upstairs."

Fellow workers nicknamed Enrico Fermi "The Pope" before he was 30, as a tribute to his infallibility. They had no way to know that "the infallible one" would blunder upon an effect he didn't understand but whose consequences would shake the world.

A native of Rome, Fermi won a doctorate in physics from the University of Pisa at 21. He returned home to teach, was elected a member of the Royal Academy of Italy at 28. This honor brought with it a title he never willingly used—*Sua Eccellenza* ("His Excellency").

Soon after it was bestowed upon him excitement rippled through the world's then-small group of theoretical physicists. As a result of using neutrons with which to bombard elements, early in 1934 the Joliot-Curies of France discovered artificial radioactivity.

Fermi had spent most of his time teaching and exploring new theories. Now he decided to turn to the laboratory. With traditional Italian enthusiasm he promised his wife that he, Enrico, would bombard every known element with neutrons.

Results came quickly. Starting with the lightest elements and working toward heavier ones he stopped momentarily with aluminum. This white metal, #13 in the periodic table, showed strong radioactive effects when peppered with neutrons.

Working with crude and flimsy equipment, the Italian moved methodically through the periodic table. Over and over he produced radioactive effects—in iron, chlorine, arsenic, barium, cobalt, and even gold.

Presumably, artificial radioactivity developed as a side effect of formation of unstable heavy isotopes. No one had any idea about ways this phenomenon could be put to practical use.

No matter. *All* elements must be tested!

In 1934 Fermi came near the end of the line. He had just one more element to bombard—the last in Mendeleev's table, with atomic number 92. It was a rare and obscure white metal called uranium.

When uranium was bombarded by Fermi's method, he got results—but they were confusing. Beta radioactivity was so complex that he confessed his bewilderment. There was one period of about one minute. Another period, about 13 minutes long, was noted in his memo of May 10, 1934, as "most intense." Other periods, less intense, lasted even longer.

Clearly, at least one (and probably two) different elements not found in nature had been produced in the laboratory. Fermi reasoned that he had made new substances whose atomic numbers would have to be 93 and 94.

Later investigation showed that neutron bombardment of uranium does produce elements #93 and #94. But this process is accompanied by another whose effects Fermi noted but whose workings he didn't grasp

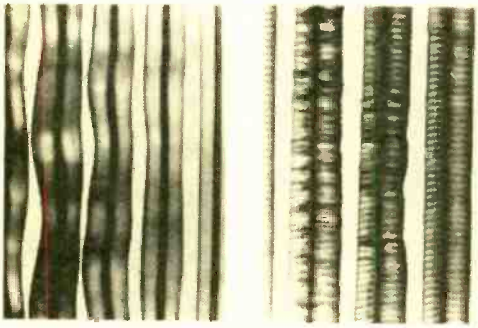
(Continued on page 99)

NEWSCAN

2 + 2 is Four-Channel

The audio field is going crazy with 4-channel sound. Everyone everywhere is talking about firsts like the world's first genuine four-channel phonograph record and sound reproducing system made by Japan. Ltd.. Tokyo.

Japan Victor's new development also gives audio fans the advantages of prerecorded multitrack tape recordings at the lower cost of discs. Best selling albums on tape now retail for \$6.95. whereas a 12" 33⅓ RPM disc can be made to sell for as little as \$1.00. Hi-fi set own-



What's in the groove? Just look above and see the difference. Magnified grooves of an ordinary LP are seen at right. Magnification makes the grooves look like slow-moving stream beds. But at left the grooves have a lot of ripple on them—that's the effect of the difference channel (A-B) recorded at 20,000 to 45,000 Hz. Can an ordinary hi-fi stereo cartridge track this groove? That's what Japan Victor claims!

ers of quality hi-fidelity audio cartridges used in their present phonographs need add only the CD-4 reproducing unit. or decoder. to obtain 4-channel results. The decoder will retail for about \$50. For those whose cartridges are not capable of wide-range reproduction, JVC will make available a suitable cartridge for approximately \$50.

Characteristics of the new system are:

1. Frequency range. 30—15.000 Hz. is the same as in ordinary stereo but the modulated carrier system is adapted for the high frequency range. 20.000—45.000 Hz. It is a 45/45 system and in that respect is like the regular stereo groove.
2. The carrier modulation system is centered around the middle frequency range (800 Hz) and features the application of frequency modulation in the low frequency range and phase modulation in the high frequency range.
3. Through the matrix circuit the sum signal (A+B) for each pair of stereo channels is cut in the low frequency range and the different signal (A—B) in the high frequency range.

There are a lot more claims made by Japan Victor. but only time will tell. After all, remember that CBS's color TV Wheel came first, too!

Count On It!

GE scientists have come up with a new semiconductor circuit element that can store information on a silicon chip at densities of a *million bits per square inch.* Called a Surface Charge Transistor, the circuit element involves a new concept for controlling the transfer of electrical charges across the surface of a semiconductor. The scientists say that its combination of high speed and small size—several hundred could fit on the period ending this sentence—promises a major increase in the information storage capacity of semiconductor memories.

Fabrication of a Surface Charge Transistor begins with a silicon chip covered with a thin layer of insulating film. Two electrodes—separated by a narrow slit—are formed by depositing a clean and precisely patterned layer of a refractory metal. such as molybdenum. over the insulator. These are the source and receiver electrodes.

A second insulating film and another metal layer are then deposited in sequence. forming a third electrode which overlaps the thin slit separating the source storage region and receiver. This narrow electrode is called the trans-

(Continued on page 99)

A new semiconductor circuit element that can store information on a silicon chip at densities of a million bits per square inch has been invented by scientists at the General Electric Research and Development Center. Here the inventors check chips by viewing them through microscopes.

ask me another

Discover by asking!

Send your questions to—
ELEMENTARY ELECTRONICS
Ask Me Another
229 Park Ave. South
New York, New York 10003

Receiver Buyer

I have a portable shortwave receiver which does a pretty good job on shortwave and standard broadcast reception. I have been thinking about buying a new Hammarlund receiver, either the model HQ-180-A or the HQ-180-AX. I would appreciate having your opinion as to whether there would be an appreciable improvement in the quality of reception, also if the range of these receivers would be great, and the reception quieter.

—J.J.H., Livermore, Calif.

The Hammarlunds are superior on all counts. Be sure to set up a good long wire or doublet antenna.

Snap, Crackle, and Smell

My portable black and white television set gives off a strong odor of ozone. Also, when turned on, it makes loud crackling sounds for a few minutes. I took it to a repair shop, but the repairman said that it wasn't anything to worry about. Just a little dampness, he said. This set is in my bedroom, not the basement, and our other television sets do not do this. Can you diagnose? Since it is obviously something beyond the repairman's knowledge, I am writing to you because you are electronics engineers.

—T.R., Union, N.J.

To get a bright picture, you need high voltage. The better TV sets provide higher voltage than the cheapies. And, when you have adequate high voltage, you can expect to hear a few crackles and smell a trace of ozone until the set warms up. It's said that ozone is dangerous—but only under prolonged exposure. Do you want a bright picture or a dim one? However, if the inside of the set is dirty, particularly around the high voltage circuits, excessive crackling can occur.

CB's the Answer

How much power output would be required for clear reception of a 100-kHz transmitter, with an antenna less than 25 feet long, at a distance of 600 miles? I would also like the same information about a 3000-MHz transmitter with a range of 10 miles.

—D.D., Waterford Works, N.J.

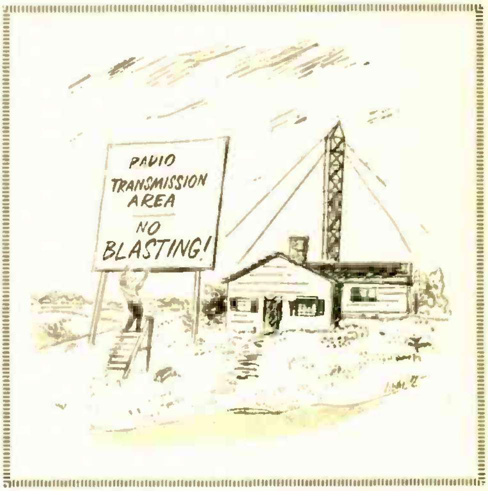
Probably many kilowatts, to answer your first question. You would also need a much longer antenna and an FCC station license which you undoubtedly could not get. Under Part 15, FCC Rules and Regulations you can operate an unlicensed low power transmitter at 100 kHz, but its range would be much less than 600 feet, not miles. If you get a General Class Amateur Radio Operator and station license, you could operate a transmitter in the 3300-3500 MHz microwave band. With a 1-watt transmitter feeding a parabolic antenna mounted 50 to 100 feet high, you could probably transmit 10 miles. The equipment would be expensive (perhaps $1000 or more). Why not get a CB license? You can buy a CB transceiver for as little as $50 used, and from $80 up for a new one.

Test It at Home!

I have an oscilloscope rated at .005 rms volt per centimeter and it has a maximum sweep of 100 kHz. How can I determine its frequency response or vertical amplifier bandwidth?

—R. K., Grand Rapids, Minn.

Connect an AF signal generator to its vertical input. Set horizontal gain to zero so you will see only a vertical bar on the screen. When the signal generator frequency is so high that the vertical bar is only half its length at a lower frequency, your vertical gain will be 6 db down (half the voltage). If the bar remains at its normal reference length at the highest frequency of the AF signal generator, use an RF signal generator. Caution: this is accurate only if the signal generator output remains constant. ■



e/e's all NEW BASIC COURSE in ELECTRICITY & ELECTRONICS

PART 8
UNDERSTANDING RL CIRCUITS

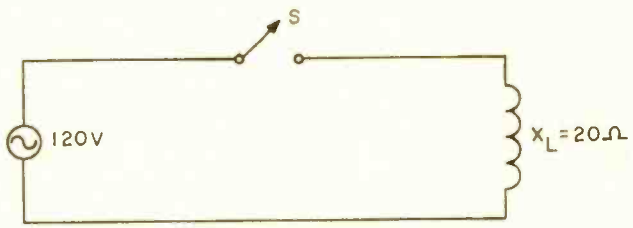
What You Will Learn—You are now going to learn how to find the equivalent reactance of inductors in series and in parallel. You will become acquainted with some of the ways to measure the relative importance of R and L in a component or circuit and how to find the time constant of a circuit. You will be able to add reactance and resistance to find impedance. You will discover how the combination of resistance and inductance affects the phase relations of voltage and current. You will also learn how to calculate current and power in RL circuits.

* This series is based on Basic Electricity/Electronics, Vol. 2, published by Howard W. Sams & Co., Inc.

INDUCTIVE CIRCUITS

A good way to understand circuits containing inductance is to work through a simple problem. For example, the following illustration shows a schematic of a basic inductive-reactance AC circuit.

SCHEMATIC OF A BASIC INDUCTIVE-REACTIVE CIRCUIT



Assume that the resistance in the leads and the coil is negligible. The problem is to find the rms value of the current in this circuit.

Ohm's law still applies.

$$I = \frac{E}{X_L} = \frac{120}{20} = 6 \text{ amperes}$$

You have learned that power in a circuit is:

$$P = EI$$

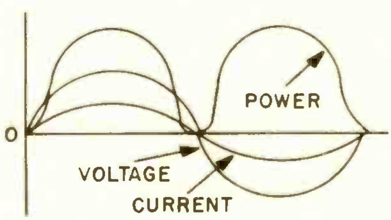
where,

E is the voltage,

I is the current.

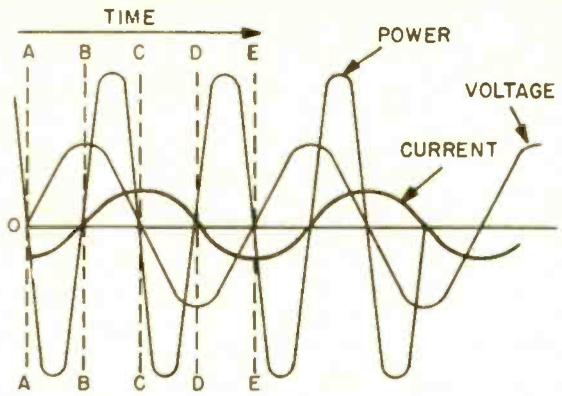
With a sine wave the power at any time during the cycle is the product of the voltage and the current at that moment. In a resistive circuit, power has a pulsating waveshape.

POWER IN A RESISTIVE CIRCUIT



You have already learned that no power is dissipated in a circuit that contains only inductance. A look at the waveforms on the next page will help you understand this.

POWER IN AN INDUCTIVE CIRCUIT



Between points B and C. both current and voltage are positive. If you multiply their values, it appears that power is being dissipated exactly as in a resistive circuit. Between points D and E, both current and voltage are negative, and again you have exactly the same situation as in a resistive circuit—power appears to be dissipated. But between points A and B and points C and D there is a situation that never exists in a resistive circuit.

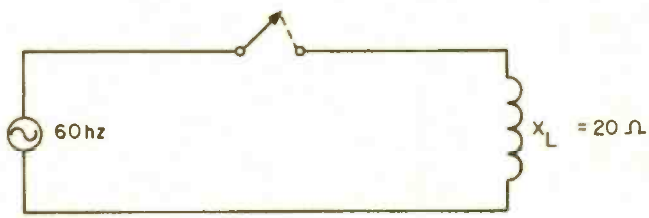
As you can see, there are pulses of negative power as well as positive power. The positive-power pulses represent the time when the circuit is utilizing power to produce a magnetic field. The negative-power pulses represent the time when the circuit is absorbing power from the magnetic field. The negative pulses and the positive pulses are equal and cancel each other, so the total power dissipated is zero.

An important rule that you must remember is:

When you multiply positive values by positive values, or negative values by negative values, the results are positive values.

When you multiply positive values by negative values, the results are negative values.

INDUCTIVE REACTANCE CHANGES WITH FREQUENCY



Inductive reactance in a circuit changes with frequency, but inductance stays the same. To find how the above circuit behaves at other frequencies, you must determine the inductance. Use the formula:

$$L = \frac{X_L}{2\pi f} \text{ (this is a form of } X_L = 2\pi fL\text{)}$$

where **L** is in henries, and **f** is in hertz.

e/e Basic Course

Q1. Is voltage positive or negative between points A and B in the figure at the top of page 83?
Q2. Is current positive or negative between A and B?
Q3. Is power positive or negative between A and B?
Q4. What is the amount of inductance in the circuit shown on the bottom of page 83?
Q5. How much current will flow in this circuit if the applied voltage is 100V at a frequency of 100 hz?

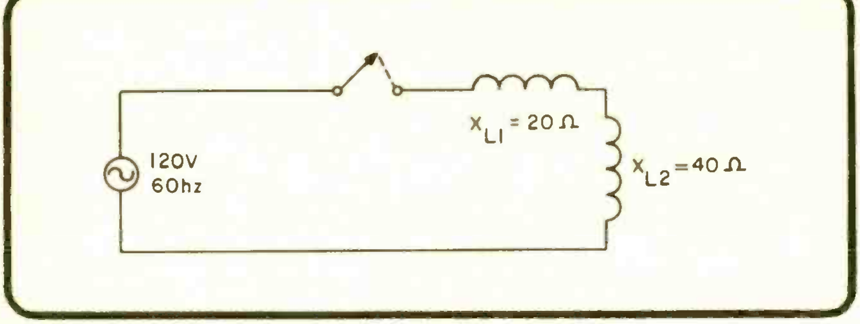
Your Answers Should Be:
A1. Voltage is positive.
A2. Current is negative.
A3. Power is negative.
A4. About 0.053 henry.
A5. X_L is 33.3 ohms.

$$I = \frac{E}{X_L} = \frac{100}{33.3} = 3 \text{ amperes}$$

Inductors in Series

The simplest form of a series inductive circuit is one with two inductors in series.

A SERIES INDUCTIVE CIRCUIT



To find the current in the circuit, add X_{L1} and X_{L2}, and then use Ohm's law with the equivalent X_L.

If the value of each inductance (L) is known, add the individual inductances to find the total inductance and then calculate X_{Leq} for the circuit.

Parallel Inductive Circuits

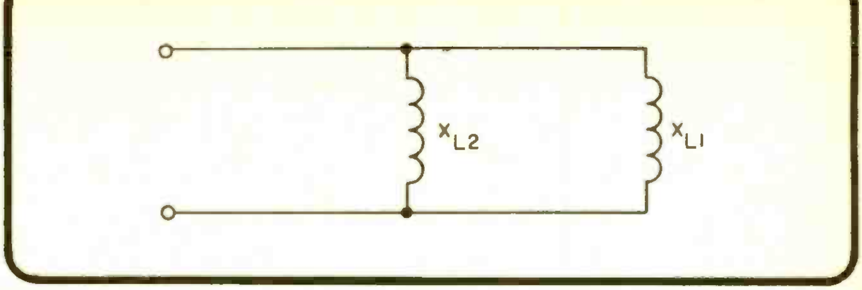
A circuit containing pure inductances in parallel can be treated much like a parallel resistance circuit.

This simple parallel circuit can be solved by the formula:

$$X_{Leq} = \frac{X_{L1} \times X_{L2}}{X_{L1} + X_{L2}}$$

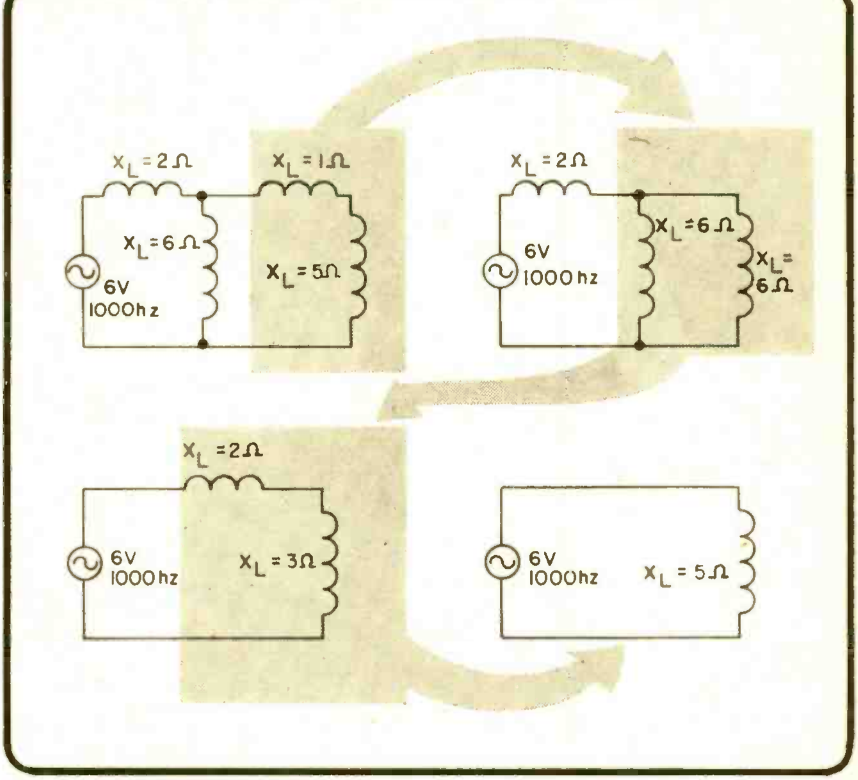
As with resistance, the equivalent inductive reactance of two inductors in

INDUCTANCES IN PARALLEL

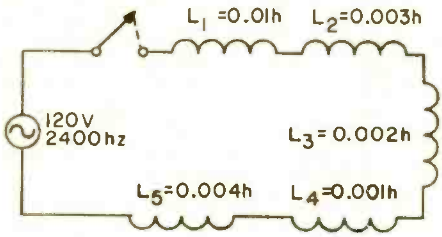


parallel is always smaller than that of either single inductor. Combined series and parallel circuits, or large groups of inductors in parallel, can be simplified in steps by the same method you have used with resistances.

SIMPLIFYING A CIRCUIT CONTAINING SERIES AND PARALLEL COILS



Q6. What is the equivalent X_L in the following circuit?



Q7. How much current will flow in the circuit in Q6?
Q8. How much power will be dissipated in this circuit?

Your Answers Should Be:
A6. $X_L = 2\pi fL = 2 \times 3.14 \times 2.400 \times .02 = 301$ ohms
A7. $I = \dfrac{E}{X_L} = \dfrac{120}{301}$ .399 ampere
A8. No power will be dissipated.

Q FACTOR

An RL circuit is one that contains both resistance and inductance. You are more likely to encounter circuits of this sort than pure inductive circuits or pure resistive circuits. In fact, even the connecting conductors in a circuit have some inductance, and every coil has some resistance.

It is sometimes important to know how "good" or how "pure" the inductance of a coil is. This quality is usually measured with a factor called **Q**. This is simply a ratio, $Q = \dfrac{X_L}{R}$. With a large Q, the power loss in the coil will be small, and the inductance will be more efficient. Notice, however, that Q varies with frequency, because the inductive reactance varies.

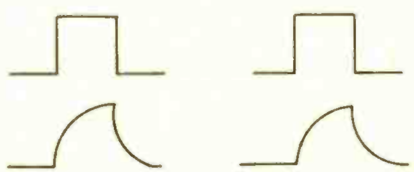
For example, a coil with an X_L value of 5.000 ohms at 10.000 cps and a DC resistance of 50 ohms has a Q at that frequency of $\dfrac{5.000}{50} = 100$. If this same coil is used at 5.000 cps, its inductive reactance will only be 2.500 ohms, and its Q will equal $\dfrac{2.500}{50} = 50$.

TIME CONSTANT

A different measure of the relative amounts of resistance and inductance is very important when dealing with pulse circuits. The shape of a pulse is changed by inductance.

When a pulse is passed through an RL series circuit, the roundness of the current rise and the time it takes for the current to rise to its final value depend

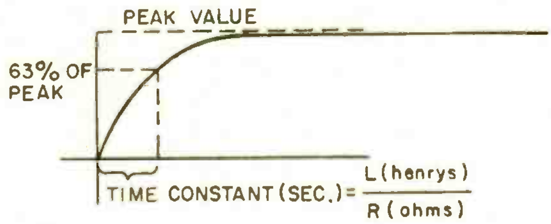
INCREASING TIME CONSTANT INCREASES THE AMOUNT OF DISTORTION



on the amounts of inductance and resistance in the circuit. As you would expect, the greater the value of inductance, the slower the current will build up. At the same time, the resistance in the circuit has the opposite effect—the smaller the resistance, the longer the current takes to reach the steady-state condition. (The reason is that when the resistance is smaller, the final current will be larger, and it will therefore take longer to reach this final value.)

When dealing with filters and pulse circuits, circuits containing L and R in series are often described by their **time constant.** This is a measure of how quickly the current in the circuit reaches its final peak value. The time constant equals L/R and is expressed in seconds. If a circuit has an L/R time constant of one-half second, the current will reach 63% of its maximum (peak) value in one-half second when a voltage is applied to the circuit.

PULSE REACHES 63% OF ITS PEAK IN L/R SECONDS



Q9. A "pure" inductance (which has no resistance) would have a (high, low) Q.
Q10. If you purchased a coil with a low Q, you would expect it to have a relatively (high, low) DC resistance.
Q11. If a coil has a high Q at 1,000 cps, would you expect it to have a higher or lower Q at 5,000 hz?
Q12. If the inductance of a circuit is 3 henrys and the resistance of the circuit is 5 ohms, how long will it take for a pulse to reach 63% of its maximum value?
Q13. The time constant of a circuit indicates the time it takes a pulse to reach ——% of its maximum value in that circuit.

Your Answers Should Be:
A9. A "pure" inductance would have a high Q.
A10. A coil with low Q would have a relatively high DC resistance.
A11. At an increased frequency, you would expect Q to increase.
A12. It would take a pulse $\frac{L}{R} = \frac{3}{5} = 0.6$ second to reach 63% of its maximum value.
A13. The time constant of a circuit indicates the time it takes a pulse to reach 63% of its maximum value in that circuit.

PHASE

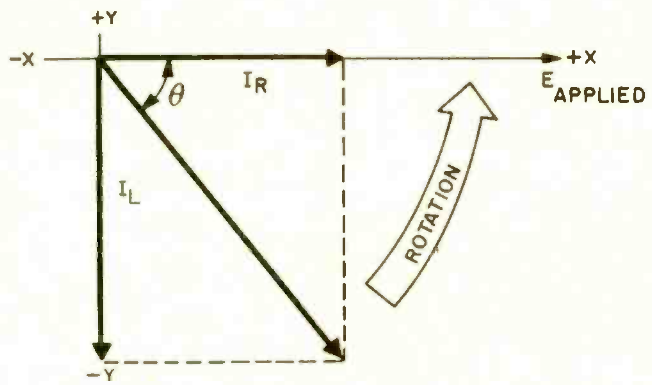
It has been previously explained that AC voltage and current are always in phase in a purely resistive circuit and that AC current through an inductance always lags the applied voltage by 90°. When resistance and inductance are

(Continued on page 92)

(Continued from page 87)

combined in a single circuit, the amount of phase difference between the current and voltage depends on which (resistance or inductance) has the greater value; that is, it depends on the Q of the circuit.

LONGEST VECTOR REPRESENTS RESISTIVE AND INDUCTIVE CURRENTS



If the applied voltage is a sine wave, the current through an RL circuit will also be a sine wave. Therefore, you can think of it as being generated by a rotating current vector.

However, this vector is a combination (or resultant) of the resistive and inductive current vectors.

As you see, these two vectors form the two sides of a rectangle, and the overall (resultant) current vector is the diagonal of the rectangle. The angle labeled with the symbol θ is the **phase angle**, the number of degrees by which the overall current lags voltage.

IMPEDANCE

To find the current flowing in a purely inductive circuit, you apply Ohm's law, using inductive reactance instead of resistance ($I = E/X_L$). Inductive reactance, of course, equals $2\pi fL$ and varies with frequency and inductance.

What happens when both resistance and inductance are in series in the same circuit? Say, for example, that the resistance is 3 ohms, and the inductive reactance (for a specific frequency) is 4 ohms.

As you know by now, the current through the resistance in an AC circuit is in **phase** with the applied voltage sine wave, while the current in the inductance **lags 90° behind** the voltage. Just as the rms value of resistive current cannot be added to the rms value of the inductive current to find the overall current, the 3 ohms of resistance cannot be added to the 4 ohms of inductive reactance. Instead, the overall effect of the two must be found in the same way that the overall current vector is found. The overall effect of resistance and reactance working together is called **impedance**. The symbol for impedance is **Z**.

Q14. If the current lags the voltage by 85° in a circuit with an

input at 1,000 hz, do you think an input at 450 cps is more likely to cause the current to (a) lag by 89°, (b) lead by 45°, (c) lag by 15°?

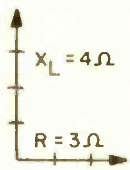
Q15. Draw vector lines representing 3 ohms of resistance (R) and 4 ohms of inductive reactance (X_L) on a sheet of paper.

Q16. Complete your vector diagram to find the impedance presented by the 3 ohms of resistance and 4 ohms of inductive reactance. Measure the diagonal.

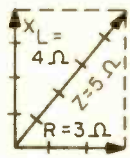
Your Answers Should Be:

A14. Current is most likely to (c) lag by 15°.

A15. You should have drawn vector lines that look like this.



A16. Your vector diagram should look like this. Z is 5 ohms.



Relationship of X_L, R, and Z

One simple way to find the overall effect of 3 ohms of resistance and 4 ohms of inductive reactance is to draw a line 4 units long pointing downward. This line represents the inductive reactance. Then draw a line to the right 3 units long. This line represents the resistance. The two lines form two sides of a rectangle. The diagonal of this rectangle will represent the impedance.

Notice the angle between the R and X_L vectors. This angle is usually indicated by the Greek letter **theta** (*θ*) and is referred to as the phase angle.

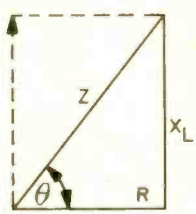
It is not enough to say that a circuit has an impedance of 5 ohms; you must also know the angle by which the current and voltage are out of phase. There are two ways to do this. You can express impedance in polar form, Z/θ. In the example above, Z is 5. Or you can express the impedance as the sum of 3 ohms resistance plus 4 ohms inductive reactance. A short way of saying this is

TRIGONOMETRIC RELATIONSHIPS OF X_L, R, Z

$$\tan\theta = \frac{X_L}{R} \text{ or } R = \frac{X_L}{\tan\theta}$$

$$\sin\theta = \frac{X_L}{Z} \text{ or } Z = \frac{X_L}{\sin\theta}$$

$$\cos\theta = \frac{R}{Z} \text{ or } Z = \frac{R}{\cos\theta}$$



3 + j4. The j tells you that the 4 is 90° behind the 3. In general $Z = R + jX_L$. This is the **rectangular** form of impedance. Although you can find impedance by drawing vector diagrams and measuring, there are other ways of finding the value of impedance.

As long as θ remains the same, the proportion between reactance and impedance will be the same. The proportion between resistance and impedance and between reactance and resistance will also be the same.

When any two facts about a combination of X_L and R are known, the other facts can be found by using a table of **trigonometric functions**. You can find a table of trigonometric functions in any mathematics textbook.

Using the above relationships, the impedance of an inductive circuit for which X_L is 7 ohms and R is 10 ohms can be found.

$$\tan\theta = \frac{X_L}{R} = \frac{7}{10} = 0.700$$

$$\theta = 35^\circ \text{ (from table); } \sin\theta = 0.574$$

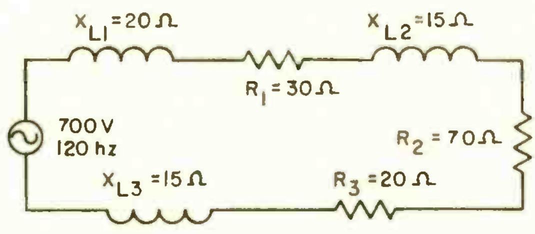
$$Z = \frac{X_L}{\sin\theta} = \frac{7}{0.574} = 12.2 \underline{/35^\circ} \text{ ohms}$$

Q17. What happens to θ if both R and X_L are doubled?
Q18. What happens to Z if both R and X_L are doubled?
Q19. What happens to R and X_L if Z stays the same but θ is increased?
Q20. What is θ if R is 17.33 ohms and X_L is 10 ohms?
Q21. What is Z for Q20?
Q22. If R is 12 ohms and θ is 30°, what is Z?
Q23. If X_L is 20 ohms and θ is 30°, what is Z?

Your Answers Should Be:
A17. If you double both R and X_L, θ remains the same.
A18. If you double both R and X_L, Z is doubled.
A19. If θ is increased, X_L becomes larger and R smaller.
A20. $\tan\theta = X_L/R = 30^\circ$
A21. $Z = X_L/\theta = 20 \underline{/30^\circ}$ ohms
A22. $Z = R/\cos\theta = 13.9 \underline{/30^\circ}$ ohms
A23. $Z = X_L/\sin\theta = 40 \underline{/30^\circ}$ ohms

Current in an RL Circuit

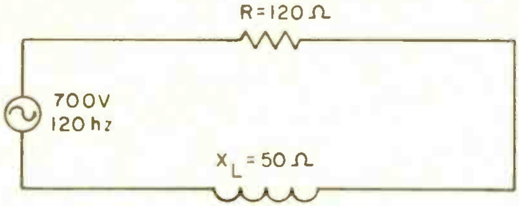
When inductors and resistors are connected in series in a circuit, simply add all the inductive reactances and all the resistances separately to get an equiva-



lent circuit with one inductive reactance and one resistance.

If it is necessary to find the impedance of this circuit, begin by simplifying it.

Even though X_L and R values are scattered through the series circuit, they may be added directly. Thus,

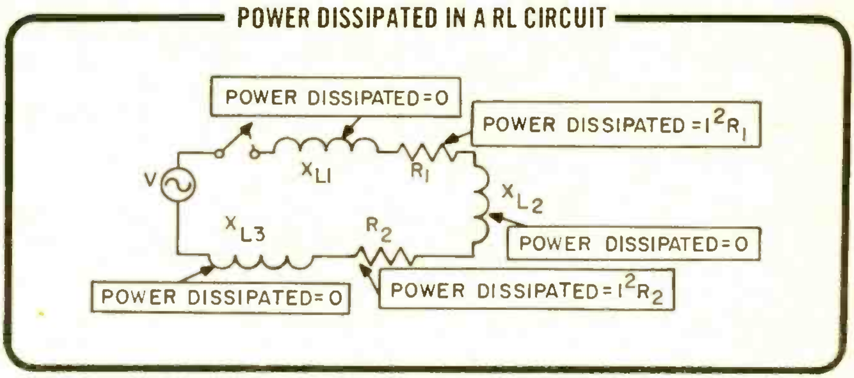


$$X_{L\ TOTAL} = X_{L1} + X_{L2} + X_{L3} = 20 + 15 + 15 = 50 \text{ ohms}$$
$$R_{TOTAL} = R_1 + R_2 + R_3 = 30 + 70 + 20 = 120 \text{ ohms}$$

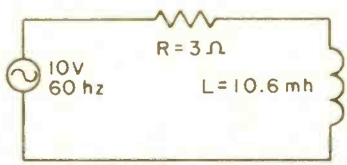
The circuit on page 94 is equal to this equivalent circuit.

POWER IN RL CIRCUITS

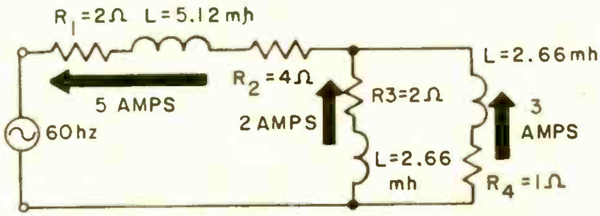
All power is dissipated in resistance. You have also learned that the formula for power is $P = I^2R$. This is only the formula that should be used to find power in AC systems.



Go through all the steps necessary to find the power dissipated in the following circuit. (See Q24 through Q27.)



Q24. What is the inductive reactance of the coil?
Q25. What is the impedance of the circuit?
Q26. How much current flows through the circuit?
Q27. How much power is dissipated in the circuit?
Q28. Here is a more complicated circuit. Notice how the current divides in the parallel parts. Kirchhoff's law is used to determine how the current divides. How much power is dissipated in this circuit?



Q29. Suppose a 4-henry filter choke and a 2,630-ohm resistor are wired in series across the terminals of a transformer that supplies 15 volts at 60 hz. Draw a schematic of the circuit.
Q30. How much current will flow in the circuit?
Q31. How much power will be dissipated by the resistor?

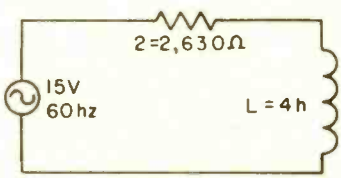
Your Answers Should Be:

A24. $X_L = 2\pi fL = 4$ ohms (approx)
A25. $Z = 5/33^\circ$ ohms
A26. $I = \dfrac{E}{Z} = 2$ amperes
A27. The power dissipated is: $P = I^2R = 12$ watts
A28. Since the current is known, the inductors can be disregarded. Use $P = I^2R$ to find the power dissipated in each resistor.

$$P_1 = 5 \times 5 \times 2 = 50 \text{ watts}$$
$$P_2 = 5 \times 5 \times 4 = 100 \text{ watts}$$
$$P_3 = 2 \times 2 \times 2 = 8 \text{ watts}$$
$$P_4 = 3 \times 3 \times 1 = 9 \text{ watts}$$

TOTAL 167 watts

A29.



A30. $X_L = 1{,}057$ ohms $I = \dfrac{E}{Z} = \dfrac{15}{3{,}000} = 5$ ma (approx.)
$R = 2{,}630$ ohms
$Z = 3{,}000/30^\circ$ ohms (approx.)
A31. $P = I^2R = 0.072$ watt

WHAT YOU HAVE LEARNED

1. Series and parallel inductive reactances can be combined in the same way as resistances.
2. L/R is the time constant of an RL circuit and indicates the time in seconds it takes a pulse to reach 63% of its maximum value.
3. Q is the ratio of X_L to R in a coil.
4. The phase angle in an AC circuit is determined by the proportions of X_L and R.
5. X_L and R are added vectorially to find impedance.
6. Impedance may be expressed as Z/θ or $R + jX_L$.

NEXT ISSUE: Part 10—Understanding RC Circuits

This series is based on material appearing in Vol. 2 of the 5-volume set, BASIC ELECTRICITY/ELECTRONICS, published by Howard W. Sams & Co., Inc. @ $19.95. For information on the complete set, write the publisher at 4300 West 62nd St., Indianapolis, Ind. 46268.

Hey, look me over

Continued from page 12

Fisher RC-80 Cassette Deck

deck to their line of quality hi-fi components. The RC-80 incorporates the ingenious Dolby noise reduction system that enables a tiny 1-⅞ *ips* tape to sound better than professional reel-to-reel recorders. The RC-80's frequency response ranges from 30 to 12,000 Hz, thanks to unusually careful design of heads, as well as advanced solid state circuitry. A newly designed tape transport mechanism with a DC drive motor has virtually put an end to wow and flutter. The RC-80 also features convenient slide controls for level setting, two VU meters for stereo recording, key-type operating controls, automatic shut-off. The price: $199.95. Get all the facts from Fisher Radio Corp., 71-40 45th Rd., Long Island City NY 11101.

Circle No. 36 on Page 17

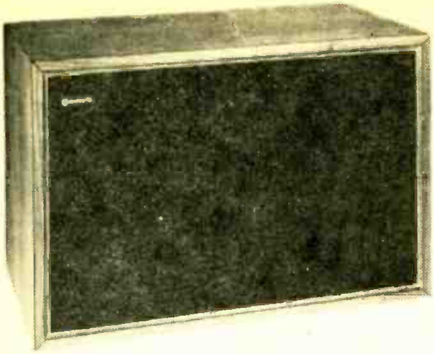
EICO TH-30 Treasure Hunter

Both ferrous metals (iron, steel, tin) and non-ferrous (gold, silver, copper)—to a depth of up to 6 inches—are ferreted out by EICO's new model TH-30 Solid-State Detector Kit, $29.95. As the "Treasure Hunter" approaches the search area, the presence of burried coins, underground and building pipes, etc., heightens the pitch of the audio-frequency beat note heard through the built-in speaker. Engineered for long-term trouble-free performance, the EICO TH-30 comprises an all-solid-state circuit design, powered by a single 9-volt battery. EICO Electronic Instrument Co. is located at 283 Malta Sreet, Brooklyn, NY 11207.

Circle No. 37 on Page 17

A Real 4 Stacker

Lafayette's new Criterion 4X deluxe bookshelf speaker system has four separate speakers, each a brilliant performer over its assigned range. Components include a big 12 in. woofer with 4½ lb. magnet structure and 2 in. voice coil good down to 25 cycles; and rigid fiber glass-filled enclosure with tube type ducted port; 5 in. mid-range with fiberglass-filled chamber; 3" speaker from 5,000 to 10,000; and a 1½ in. super tweeter from 10,000 to 20,000 Hz. Includes high frequency and mid-range controls which permit adjustment of the tonal response, and polarized input terminals. Handsome, deluxe oiled walnut enclosure gives the look of



Lafayette's Criterion 4X Speaker System

fine furniture. Capacity: 50 watts. Price: $69.95. Available from Lafayette Radio, 111 Jericho Turnpike, Syosset NY 11791.

Circle No. 38 on Page 17

Safety First

Kalimar has just introduced a new safety device that should be in every room in your home, office, and factory; and should also be

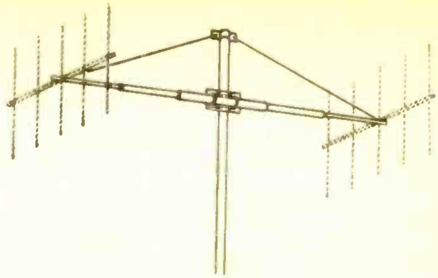
Kalimar Fire Alarm

carried with you on those out-of-town trips. No batteries or springs are needed. Just plug into any 110-volt AC outlet. When room temperature reaches 140°F., a loud *BUZZ* will alert you to take action. Sells for $9.95. Available through Kalimar Inc., 2644 Michigan Ave., St. Louis MO 63118.

Circle No. 39 on Page 17

Doubling Up

A universal stacking kit has been introduced by The Antenna Specialists Company. When used with a pair of 3, 4, or 5 element beams or quads, the result is an additional gain of 3 db (the equivalent of doubling the transceiver's power output). The stacking arrangement also results in a narrowed beam path which allows the operator to "zero in" on the received signal more precisely and also eliminate many interfering signals that are off the



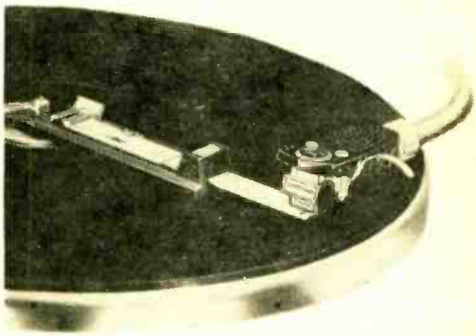
Antenna Specialists Stacking Kit

beam path. Supplied with the stacking kit is a phasing harness that allows easy matching and hookup of any pair of conventional beams or quads. Suggested price of the stacking kit, model M-205, is $49.95. Complete information is available from local A/S dealers or by writing to The Antenna Specialists Company, 12435 Euclid Avenue, Cleveland OH 44106.

Circle No. 40 on Page 17

Feather Weight

Hi-fi buffs concerned about the danger of excess stylus pressure destroying their valuable records will appreciate a new ultra-accurate stylus force gauge announced by Shure. The design of the new Shure Model SFG-2 stylus force



Shure SFG-2 Stylus Force Gauge

gauge is based upon a positive counterweight balance principle. There are no springs to weaken or wear out. It is designed to measure stylus pressure with the tone arm in actual playing position and is accurate to within 1/10 of a gram in the optimum tracking range of ½ to 1½ grams. List price of the Shure Model SFG-2 is $4.95. For additional information, write: Shure Brothers, Inc., 222 Hartrey Avenue, Evanston, IL 60204.

Circle No. 41 on Page 17

One of the best sources for information on New Products is the advertisements seen in this magazine. Why not look at them, then circle the appropriate service number on page 17—our Reader Service Page?

Newscan

Continued from page 79

fer gate. The function of the transfer gate is similar to that of a sluice gate in a water system, controlling the transfer of water between reservoirs of different levels.

The higher level corresponds to the source electrode; the lower level to the receiver. The effort required to operate the sluice gate in the water system is only a fraction of the total energy released. Similarly, only a small amount of charge on the transfer gate is required to control the transfer of a much larger charge across the Surface Charge Transistor. Amplification of both charge and voltage is possible with the new circuit element. This amplified output is electrically isolated from the input and thus the structure is referred to as a transistor.

A series of Surface Charge Transistors can be easily linked to form a shift register, a basic component in computer memories. In this application, the circuit elements are merely placed adjoining each other along the surface of a silicon chip, with the receiver electrode on one unit serving as the source electrode of the next. ■

DX Central Reporting

Continued from page 16

from 780 to this new spot, where medium wave listeners, particularly in the east and south, have a chance to hear its "Radio 900" identification announcements. **5,010**—One of the rarer stations from West Africa is Radio Garoua, Cameroon, which has been reported by several listeners lately. Programming usually is in French, but don't be too surprised to hear Arabic music and chants until 2200 s/off. **5,980**—From the far, far north come the shortwave signals of Grønlands Radio Godthab, Greenland, a good catch in anyone's log book. You may hear them signing on around 1015 if you can roll out of bed that early. **7,235**—A lot of listeners have been looking for the Solomon Islands Broadcasting Service, but were stymied when they only used the hard-to-hear 3,995 outlet. After a brief sojourn on 7,115, SIBS has moved here and is audible before dawn. **9,770**—Need Austria in your logbook? Try Austrian Radio at 0030, when they are broadcasting in English news at 1540. **15,365**—Here's another they used to say on the old "Blondie" radio show. Try the same frequency around 1400, when you should hear the Haitien missionary station, 4VEH in English with a kiddie show. **11,940**—Radio Singapore, from the island nation in Southeast Asia, may be heard here with English news at 1540. 15,365—Here's another frequency to try for Radio Espana Independente, mentioned above. Listen at sign on time, 0200. (Credits: Gordon Nelson, Mass., Alan Roth, Conn., Jerry Berg, Mass., George Schnabel, N.Y., Bob Zilmer, Wis., Woody Seymour Jr., North Carolina, Stewart MacKenzie, Cal., Ed Shaw, Virginia, National Radio Club, Box 99, Cambridge, Mass., 02138, American SWL Club, 16182 Ballad Lane, Huntington Beach, Cal., 92649)

Backtalk. Craig Masters of Ft. Wayne, Indiana, writes about a strange new station he heard recently on about 13 mHz.

"At first I thought it was WWV's time clock, because of the ticking, but I was wrong. At intervals of one or two minutes, the announcer said, 'This is KC2XIO. These experimental transmissions are not on a continuous basis.' No location was given. I need help!"

You came to the right place, Craig. First, you weren't far off when you guessed it was WWV, the National Bureau of Standards' time and frequency station. Last June, NBS received authorization to broadcast, daytime only, from KC2XIO. Its purpose is to test different broadcast formats. NBS is anxious to improve the usefulness of WWV and its Hawaiian counterpart, WWVH. Hence the experiments.

Secondly, the station is located at Ft. Collins, Colorado. Transmissions began last July 9, on a single frequency, 13.560 kHz., plus or minus four kHz., from a 10 kilowatt WWV standby transmitter. KC2XIO probably will end these tests before spring.

Great Men of Science

Continued from page 78

at the time.

The second process, triggered by presence of minute quantities of the then-unknown isotope U235, is atomic fission.

In a primitive laboratory Enrico Fermi had split the atom—but didn't know it. Even when he was awarded the 1938 Nobel Prize for physics the full impact of his work wasn't recognized.

To escape the Fascist government, Fermi fled the country. He came to the U.S. and joined the faculty of Columbia University.

With his wife Laura he soon went to the pier to meet another incoming scientist in exile—Niels Bohr, of Denmark. Bohr brought news about the way Otto Hahn and Fritz Strassman had gone about effecting nuclear fission.

Working as a key member of the Manhattan project, Fermi embarked on a search for ways to achieve a controlled chain reaction among atoms.

He was an enemy alien, not eligible for U. S. citizenship. Still he was invited to join a team headed by Arthur H. Compton. Compton, Fermi, and their colleagues worked in secret under a tight security cover. In this climate they built the world's first atomic pile in a squash court at the University of Chicago.

Controlled reactions within that atomic pile prepared the way for creation of the first A-bomb . . . and also for mass production of radioactive isotopes.

Fermi brooded over destructive forces of atomic power, but predicted that the forces he had helped unleash would prove more important in peace than in war. They might even help to usher in a new era of health for all mankind.

Fermi didn't live to see that era unfold. Cancer of the stomach claimed him at 53—in the early dawn of the period during which radioactive isotopes were put to work saving lives of persons whose malignancies are discovered at early stages. ■

Bookmark

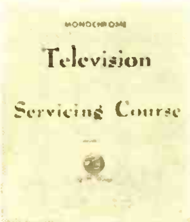
Continued from page 14

rect, taking into account both electrical and physical parameters (size, shape, and lead configurations). In case you didn't know, H. A. Middleton is also author of the widely used tube substitution guide, *Tube Caddy*. The handbook is published by Hayden Book Co., 116 West 14th Street, New York, N.Y. 10011.

Circle No. 45 on Page 17

TV Fix-it Course

Monochrome Television Servicing Course by M. N. Beitman is now available—totally revised and updated, the new edition is based on an old favorite that sold in the hundreds of thousands. It is intended to bring to servicemen with radio repair experience, practical television knowledge needed to repair monochrome (black-and-white) TV sets. Starting with hints on simple TV repairs using picture faults as a guide, the course covers all topics including understanding transmitted signals, antennas, circuits, alignment, and a complete study of tube and transistor sets. Published by Supreme Publications, 1760 Balsam Rd., Highland Park IL. ■



Soft cover
160 pages
$3.00

Circle No. 46 on Page 17

Wheatstone

Continued from page 77

sensitivity of the meter and permit you to obtain a better balance. Finally, pushing the last pushbutton connects the meter directly across the bridge without any protective resistors in series, giving maximum sensitivity and accuracy.

The voltage of the battery used to power the bridge is not critical. However, the lower the voltage used, the less sensitive the bridge becomes, especially on the high-resistance ranges. On the other hand, high voltages force excessive currents through the resistors in the bridge, especially on the low-resistance ranges. These currents can damage the unknown or the calibrated variable resistor. A good compromise for the values shown is provided by a voltage of around 3 volts. At this voltage, the 10-ohm resistor should have a one-watt rating; at 1.5 volts, a ¼-watt unit may be used. At these low voltages, however, the "X 100" range should be omitted, because the balance point becomes so broad that it is undetectable.

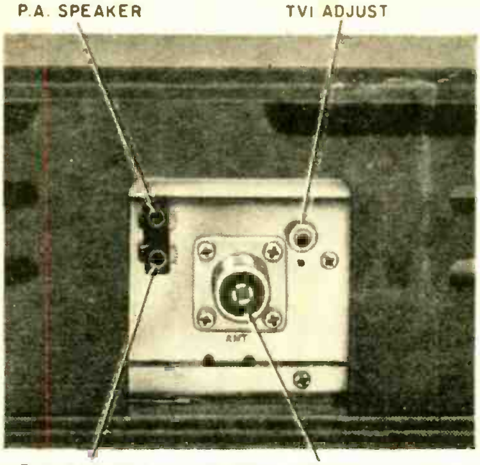
To avoid the compromise, another deck can be added to the selector switch to automatically provide higher voltages for the higher ranges. Up to 20 volts can be used in any range above "X 1". Yet another alternative is to use a vacuum-tube voltmeter as the detector, which makes the balance point for the "X 100" range easily detectable, even with a 1½-volt battery powering the bridge.

Remember that the bridge will drain the battery even when not in use, so a switch should be included to disconnect the battery when your measurements are completed.

Well over a century separates Wheatstone and Christie from the present day, but you can bridge those years, electronically, as you find that their concise and clever circuit still does an excellent job in the integrated circuit era. ■

Kathi's CB Carousel

Continued from page 69



Gee whiz, I wish more transceiver rear panels were this easy to figure out! With only three jacks, one knob, you can't go wrong.

only-12 dB. It took a little more voice level than average for 100% modulation, but there's a very effective limiter preventing overmodulation—even if you shout!

The *Courier Citation* rig proves that you can't tell a CB rig by its cabinet. I've seen professional-appearing rigs that are guaranteed to sit in the CB dugout—and do nothing else. The *Courier Citation*, on the other hand, is an attractive transceiver selling for $199 that'll earn you home runs on the Citizens Band. For more information describing the *Courier Citation* circle number 31 on the Reader Service Coupon located on page 17. ■

"Say, 'Buzzz . . . zap . . . click'!"

Prophet Goddard

Continued from page 32

the gas evolved, or the change in mass producing the desired result."

In the *Ultimate in Jet Propulsion*, Goddard updated his view. "It has long been known that protoplasm can remain inanimate for great periods of time and can also withstand intense cold if in the granular state. In this connection, it may be pointed out that quick freezing of food products as a technique is at least suggestive. Furthermore, Drs. John Field II and Frederick Fuhrman, physiologists, have recently found that cold does not cause the killing of brain cells. Perhaps, this latter is a hint of a solution . . ." As an alternative, Goddard mentioned the possibility of enclosing granular protoplasm and sending it out of the solar system there to create intelligent life—the protoplasm being of such a nature as to produce human beings, in time, by evolution.

A New Plymouth Rock. Goddard predicted that, in one state or another, men eventually would set out as did the pilgrims in the early voyages to New England in search of a new home. They would carry with them as much as they could of all human heads in as light, condensed, and indestructible a form as possible so that a new civilization might begin where the old one ended.

This then is Goddard's imagination, unfurled like his solar sail, reflecting everything within its great range—an imagination that could carry mankind through galaxies. If this still seems like Jules Verne or Buck Rogers, there is an important difference—Goddard not only thought and wrote about the most advanced ideas in space science but also explored most of them mathematically, developed detailed theories, and then drew detailed designs for them.

Apollo 11 brought to realization much of Goddard's research and testing. The moon landing itself flipped pages of his ideas from fiction to fact and lent considerable credibility to his ideas for interplanetary travel, intergalactic exploration, and the last migration of the human race.

Certainly, Goddard was one from the earliest and most significant architects of Apollo. Dr. Wernher von Braun, director of NASA's George C. Marshall Space Flight Center and the man most responsible for the development of the Saturn 5 and other space program rockets is quick to point out Apollo's "debt" to Goddard's work. He stresses the importance of Goddard's 214 patents, stating that "Many of these were for components that have become standard today. He introduced, among other things the gyroscope control, turbopump-fed liquid-propellant engines, regeneratively cooled engines, and the gimballed engine mounting. All these proved essential to the later rockets that boosted man into space, and without them Saturn 5 simply would not have been possible. It can be said that Goddard did most of his basic research that made possible such rockets as Saturn 5."

Von Braun feels that Goddard's greatest single contribution was proving that liquid-propellant rockets could be built and would fly. Goddard's 1926 test, conducted with homemade rocketry hardware and carried out on the basis of theories he pieced together, was a modest beginning for the space age. The liquid-fueled rocket rose only to a height of 41 feet, but it was the first burst skyward in man's 238,000-mile journey to the moon. For this Goddard was rewarded with verbal abuse, derision, snickering, and indifference. As a result, he became increasingly secretive and shy in public, devoting himself to the realization of a dream rather than answering his critics. History now reflects on the test in terms as epochal as the Wright brothers' first flight at Kitty Hawk.

Now He is Gone! His widow Esther explains her husband's plight this way: "Granted he couldn't talk about space travel, even though he knew it was coming: granted he could only hint at the moon, though he knew that was coming: granted, then, he couldn't talk about what was closest to his heart. What outlet, then? First, he could write about it privately, which he did, and he could patent his ideas, which would someday point out *cognoscenti* what he had in his heart—which they did. He was sure they would not come true in his time. But it was precisely these patents that would tell scientists that they had a forerunner who had understood what they could live to accomplish. They were his messages to the future."

On the day the Apollo 11 crew returned from its magnificent mission, Mrs. Goddard was overjoyed. But, like her husband, she looked to the future. "Now that this has been attained, perhaps his further dreams as found in his papers may be met with less elevating of the eyebrows. I am blessed to have seen part of his dream fulfilled today. I can do no less than express the conviction that the rest will follow." ■

Stamp Shack

Continued from page 22

pendent telephonic systems, posed many problems. But with serious cooperative efforts, it now is possible for a subscriber in any one nation of the European Telecommunications Union to reach a number in some other nation without having to go through an international long-distance operator.

● The one-shilling denomination is another

Great Britain 1/-Pulse Code Modulation

"mysterious" stamp design with a series of horizontal dashes flanked by wavy lines with small, circular dots. This one is supposed to suggest Pulse Code Modulation. Invented by A. H. Reeves in 1937, it was only recently that its operation was made possible by the introduction of transistors.

● PCM was developed by the post Office primarily for use on telephonic junction cables between 10 and 20 miles in length. Its high resistance to cross talk and noise disturbances makes it especially suitable for use in urban areas. By it, speech is sampled 8,000 times per second at the sending end, and converted to pulses sent along the line at the rate of 1½ million per second. Watertight transistorized repeaters along the route maintain the pulses until they reach the receiving terminal and converted back into speech.

● The 1½-shilling, and fourth value of the set has the clearest design of all. It shows a batch

Great Britain 1/6 Sorting Machine

of letters passing through an automated sorting machine, falling into boxes for more rapid distribution.

● Ever since two Dutch engineers inj 1935 injvented their Transorma—a huge device by which clerks, scanning addressed envelopes, could sort mail by punching numerical keys something like an adding machine—postal authorities all over the world looked to automation.

● Today, automated sorting and postmarking machines are used in many parts of Europe, the Americas and other parts of the earth. Key to the success of these machines is a luminescent chemical with which stamps are coated, or which has been added to paper or ink. Extremely sensitive scanners are fed with mail tonnages at offices that have the machines. They read the stamps and automatically "face" each envelope, turning or flipping them faster than the eye can see until all—when they reach the last compartment—are in the same position to be properly postmarked. They then are read a second time and dispatched to their destination. This operation is no cheap matter; the machines cost millions and require expert control manpower. Once coding is more universally adopted (they call it "Zip" Code in the U.S. and Canada; "Postcode," elsewhere) these behemoths will scan envelopes for this code as well and eventually eliminate the necessity of human, manual sorting-distribution—a dream postal authorities hope will be completed by 1975. ■

En Passant

Continued from page 25

sight of the board and pieces!

News and Views. The United States Team finished 4th in the 19th Chess Olympiad at Siegen, West Germany, last September. Scoring 24½ points behind USSR, 27½, Hungary, 26½, and Yugoslavia, 26, the performance was a great disappointment as the team was headed by Fischer and included Reshevsky, Benko, Evans, Rev. Lombardy, and Mednis. Except for Robert Byrne, the outfit was at full strength.

Grandmaster Robert J. Fisher of Los Angeles, whom statistics prove to be the strongest player in the world at the present time, has agreed to compete in the 8th FIDE Interzonal Tournament in Palma de Mallorca during November. Expert politicing in FIDE meetings and the proper persuasion of RJF was needed to bring about this desirable happening. The Interzonal is the second step in a qualification cycle to the world championship, now held by Boris Spassky of the USSR.

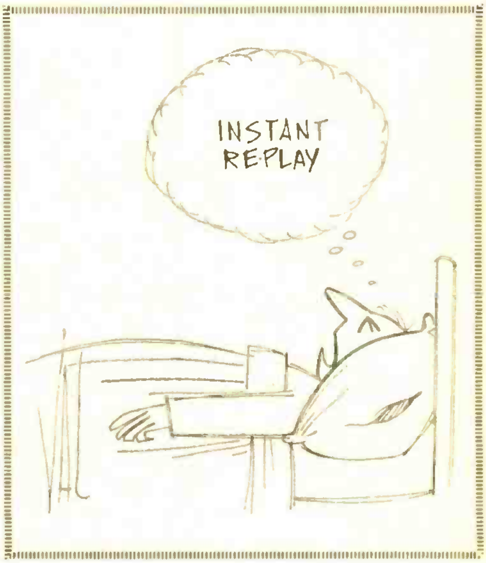
The United States won the World Student Team Championship held at Haifa, Israel, during August. No communist countries participated. Our boys - Kenneth Rogoff, Michael Sienkiewicz, Andrew Soltis, James Tarjan, Richard Verber and Marc Yoffe—scored 27½ to finsh ahead of England, 26½ West Germany, 26, and Israel, 22. Hats off!

Lubomir Kavalek, USCF Senior Master, of Maryland, formerly of Czechoslovakia, (a great new asset to American chess) took top honors with 13-4 in the recent international tournament at Caracas. Other U. S. entries were Benko, 4th, Bisguier, 9th and Addison, 11th.

International Grandmaster Robert Byrne of Indianapolis won a record breaking (394 entrants) Atlantic Open in New York last summer. He amassed 7-1 (two draws) to pocket the $1000 top award. Placing 2nd though 5th with 6½-1½ were: R. Blumenfield, W. Browne, Eugene Martinovsky, and Orest Popovych.

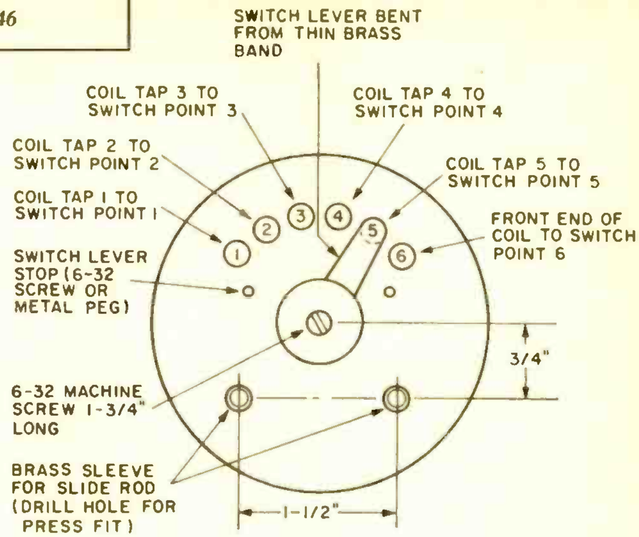
Kenneth Rogoff, 17, of Rochester, N.Y. a USCF Master, won the 1970 U.S. Junior Championship with a 5½-1½ score. A. Deutsch, 5-2, was 2nd, and E. Meyer, 4-3, came 3rd. Having won the title in 1969 too, Rogoff becomes the first one to be champion two years running.

Au Revoir En Passant. This is my last column. Editor-in-Chief Julian M. Sienkiewicz advises there is insufficient reader interest to warrant its continuation. Unfortunately, it has not obtained the acceptance we though it would when it began 29 issues ago. I have enjoyed doing the column for Elementary Electronics and hope some of you have found it entertaining. For those of you who might like to follow my writings I suggest you read "Postal Games" and "Games By USCF Members" in "Chess Life & Review," the official organ of the United States Chess Federation. The magazine, a monthly, is available at newstands, or may be subscribed to by writing to the United States Chess Federation, 479 Broadway, Newburgh, N.Y. 12550. Have fun with chess and farewell. ■



Loose Coupler

Continued from page 46



Layout for hardware on front end disc. Note holes for brass sleeves—they must be positioned accurately, then drilled perpendicularly to front end disc. Otherwise, secondary coil might not slide completely into primary coil.

dry goods store! Ask for two pairs of $\frac{3}{16}$-in. diameter, brass curtain rods, each rod at least 18 inches long. Cut two rods down to about 16½-in. overall length, threading each with a 10-24 die.

The length of the rod's threaded portion isn't critical: two inches on both ends of each rod does the trick. And you'll probably want to drill the end support holes for both slide rods slightly oversize. Reason is this insures that the secondary coil assembly will glide smoothly over the rods when they're adjusted. (Otherwise, any mechanical eccentricity in either pair of end supports or slide rods can't be corrected, and you won't be able to push the secondary coil more than halfway into the primary coil). Assemble both secondary rods and secondary coil tube form as our diagram shows. After you've aligned the rods, tackle the primary coil slide tube.

The author fabricated his primary coil slide tube from a piece of $\frac{7}{32}$-in. O.D. square brass tube. But for simplicity's sake, make your tube from another length of curtain rod.

After cutting a rod down to seven inches, you drill a hole in both ends. Then fasten the slider to both end supports as shown. Although the author made his own primary tube slider, it's a heck of a lot easier if you made your slider from the same brass material you need for the secondary coil slider.

Countdown to Hookup. By now you should be well on your way toward completing your loose coupler's construction. And by now you've also strung up a *very long* wire antenna—that's one of the keys to a loose coupler's success.

Referring to our schematic of the complete receiver, you'll see that the loose coupler appears as a crystal rig. You're right! While it looks like a free power rig's schematic, the loose coupler far outpaces the ordinary crystal radio by virtue of its super-selective secondary coil. And, with a 365 picofarad variable capacitor tied across the coupler's secondary coil, you can tune this rig between 2 MHz and 300 kHz. No superhet can match this kind of bandspread in one sweep of its tuning knob!

Although the loose coupler is a reasonably sensitive and selective rig as we've presented it, you can extract outstanding performance from it by adding two variable 365 picofarad capacitors. The first capacitor is soldered in parallel with the primary coil. And the second pico-picker is thrown in series with your antenna's hot lead. Now you can resonate both primary coil and antenna wire, respectively.

Many of you have never built a golden oldie like this one, so we suggest that you get the hang of this rig by starting out with the most basic circuit we've shown. After you've mastered the fundamentals, proceed to soup up your loose coupler's performance with the capacitors we've mentioned. And then get set for some of the most exciting DX perfomance this side of an Audion tube! ■

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