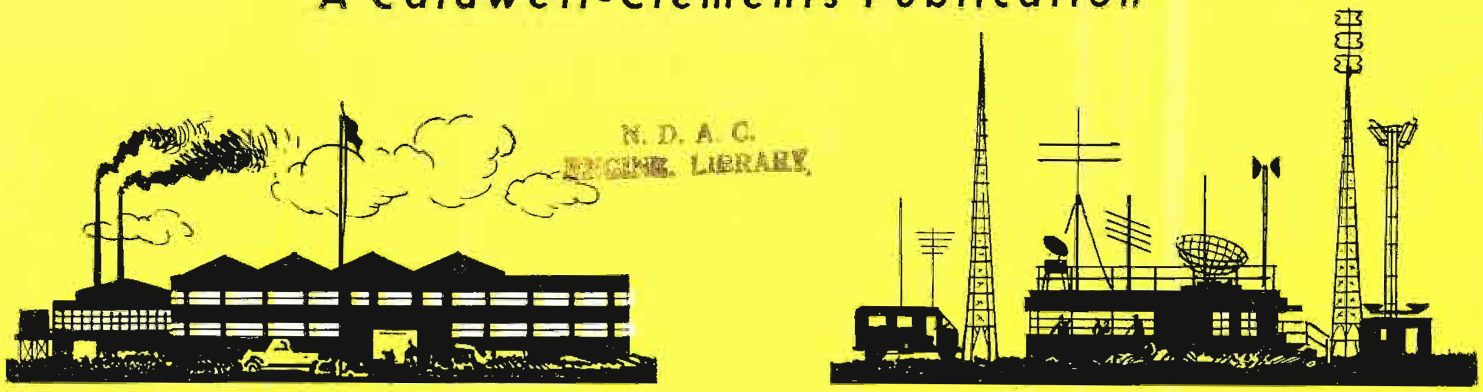
TELE-TECH

A Caldwell-Clements Publication



MANUFACTURING • ENGINEERING • OPERATING

4230
Radio-Electronic Manufacturers, employing

9850
Key Manufacturing Engineer Executives

490
Consulting Engineers

3270
Broadcast Stations, AM, FM & TV

3944
Key Broadcast Engineer Executives

1030
Broadcast-Station Applications Pending

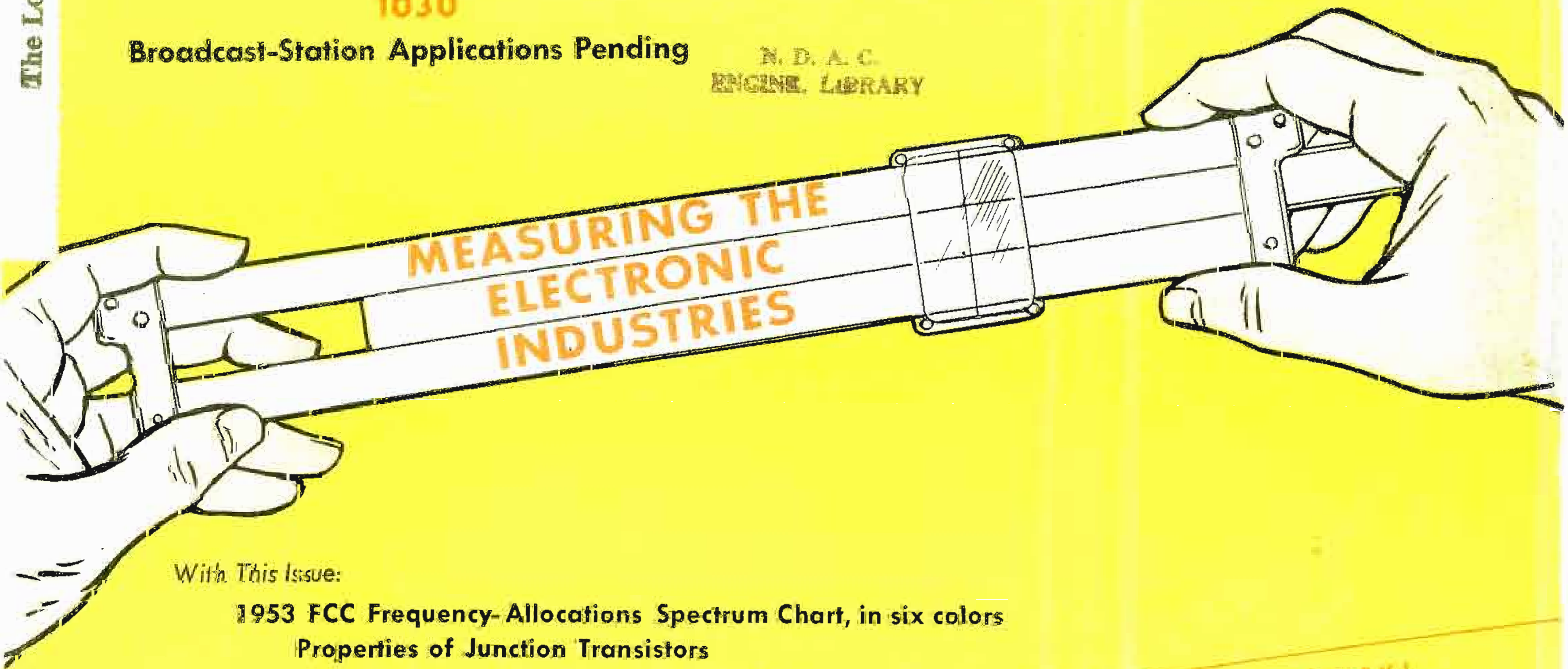
2937
Communications Engineer Executives

343
Film & Sound Recording Studios

1300
Armed Forces Engineering & Purchasing Officials (Air, Navy, Army)

600
Engineering-Sales Representatives ("REPs")

2000
Radio-Electronic Distributors



With This Issue:

1953 FCC Frequency-Allocations Spectrum Chart, in six colors
Properties of Junction Transistors
Statistics of the Electronic Industries

January • 1953

Admiral
Arvin
Capehart
CROSLEY
DEWALD
FADA
DUMONT
Emerson
General Instrument
GENERAL ELECTRIC
hallicrafters
Hoffman
JACKSON
Magnavox
Majestic
Meck
MIDWEST
Motorola
Olympic
Packard Bell
PILOT
RCA
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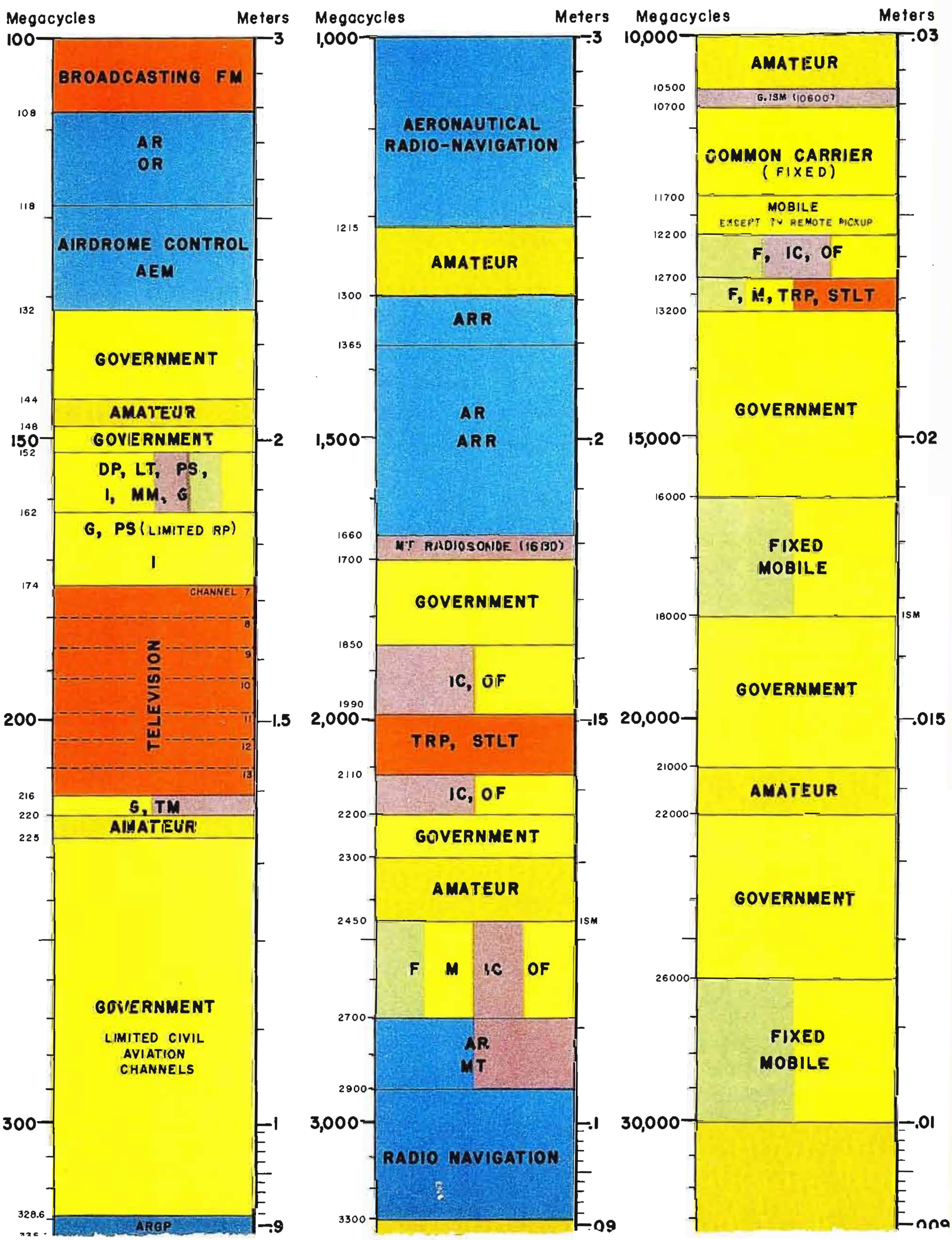
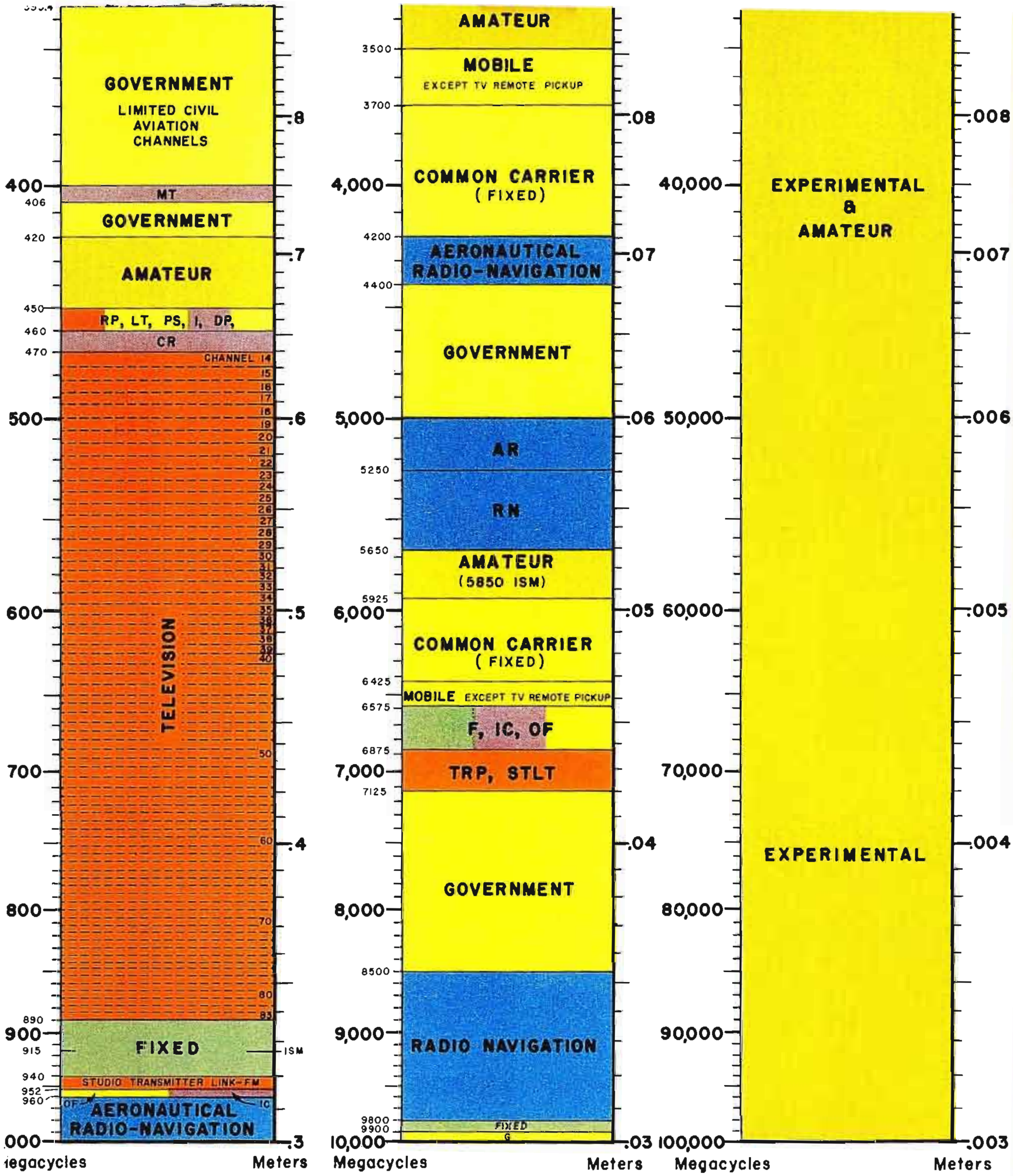
TELEVISION RETAILING & Technician

E = 1000 KILOCYCLES — ALL WAVELENGTHS ARE SHOWN IN METERS





Note: All allocations shown are final. The section from 2 to 25 megacycles is expected to become effective sometime during 1953.

ey to Chart Color Groupings

PUBLIC SERVICE | **MISCELLANEOUS** | **EXPERIMENTAL**

al

MMP Maritime Mobile Phone
MMT Maritime Mobile Telegraphy
MMCT Maritime Mobile Coastal Telegraphy
MMPC Maritime Mobile Phone Coastal
MMTC Maritime Mobile Telegraphy Calling
MRDF Maritime Radio Direction Finding
MMPDC Maritime Mobile Phone Distress and Calling
MMTDC Maritime Mobile Telegraphy Distress and Calling

OF Operational Fixed
OR Omni-Directional Radio Range
P Police
PS Public Safety
R Radiolocation
RN Radio Navigation
RP Remote pickup broadcast

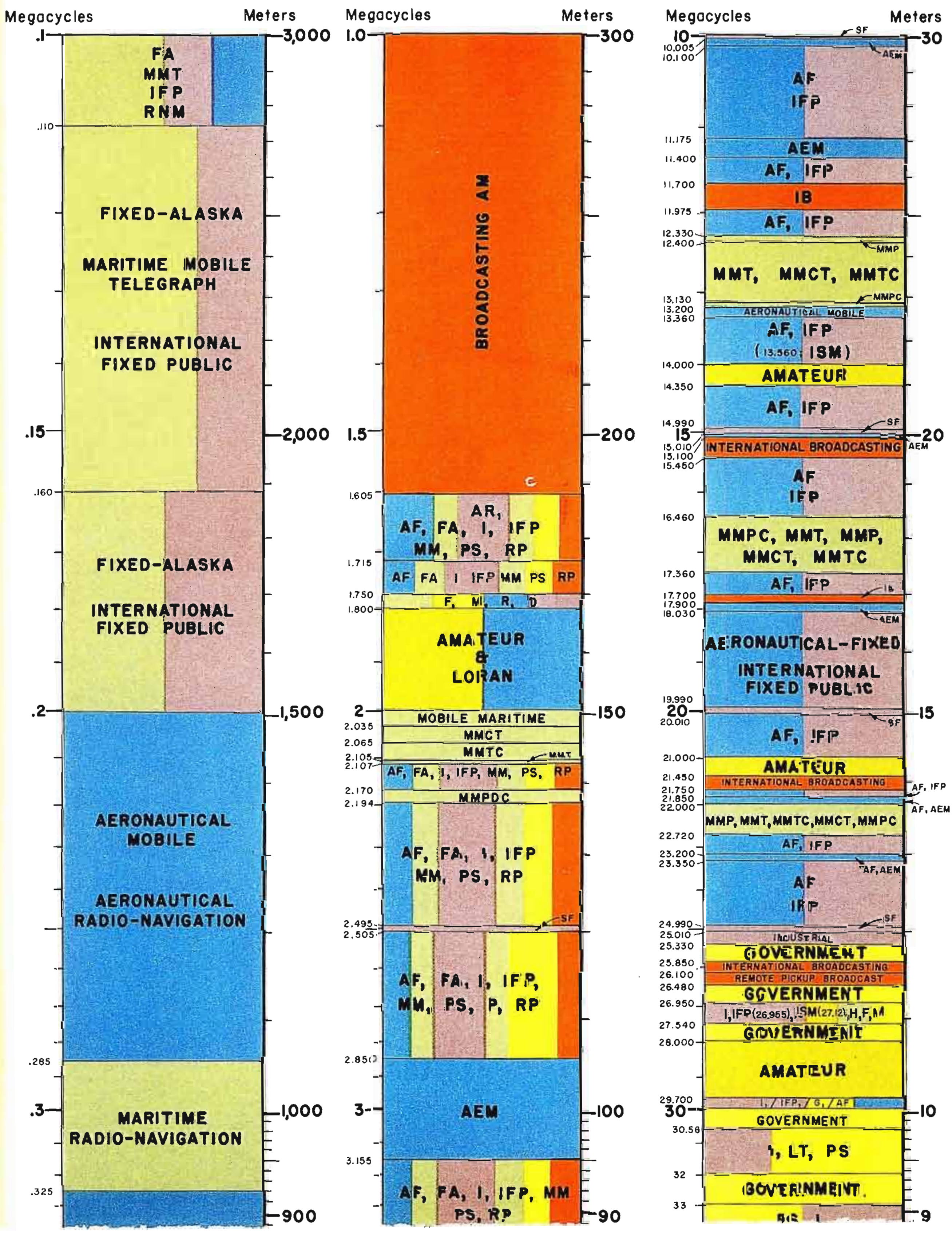
RNM Radionavigation Mobile
SF Standard Frequency Transmission
STL Studio Transmitter Link-FM
STLT Studio Transmitter Link-TV
TM Telemetering
TRP TV Remote Pickup
TV Television Broadcasting

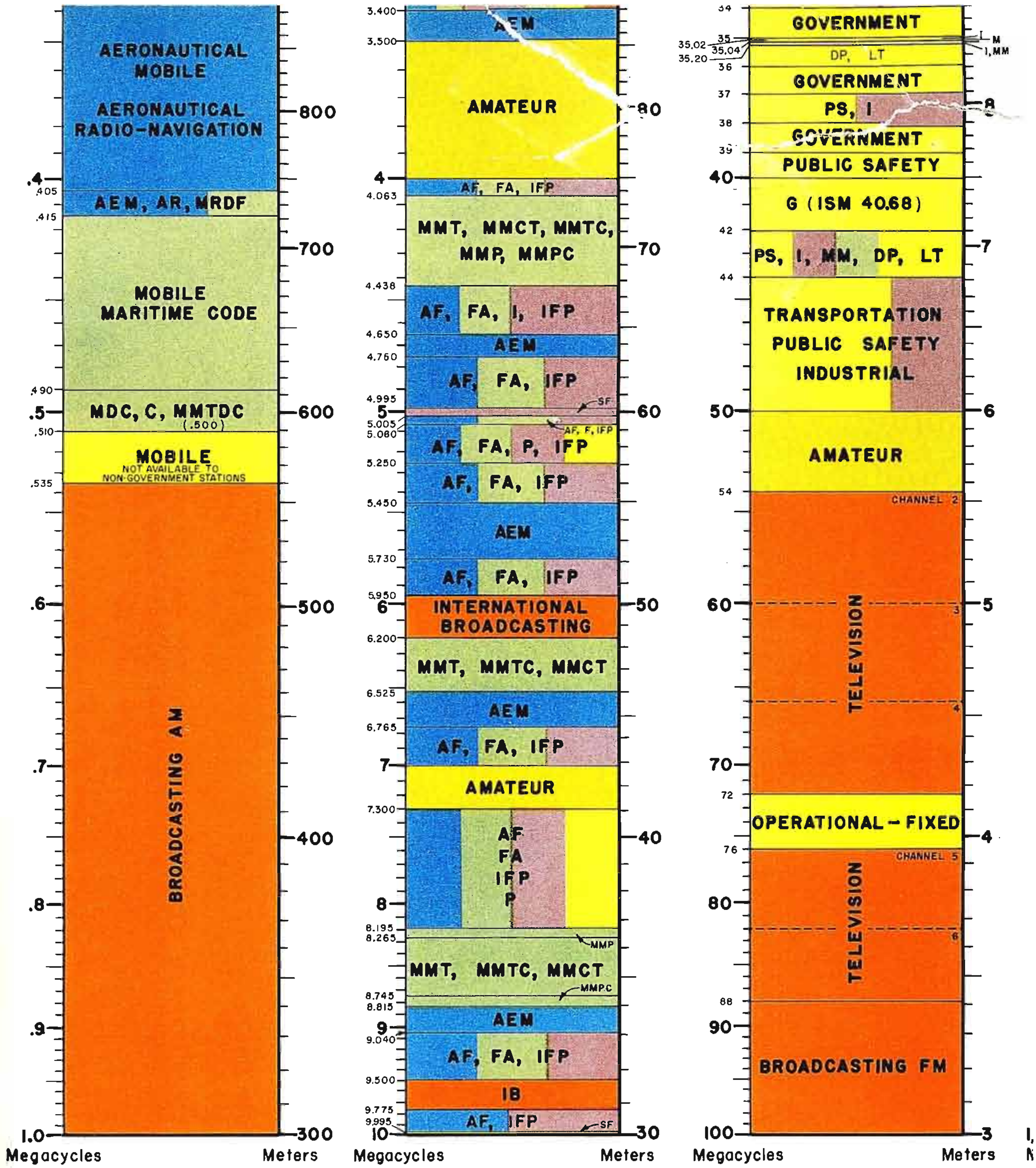
. INC., 480 Lexington Avenue, New York 17, N. Y.

TELE-TECH
& Electronic Industries

The 1953 S
FCC FREQUENC

ALL FREQUENCIES ARE SHOWN IN MEGACYCLES — ONE MEGACYCL





Index to Abbreviations and K

MARINE | **BROADCASTING** | **AERONAUTICAL**

AC	Airdrome Control	C	Coast	FA	Fixed-Alaska	ISM	Industrial Scientific Medic
AF	Aeronautical Fixed	CC	Common Carrier	FM	Frequency Modulation Broadcasting	L	Loran
AEM	Aeronautical Mobile	CR	Citizens Radio	G	Government	LT	Transportation
AR	Aeronautical Radio-Navigation	D	Disaster	H	Amateur	M	Mobile
ARR	Aeronautical Radio-Navigation Radar	DP	Domestic Public	I	Industrial	MM	Maritime Mobile
ARGP	Aeronautical Radio-Navigation Glide Path	EX	Experimental	IB	International Broadcasting	MT	Meteorological Aids
BAM	Broadcasting AM	F	Fixed	IC	International Control	MDC	Mobile Distress Calling
				IFP	International Fixed Public		

Supplement to TELE-TECH & ELECTR

ELECTRONIC INDUSTRIES

TELE-TECH

A Caldwell-Clements Publication

JANUARY, 1953

FRONT COVER: MEASURING THE ELECTRONIC INDUSTRIES—A summary of the salient engineering, manufacturing, and operating factors of concern to the radio-TV-electronic industries in producing more than $6 billion worth of goods in 1952. Of the total goods produced during this "guns and butter" economy, $4.4 billion worth were for military electronic production with $1.2 billion being obligated by the Army, $1 billion by the Navy, and $2.2 billion by the Air Force. During the last five years the annual output of the electronic industries has shown consistent growth over each previous year, and this year's production is some 13% greater than the previous production peak occurring at about June of 1944 for World War II material. For other interesting statistics concerning the electronic industries, please turn to Electronic Industries Totals on page 3 and to the section starting on page 45 entitled "What's Ahead for '53?"

DEPARTMENTS

TELE-TECH, Vol. 12, No. 1, January, 1953. 75 cents a copy. Acceptance under Section 34.64 Postal Laws and Regulations authorized at Bristol, Conn., February 8, 1952 with additional entry at New York, N. Y. Annual Subscription Rates: United States and Possessions: $7.00; Canada: $8.00; All Other Countries $10.00. Please give title, position and company connection when subscribing. Copyright by Caldwell-Clements, Inc., 1953. Printed in U.S.A. Published monthly by

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Publication Office, Bristol, Conn. Editorial/Business Offices, 480 Lexington Ave., New York 17, N. Y., Tel. Plaza 9-7880

Publishers also of TELEVISION RETAILING

Employed in Electronic Manufacturing

	For 1951	For 1952
Military Production	40,000	120,000
Commercial End Equip't	15,000	15,000
Radio & TV Receivers	85,000	45,000
Parts Production	100,000	110,000
Electronic Tubes	60,000	70,000
	300,000	360,000

Figures from U. S. Dept. of Labor.

Radio and TV Receiver Production

	TV		Radio
November 1952		Home	385,000
		Battery	130,000
		Auto	184,000
		Clock	183,000
Total	871,000		882,000
Eleven months through November 1952		Home	3,363,000
		Battery	1,264,000
		Auto	2,362,000
		Clock	1,528,000
1952, 11 mo.	5,409,000		8,517,000
1951, year	5,562,000		12,895,000
1952, year	7,520,000		14,630,000

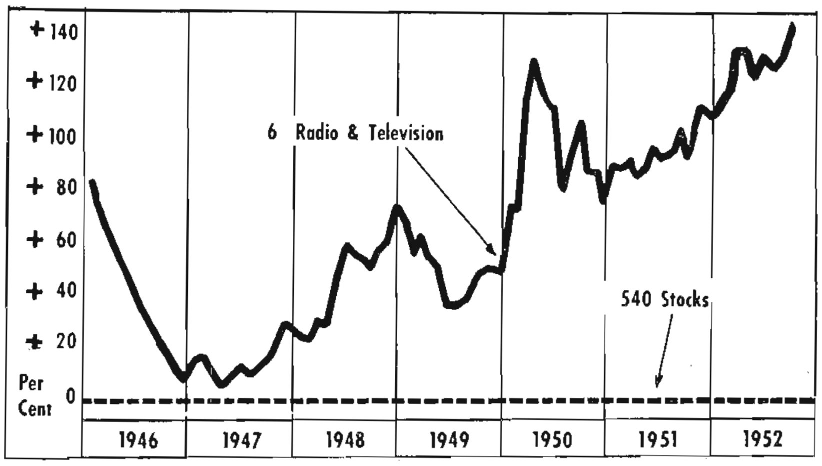


Chart shows how prices of stocks of six leading radio-TV manufacturers have raced ahead of the general stockmarket level since 1947, culminating in a 1952 lead of 140%. Compiled by Merrill Lynch, Pierce, Fenner & Beane.

Broadcast Stations in U. S.

	AM	FM	TV
Stations on Air	2368	624	115 VHF & 4 UHF
Under Construction (CPS)	138	60	22 VHF & 67 UHF
Applications Pending	255	8	465 VHF & 302 UHF

Note: Still-pending applications for new TV stations are thus approaching the 800 mark. New and amended pre-freeze applications exceed 760, of which number some 460 are for VHF and over 300 are for UHF operation. So far nearly 80 of these applications have been designated for hearing because they are "in competition," and some 230 other applicants have been notified that they face hearing for the same reason. On October 15, 1952, the Commission suspended the processing of competitive applications for new TV stations which face hearing.

U. S. Broadcast Licenses Total Nearly 5000, Two-Thirds in AM-FM-TV Groups

The growth of the AM, FM, and TV commercial broadcast services since 1943 is shown in the following table of statistics based on FCC reports:

	AM Authorized	AM Licensed	FM Authorized	FM Licensed	TV Authorized	TV Licensed	Total Authorized	Total Licensed
1943	912	911	48	37	6	6	966	954
1944	924	912	52	45	9	6	985	963
1945	955	931	53	46	25	6	1,033	983
1946	1,215	961	456	48	30	6	1,701	1,015
1947	1,795	1,298	918	48	66	6	2,779	1,352
1948	2,034	1,693	1,020	142	109	7	3,163	1,842
1949	2,179	1,963	865	377	117	13	3,161	2,353
1950	2,303	2,118	732	493	109	47	3,144	2,658
1951	2,385	2,248	659	534	109	81	3,153	2,863
1952	2,420	2,368	648	624	202	119	3,270	3,111

Note—As 1952 closed, there were nearly 5,000 broadcast stations in eleven categories. The three principal commercial broadcast services are the older AM (amplitude modulation); the newer FM (frequency modulation) type of high-fidelity and static-free broadcasting; and TV (television), also known as video. Detail figures for these are shown in table above.

In addition, there are noncommercial educational FM and TV and international broadcast facilities; remote pickup and studio links, TV auxiliary service, and experimental and developmental broadcast stations, adding up to 1800 stations not included in tabular columns at left.

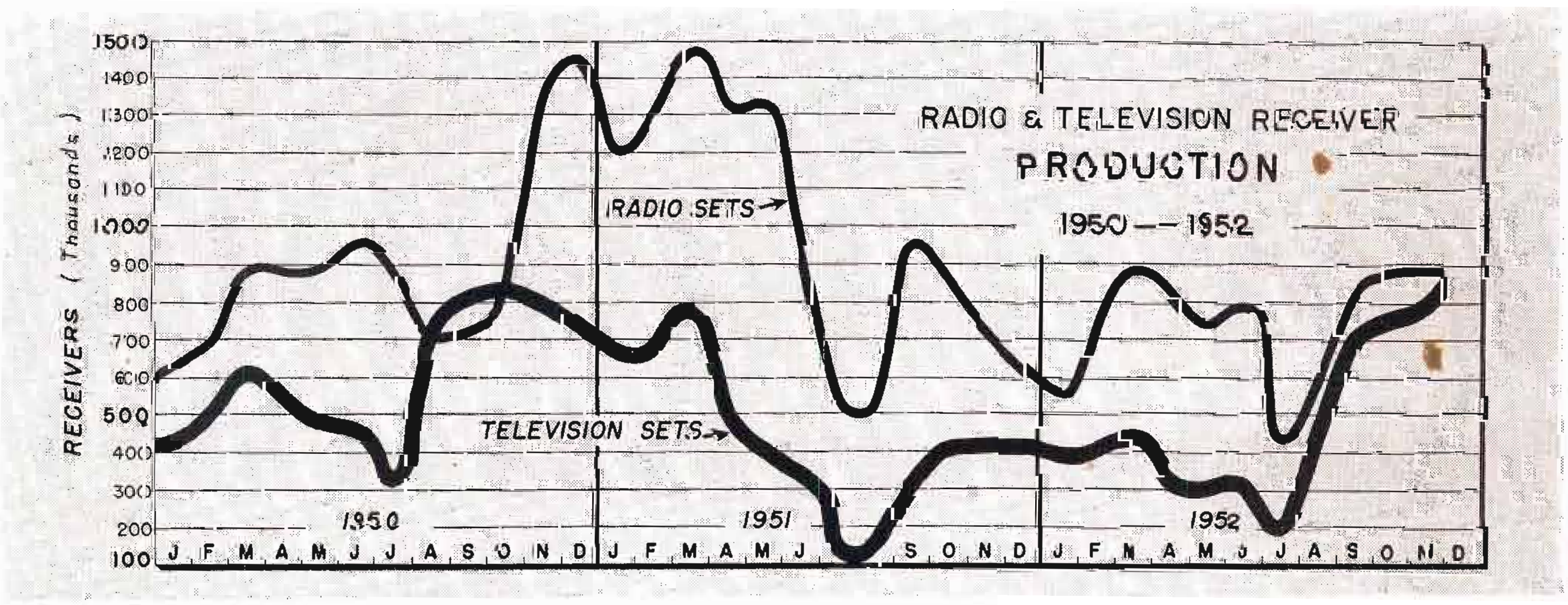
The Electronic-TV Industries as 1952 Closed

	Total Investment	Annual gross rev.	Number of employees	Annual payroll
Electronic mfrs. (4230)	$350,000,000	$4,000,000,000	360,000	$700,000,000
Radio distributors, dealers, etc.	550,000,000	3,300,000,000	200,000	650,000,000
Broadcasting stations (3270) incl. talent costs	330,000,000	990,000,000	*40,000	500,000,000
Commercial communication stations	100,000,000	—	20,000	80,000,000
Listeners' sets in use (131,000,000)	10,000,000,000	—	—	†1,400,000,000

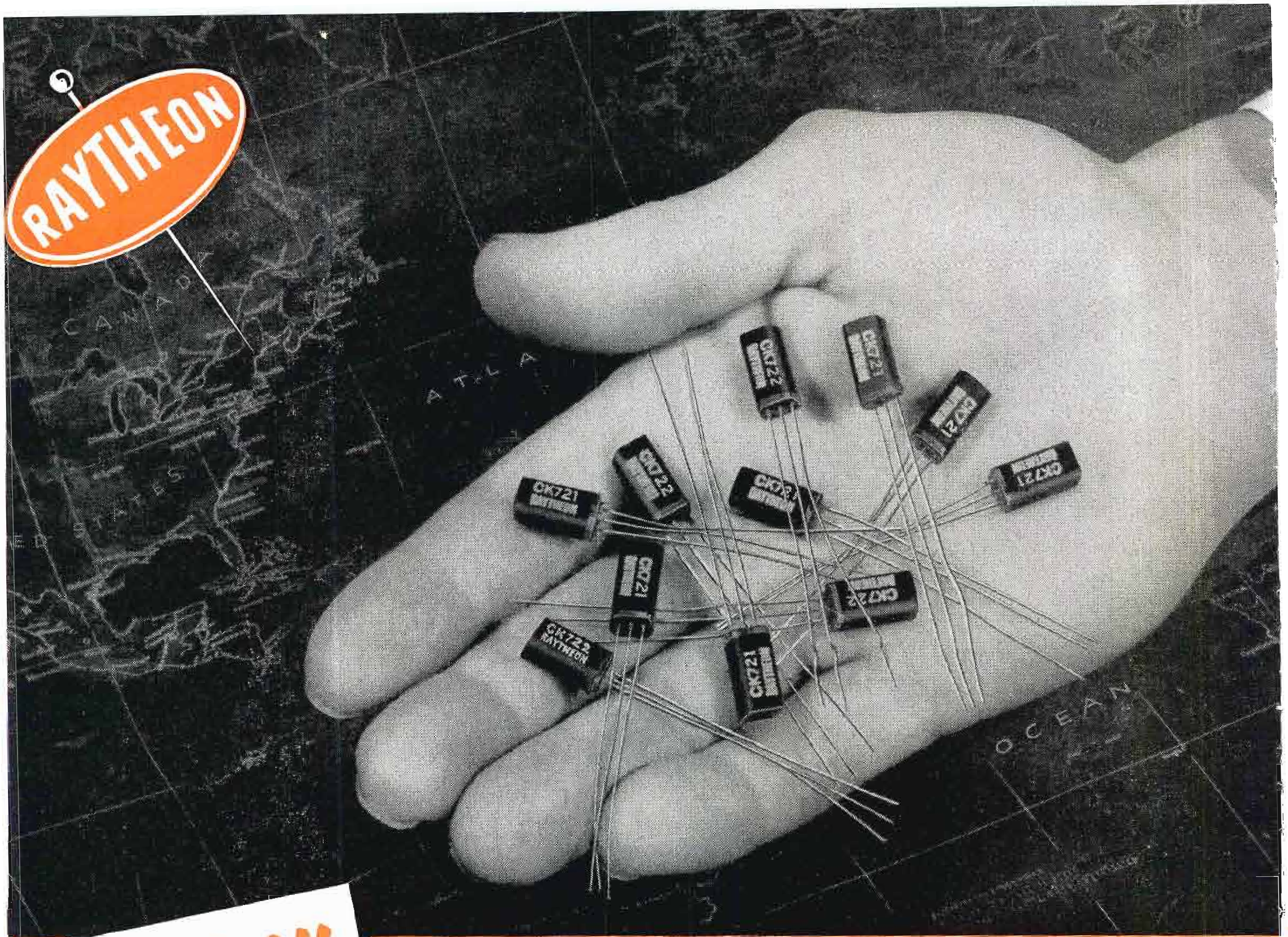
*Regular staff—not including part-time employees, artists, etc., who number at least 40,000 more.

†Annual operating expense for listeners, sets, for tube replacements, electricity, servicing, etc.

1952 TELEVISION OUTPUT LEAPS UPWARD—RADIO LEVELS OFF



For additional statistics of 1952-53, see TELE-TECH's Annual Statistical Survey, pages 46 to 49 of this issue, also Front Cover



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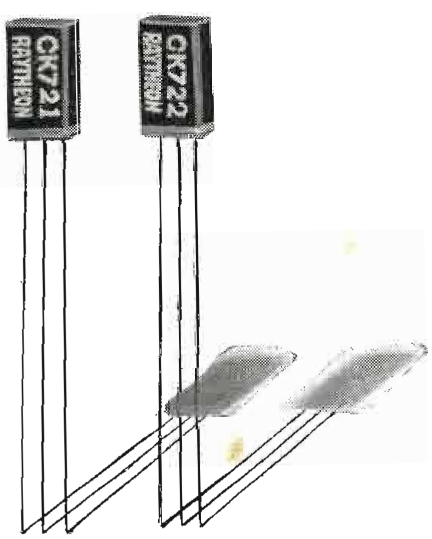

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Collector Current (ma.)	−0.5	−0.5
Base Current* (ua.)	−6	−20
Current Amplification Factor*	40	12
Power Gain* (db)	38	30
Noise Factor* (1,000 cycles) (db)	22	22

*Grounded Emitter connection

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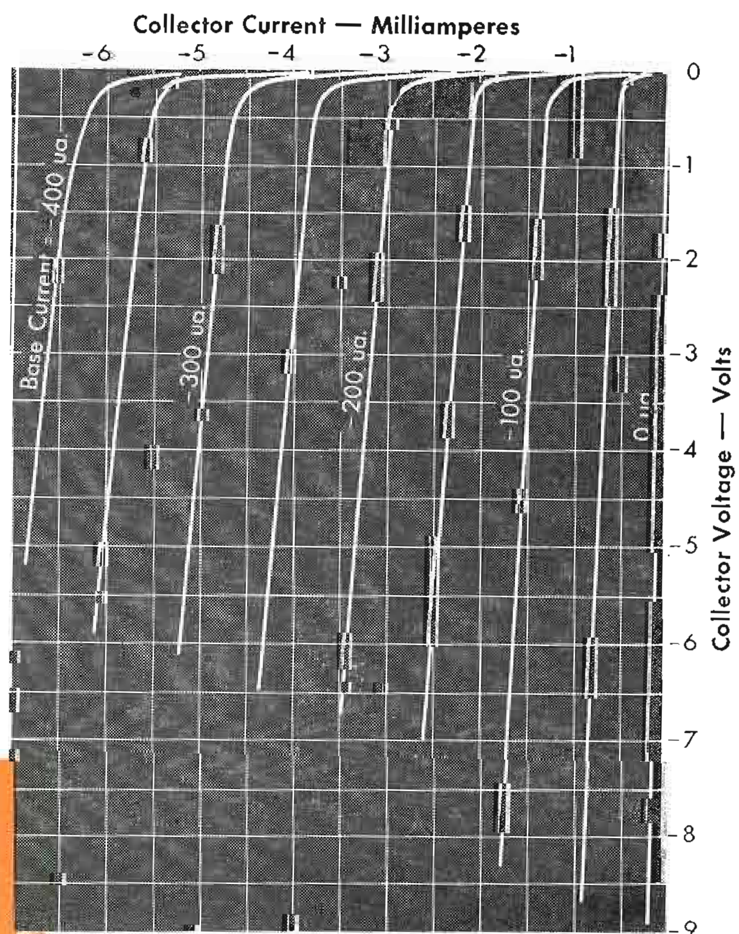
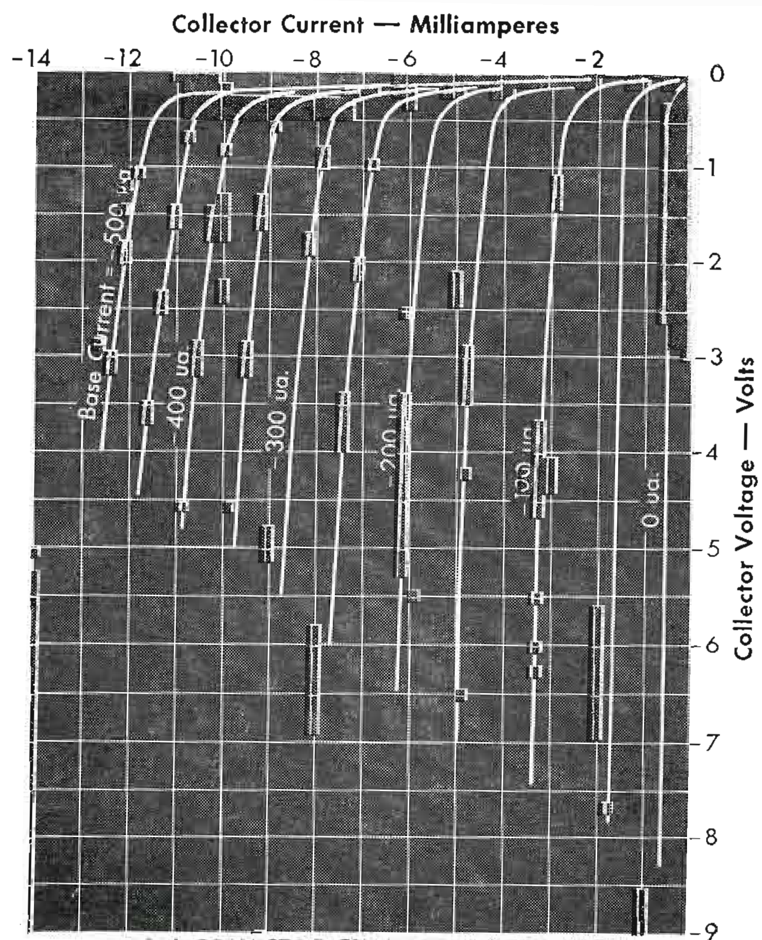


TYPICAL COLLECTOR CHARACTERISTICS CK722



TYPICAL COLLECTOR CHARACTERISTICS CK721

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TELE-TECH
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TELE-TECH* is edited for top-level engineers and executives throughout the electronic industries. It gives the busy engineering executive authoritative information and interpretation of the latest developments and new products in the telecommunications and electronic fields, with emphasis on subjects of engineering import and timeliness. Special attention is given to the following fields:

MANUFACTURING—Design and production of end products, components and accessories for:
- **—Electronic equipment, communications, broadcasting, microwave relay, instrumentation, telemetering, timing, counting, computing.**
- **—Military equipment, including radar, sonar, field sets, guided missiles, gunfire controls.**
- **—TV-FM-AM receivers, phonographs, recorders, reproducers, amplifiers.**

OPERATION—Installation, operation and maintenance of:
- **—Fixed, mobile and airborne communications in commercial, municipal, aviation and government services.**
- **—Broadcasting, video and audio recording, records, audio and sound systems, motion picture production, lighting, acoustics.**
- **—Military, civilian and scientific electronic computing and control systems and equipment.**

* Reg. U.S. Pat. Off.

TELE-TIPS

$ FOR IDEAS—Output of ideas for inventions has been boosted 80 per cent by an invention-award plan adopted by Westinghouse Electric Corp. Each person submitting a patent disclosure OK'd by a reviewing committee, receives $25. An additional $200 goes to inventor whose disclosure is best in each group of 50, and $50 more is paid when application is filed. Special awards go to inventions of high commercial value. Each engineering department is given a quota, to add an element of competition.

$2,000 PER EMPLOYEE minimum, is the way Raytheon figures its investment in the job of each person hired. This amount was arrived at by taking the depreciated value of buildings, machinery and equipment, plus the value of leased buildings and equipment, and then dividing by the number of employees. By using total assets of the company, including inventories, etc., the figure could be increased to $5400 per employee.

ANTENNA LICENSES!—From Great Britain comes the news that in addition to compulsory television-receiver licenses, certain cities are requiring additional licenses covering the erection of any outside antennas! These licenses range from about fifty cents up to $1, and in some cases additional compulsory insurance is required, costing another fifty cents. In an age of increasing government control the licensing racket can very easily be overdone as in the case of the Canadians who have to purchase a Canadian TV license for their receivers even if they are not within the range of any of Canada's TV stations!

THEATRE-TV—After forty years of building, there are still only twelve million movie seats in the United States, with a population exceeding one hundred fifty millions. In contrast, after only five years of TV there are already more than nineteen million TV sets in homes, and the estimated home audience for major telecasts has approached sixty million people. This is 400 times as many people as saw the recent Marciano fight on theatre TV, when, in 39 cities, 150,000 people paid $2.50 to $5 each for seats in a sell-out demonstration.

NBS PROPAGATION LAB—A huge barnlike building on North Broadway, Boulder, Colo., is the nucleus of the western plans now being made for moving the Central Radio Propagation Laboratory of the National Bureau of Standards to a new site in the Rocky Mountain area. Within two years, the whole laboratory is expected to be moved from Washington to Boulder, reports Herbert H. Rosen, of the NBS Technical Reports Section.

12-VOLT AUTO BATTERIES may be only way out from present heavy loading of car lighting circuits by window lifts, top lifts, directional signals, defrosters, power seat-adjusters, radios, and now air-conditioning systems. Already adopted for busses and trucks, 12-volt equipment for general motoring purposes may require several years before general adoption for passenger cars.

CONDUCTIVE FLOORS are an essential factor in the safe operation of hospitals and factories containing explosive gases. The often overlooked hazard of static electricity setting off an explosion can be overcome by providing a conductive path to neutralize the body-stored charge. According to the Bureau of Mines, the ideal floor resistance to ground should be 1 megohm, but for practical considerations it may range from 0.2 to 2 megohms. The overall neutralizing circuit should not be above 5 megohms.

PLUGGED NICKEL—On a per-capita basis, says FCC Commissioner Bartley, the Commission's yearly budget figures out as "4.077 cents per annum for each man, woman and child in the United States." FCC's Safety and Special Radio Services Bureau, which handles the great majority of licensed stations has fewer than 100 persons. This group will process 141,000 applications in the current fiscal year, yet a backlog of 9,500 applications continues to exist.

MINIATURE TV!—"After 33 years of electronic pioneering, I look forward as excitedly as a boy not only to color and third-dimension TV, but to the day when you can pack a miniature TV set in your luggage to take along on trips."—Frank A. D. Andrea.

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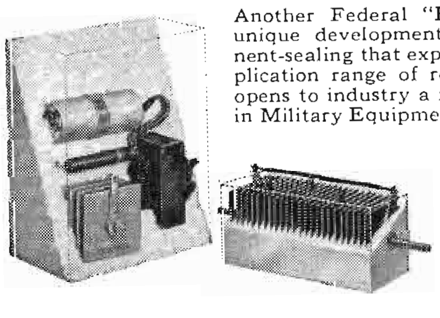

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TELE-TECH

& ELECTRONIC INDUSTRIES—RADIO-TELEVISION

O. H. CALDWELL, Editorial Director ★ M. CLEMENTS, Publisher ★ 480 Lexington Ave., New York (17) N. Y.

WHAT'S AHEAD for '53?

ELECTRONIC BUSINESS

WHILE GENERAL BUSINESS is expected to undergo a mild setback sometime in the latter half of 1953, the outlook for civilian radio-TV manufacturing is favorable, with the many new areas being opened up for television, and wider uses of radio communications. Military electronic demands seem destined to level off as the military picture stabilizes and overall expenditures are put under control. Dollar stabilization is expected to come during 1953, and this will help the electronic industries. Labor shortages will still be with us. Competition will continue to be severe, with narrowing profit margins between costs and selling prices. Sales effort will have to be speeded up. Complex taxes, forms, deductions and paper work will haunt management, but these burdens should be lightened under the new Administration at Washington.

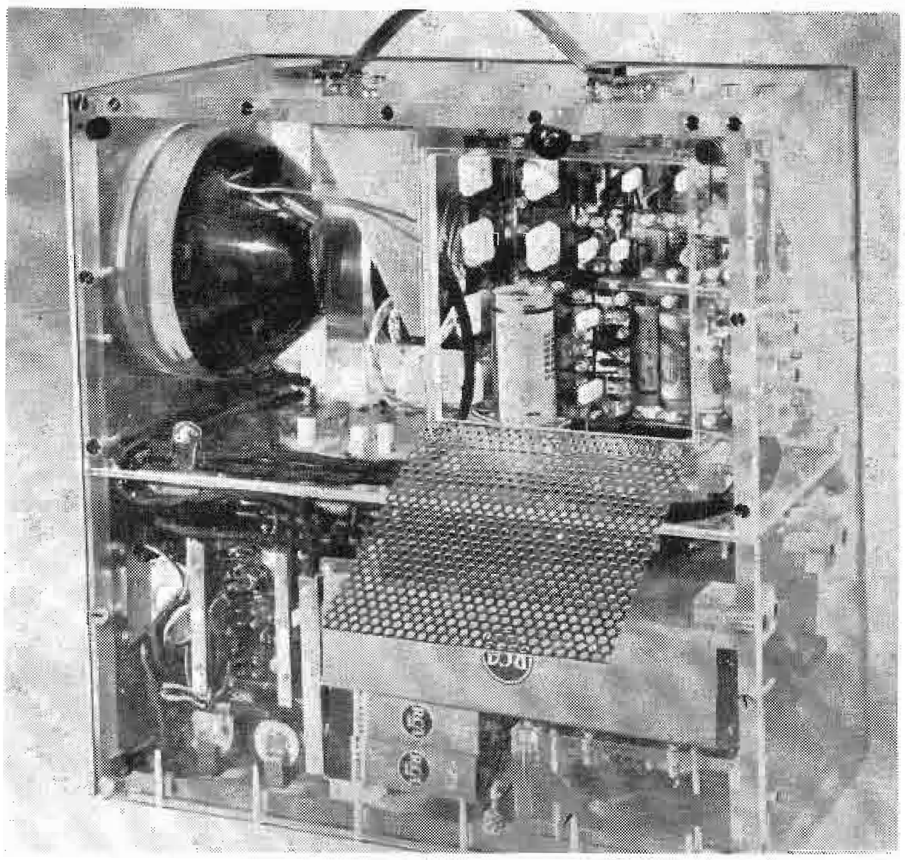
BINAURAL SOUND

SPURRED by the success of the multiple sound sources used in the smash Broadway hit "Cinerama," the idea of binaural listening is now receiving active attention in the broadcasting field. With duplicating channels from studio to home already provided by the AM and FM services operated by many stations, it becomes an economical step to utilize them for the right-hand and left-hand sound channels required for stereophonic listening. Already a notable New York station has begun a weekly commercial program of binaural music. For home and commercial use both tape and disc recordings of stereophonic music are now available. And experiments are to be repeated early in 1953, demonstrating binaural effects on a single FM channel.

TRANSISTORS

MOST MANUFACTURERS of transistors are still in the pilot production stages, but the next year should see some important mass production starts. Nearly all of this year's 100,000 estimated unit production went for military applications. It is significant to note too that many of the manufacturers now interested in transistors have not been previously associated with the manufacture of vacuum tubes, having been engaged in such diverse activities as resistor and capacitor manufacture, glass production, and audio equipment manufacture. From an application standpoint, differences in electrical characteristics will require using both point-contact and junction types in most end equipments. Transistors can be employed in almost every case where a receiving type vacuum tube is now employed. However, because of high costs, manufacturers will be apt to use them initially where some of their special features such as small physical size, operation on extremely low voltages, etc., are of paramount importance in the equipment involved. In general, transistorized equipments will be about 1/3 the size and weight of their vacuum tube counterparts, this great reduction coming about because the extremely low-voltage power supply requirements and low input and output impedance characteristics of transistors minimize iron-cored transformer requirements.

TRANSISTORIZED TV SET



Portable battery-operated TV receiver with developmental and experimental transistors uses no tubes except the 5-in. picture tube. Developed at RCA in Princeton, N. J. to explore transistor possibilities, the single-channel receiver weighs 27 lbs. and is housed in a cabinet 12 x 13 x 7 in. When operated from its self-contained loop antenna, the set produces a satisfactory picture five miles from the Empire State TV tower. With a small "rabbit-ear" antenna, the range increases to 15 miles with similar results. (See Page 75)

1952-1953 Statistics of the

Annual Bill of U. S. for Radio-TV

Sales of time by broadcasts, 1952	$ 850,000,000
Talent costs	140,000,000
Electricity, batteries, etc., to operate 136,710,000 radio and TV receivers	450,000,000
10,000,000 home radio receivers, at retail value	500,000,000
6,300,000 television receivers, at retail value	2,360,000,000
Phonograph records, 200,000,000	250,000,000
Radio repairs and supplies:	
80,000,000 replacement tubes	242,360,000
Parts, accessories, etc.	350,000,000
Labor	400,000,000
Total	$5,542,360,000

Radio and TV Sets in U. S.: World

United States homes with radios	46,000,000
Secondary radio sets in above homes	36,000,000
Radios in business places, institutions, etc.	7,500,000
Automobile radios	25,000,000
Television sets	22,210,000
Total sets in United States	136,710,000
Total radio sets in rest of world: North America, 9,500,000; South America, 10,000,000; Europe, 67,000,000; Asia, 14,000,000; Australia, 4,500,000; Africa, 3,000,000	108,000,000
Total sets in world	244,710,000

PRODUCTION OF CIVILIAN RADIO SETS — 1922 TO 1952

	Total Civilian Radio Sets Manufactured		Total Receiving Tubes* Manufactured		Automobile Sets Manufactured		Total Radio Reception Equipment	Auto Sets in Use	Homes with Radio Sets	Total Radio Sets in Use in U.S.	At Close of
	Number	Retail Value	Number	Retail Value	Number	Retail Value	Value	Number	Number	Number	
1922	100,000	$ 5,000,000	1,000,000	$ 6,000,000	....	....	$ 60,000,000	....	260,000	400,000	1922
1923	550,000	30,000,000	4,500,000	12,000,000	....	....	151,000,000	....	1,000,000	1,100,000	1923
1924	1,500,000	100,000,000	12,000,000	36,000,000	....	....	358,000,000	....	2,500,000	3,000,000	1924
1925	2,000,000	165,000,000	20,000,000	48,000,000	....	....	430,000,000	....	3,500,000	4,000,000	1925
1926	1,750,000	200,000,000	30,000,000	58,000,000	....	....	506,000,000	....	5,000,000	5,700,000	1926
1927	1,350,000	168,000,000	41,200,000	67,300,000	....	....	425,600,000	....	6,500,000	7,000,000	1927
1928	3,281,000	400,000,000	50,200,000	110,250,000	....	....	690,550,000	....	7,500,000	8,500,000	1928
1929	4,428,000	600,000,000	69,000,000	172,500,000	....	....	842,548,000	....	9,000,000	10,500,000	1929
1930	3,827,800	300,000,000	52,000,000	119,600,000	34,000	$ 3,000,000	496,432,000	....	12,048,762	13,000,000	1930
1931	3,420,000	225,000,000	53,000,000	69,550,000	108,000	5,940,000	300,000,000	100,000	14,000,000	15,000,000	1931
1932	3,000,000	140,000,000	44,300,000	48,730,000	143,000	7,150,000	200,000,000	250,000	16,809,562	18,000,000	1932
1933	3,806,000	180,500,000	59,000,000	49,000,000	724,000	28,598,000	300,000,000	500,000	20,402,369	22,000,000	1933
1934	4,084,000	214,500,000	58,000,000	36,600,000	780,000	28,000,000	350,000,000	1,250,000	21,456,000	26,000,000	1934
1935	6,026,800	330,192,480	71,000,000	50,000,000	1,125,000	54,562,500	370,000,000	2,000,000	22,869,000	30,500,000	1935
1936	8,248,000	450,000,000	98,000,000	69,000,000	1,412,000	69,188,000	500,000,000	3,500,000	24,600,000	33,000,000	1936
1937	8,064,780	450,000,000	91,000,000	85,000,000	1,750,000	87,500,000	537,000,000	5,000,000	26,666,500	37,600,000	1937
1938	6,000,000	210,000,000	75,000,000	93,000,000	800,000	32,000,000	350,000,000	6,000,000	28,000,000	40,800,000	1938
1939	10,500,000	354,000,000	91,000,000	114,000,000	1,200,000	48,000,000	375,000,000	6,500,000	28,700,000	45,300,000	1939
1940	11,800,000	450,000,000	115,000,000	115,000,000	1,700,000	60,000,000	584,000,000	7,500,000	29,200,000	51,000,000	1940
1941	13,000,000	460,000,000	130,000,000	143,000,000	2,000,000	70,000,000	610,000,000	8,750,000	29,700,000	56,000,000	1941
1942	4,400,000	154,000,000	87,700,000	94,000,000	350,000	12,250,000	360,000,000	9,000,000	30,800,000	59,340,000	1942
1943	....	....	17,000,000	19,000,000	....	....	75,000,000	8,000,000	32,000,000	58,000,000	1943
1944	....	....	22,000,000	25,000,000	....	....	85,000,000	7,000,000	33,000,000	57,000,000	1944
1945	500,000	20,000,000	30,000,000	35,000,000	....	....	105,000,000	6,000,000	34,000,000	56,000,000	1945
1946	14,000,000	700,000,000	190,000,000	200,000,000	1,200,000	72,000,000	900,000,000	7,000,000	35,000,000	60,000,000	1946
1947	17,000,000	800,000,000	220,000,000	260,000,000	2,500,000	150,000,000	1,100,000,000	9,000,000	37,000,000	66,000,000	1947
1948	16,000,000	700,000,000	200,000,000	230,000,000	2,800,000	200,000,000	950,000,000	11,000,000	40,000,000	74,000,000	1948
1949	10,000,000	500,000,000	200,000,000	350,000,000	3,500,000	240,000,000	1,500,000,000	14,000,000	42,000,000	81,000,000	1949
1950	14,600,000	721,000,000	383,000,000	644,000,000	4,760,000	248,000,000	2,800,000,000	17,000,000	45,000,000	90,000,000	1950
1951	13,000,000	605,000,000	430,000,000	640,000,000	4,800,000	255,000,000	3,000,000,000	20,000,000	45,850,000	100,000,000	1951
1952	10,000,000	500,000,000	360,000,000	740,000,000	2,750,000	148,000,000	3,300,000,000	25,000,000	46,000,000	114,500,000	1952

* Total tubes include those used in TV. Replacements accounted for about 25% in 1951.

Engineers in Electronic Manufacturing and Broadcasting — 1952*

Military and commercial equipment	11,360
Radio and TV receivers	2,120
Parts production	2,200
Electronic tubes	3,290
Broadcast station operation	15,000
Total	33,970

*See also "Employed in Electronic Manufacturing," page 3—Electronic Industries Totals

Engineers in All Fields — 1952

Industry	300,000
Government	90,000
Education	10,000
Total	400,000

TELEVISION-SET OWNERS, JAN. 1, 1953

Market Area	No. TV Stations	TV Sets in Use
Atlanta	3	268,000
Baltimore	3	456,000
Binghamton	1	97,000
Birmingham	2	146,000
Boston	2	1,009,000
Buffalo	1	329,000
Charlotte	1	178,000
Chicago	4	1,360,000
Cincinnati	3	372,000
Cleveland	3	715,000
Columbus	3	254,000
Dallas-Fort Worth	3	252,000
Davenport-Rock Island	2	176,000
Dayton	2	220,000
Denver	2	99,000
Des Moines (Ames)	1	113,600
Detroit	3	763,800
Erie	1	105,400
Grand Rapids-Kalamazoo	2	204,000
Greensboro	1	111,000
Houston	1	227,000
Huntington	1	122,600
Indianapolis-Bloomington	2	358,000
Jacksonville	1	96,000
Johnstown	1	192,000

Market Area	No. TV Stations	TV Sets in Use
Kansas City	1	264,000
Lancaster	1	185,000
Lansing	1	108,000
Los Angeles	7	1,300,000
Louisville	2	176,000
Memphis	1	179,000
Miami	1	129,000
Milwaukee	1	399,000
Minneapolis-St. Paul	2	332,000
Nashville	1	93,400
New Haven	1	350,000
New Orleans	1	155,000
New York	7	3,270,000
Norfolk	1	155,000
Oklahoma City	1	179,000
Omaha	2	163,000
Philadelphia	3	1,181,000
Phoenix	1	40,200
Pittsburgh	1	525,000
Portland Ore.	1	42,000
Providence	1	253,000
Richmond	1	154,000
Rochester	1	174,000
Salt Lake City	2	81,000
San Antonio	2	114,000

Market Area	No. TV Stations	TV Sets in Use
San Diego	1	131,000
San Francisco	3	515,000
Schenectady	1	251,000
Seattle	1	225,000
St. Louis	1	487,000
Syracuse	2	182,000
Toledo	1	236,000
Tulsa	1	81,400
Utica	1	78,500
Washington	4	425,000
Wilmington	1	132,000
Non Interconnected Cities		
Albuquerque	1	21,000
Brownsville (Matamoros)	1	11,100
U.S. Total for All Stations 112*		21,000,000
Canadian audience for Buffalo and Detroit Stations		135,000
Total audience all U.S. Stations		21,135,000

* As of Dec. 5, KDUB, Lubbock, Texas reported on air—Number of TV sets in use not known as yet.

TV-Radio-Electronic Industries

VITAL TELEVISION STATISTICS: 1946-1952

	Total TV Sets Manufactured		Receiving Tubes Used in New TV Sets and for Replacement		Total TV Picture Tubes Manufactured		Total Receiving Sets Manufactured AM-FM-TV	TV Stations on Air	Homes With TV Sets	Total TV Sets in Use in U.S.	At Close of
	Number	Retail Value	Number	Retail Value	Number	Retail Value					
1946	10,000	$ 5,000,000	350,000	$ 588,000	20,000	$ 100,000	14,010,000	5	8,000	8,000	1946
1947	250,000	100,000,000	8,500,000	15,000,000	300,000	150,000	17,250,000	20	250,000	250,000	1947
1948	1,000,000	350,000,000	32,200,000	53,000,000	1,500,000	75,000,000	17,000,000	44	1,000,000	1,000,000	1948
1949	3,000,000	950,000,000	87,000,000	146,000,000	3,500,000	210,000,000	13,000,000	100	4,000,000	4,000,000	1949
1950	7,500,000	2,700,000,000	225,000,000	378,000,000	8,000,000	400,000,000	22,100,000	107	10,400,000	10,500,000	1950
1951	5,600,000	2,100,000,000	161,000,000	270,000,000	6,000,000	300,000,000	19,100,000	108	15,500,000	15,750,000	1951
1952	6,300,000	2,360,000,000	168,000,000	380,000,000	6,500,000	260,000,000	16,300,000	123	21,000,000	22,210,000	1952

1952 Radio & TV Export

Radio
- Kits 115,000
- Complete Sets 300,000

TV
- Kits 18,000
- Complete Sets 73,000

Note: North Central & South America account for appr. 95% of all TV export and 85% of all radio export

1952 Semiconductor Production

Germanium Diodes	8,500,000
Transistors (point contact)	106,000
Transistors (junction)	6,000

Electricity Generated in US

Total public supply in thousands of kilowatt hours

1952	398,000,000
1951	370,234,364
1950	329,141,343

Note: Cost of electric power consumed by home TV receivers in 1952 was $200,000,000

1952 TV Set Figures

TV Production 1947-1951	17,360,000
TV Production 1952	6,300,000
TOTAL Post-War TV set production	23,660,000
Homes with TV, Jan. 1, 1953	21,000,000
2nd set homes	450,000
Bars, hotels, hospitals, etc.	760,000
Obsoleted Receivers	600,000
Inventories: Factory, Distributor, Dealer	850,000
TOTAL	23,660,000

TV Sets produced, by tube sizes, 1947-1952

7-8"	275,000
10"	2,000,000
12-14"	3,100,000
15-16-17"	13,225,000
19-20-21"	4,985,000
Over 21"	75,000
TOTAL	23,660,000

1952 Production of Radio-TV Tubes and Accessories

TV PICTURE TUBES
- Total Units 6,500,000
- Retail Value $260,000,000

RADIO BATTERIES
- Total Units 20,000,000
- Retail Value $60,000,000

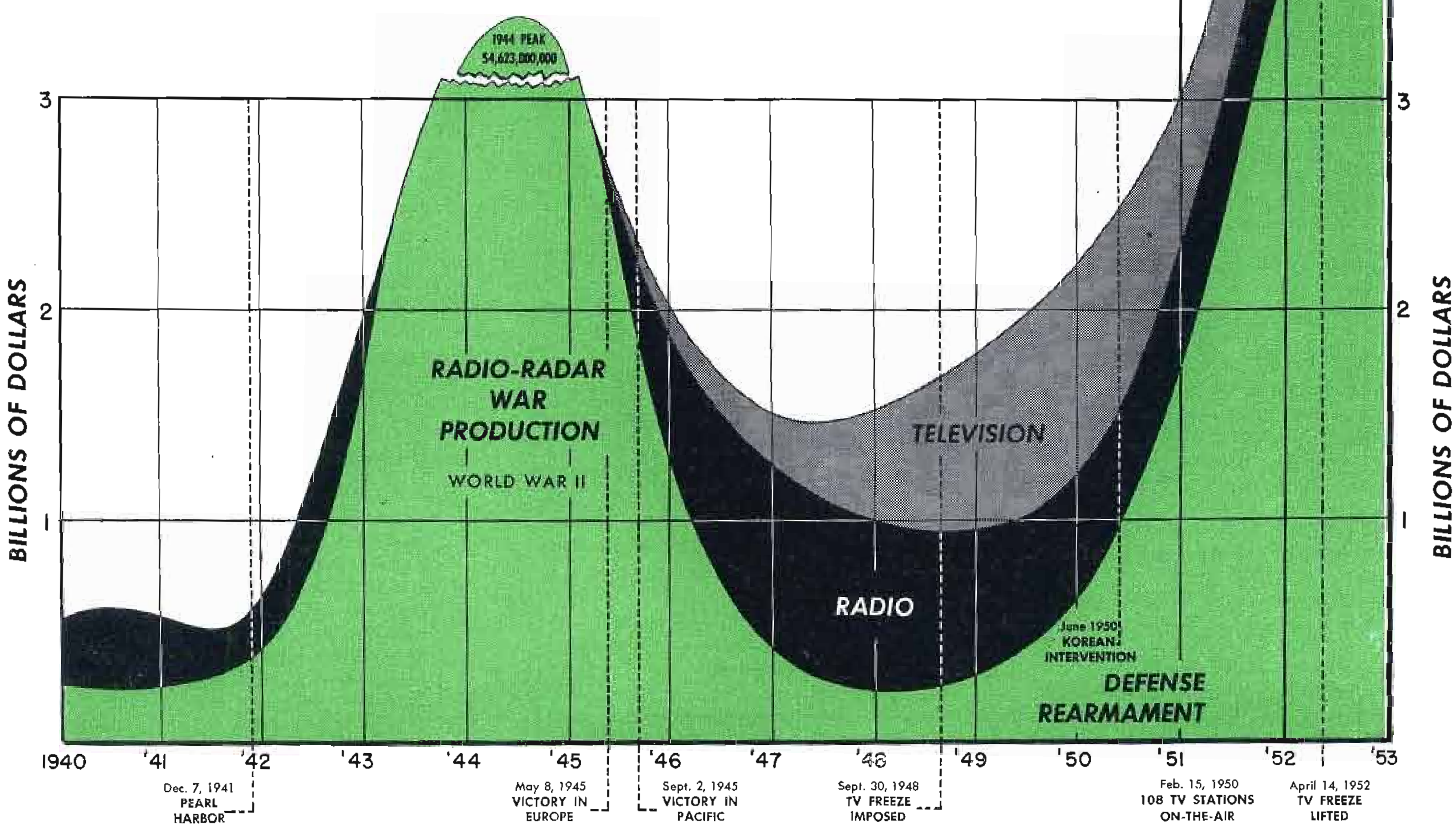
PHONOGRAPH RECORDS
- Total Units 200,000,000
- Retail Value $250,000,000

PHONOGRAPHS (Players; Combinations)
- Units 4,200,000
- Value $210,000,000

UHF CONVERTERS
- Units 75,000
- Value $3,000,000

1952 ELECTRONIC INDUSTRIES OUTPUT EXCEEDS $6 BILLION

These curves show (1) pre-war scale of home radio production, (2) tremendous rise of military production during war years—with erasure of civilian radio, (3) sudden cutback of military radio after V-J day with resumption of civilian radio, (4) rising volume of TV output with contraction of radio, (5) recent and future increases in military and defense production. In 1944-45, output of industry was 4.6 billion dollars. That figure, however, includes production from plants not normally engaged in radio manufacture. The 1952 peak exceeds $6 billion with more than $4 billion for military production.



METALS USED in PRODUCTION of RADIO and TELEVISION RECEIVERS

Metal	Portable Radio (%)	Table Radio (%)	Radio-Phono (%)	TV Table & Console (%)	Radio-TV Phono Comb. (%)	Auto Radio (%)	Tons Used 1952	Tons Used 1951	Tons Used 1950
Aluminum	4.0	15.1	4.7	63.0	1.6	11.6	3,582	5,905	6,229
Cadmium	1.0	5.9	1.7	9.4	0.3	81.7	136	218	284
Cobalt	3.8	15.1	6.7	31.6	0.2	42.6	249	400	629
Copper*	1.5	8.4	7.0	60.5	4.4	18.2	14,800	30,800	40,487
Lead	1.6	11.0	19.5	51.5	7.0	9.4	2,050	915	1,154
Nickel	2.8	12.9	3.5	50.6	2.2	28.0	515	911	1,287
Iron & Steel	1.1	6.5	8.0	51.9	3.9	28.6	136,000	170,057	224,115
Tin	4.7	10.4	1.5	48.8	1.8	32.8	600	798	1,064
Zinc**	0.1	0.5	37.1	21.7	6.4	34.2	6,560	11,514	15,361
Brass	2.5	11.9	3.8	53.6	2.4	25.8	5,540	10,577	13,361
						TOTALS	170,032	232,095	304,232

*Contains copper used in brass
**Contains zinc used in brass

PRODUCTION of PRINCIPAL COMPONENTS USED in RADIO-TV RECEIVERS

Year	Coils, Transformers (Iron-Core)	Coils, Transformers (Air-Core)	Capacitors, (Electrolytic)	Capacitors, (Mica-Fixed)	Capacitors, (Ceramic-Fixed)	Capacitors, (Tubular)	Resistors, (Composition)	Resistors, (Wire Wound)	Loudspeakers	Year
1946	28	126	28	57	170	155	477	29	14	1946
1947	44	163	35	70	209	196	608	37	17	1947
1948	22	169	36	71	214	212	654	42	17	1948
1949	24	165	32	61	186	218	670	50	13	1949
1950	43	280	58	88	280	351	1090	70	22	1950
1951	37	234	50	75	236	284	862	59	19	1951
1952	41	257	55	83	259	312	948	67	17	1952

MOTION PICTURE FILM

In 1952 TV used:
- 650 million feet of 16 mm film—Appr. cost $32,000,000
- 6 million feet of 35 mm film—Appr. cost $420,000
- All TV broadcast stations used 16 mm projectors
- Appr. 35 TV stations used 35 mm projectors

In 1951 TV used:
- 400 million feet of 16 mm film—Appr. cost $20,000,000
- 4 million feet of 35 mm film—Appr. cost $300,000
- All TV broadcast stations used 16 mm projectors
- Appr. 35 TV stations used 35 mm projectors

In 1950 TV used:
- 300 million feet of 16 mm film—Appr. cost $12,000,000
- 3 million feet of 35 mm film—Appr. cost $200,000
- All TV broadcast stations used 16 mm projectors
- Appr. 30 TV stations used 35 mm projectors

SOUND RECORDING

In 1952 Radio & TV used:
900 million feet magnetic tape—Appr. cost $2,000,000
3.5 million transcription discs (all types—Appr. cost $10,500,000

In 1951 Radio & TV used:
800 million feet magnetic tape—Appr. cost $2,250,000
3 million transcription discs (all types)—Appr. cost $9,000,000

In 1950 Radio & TV used:
400 million feet magnetic tape—Appr. cost $1,200,000
2.5 million transcription discs (all types)—Appr. cost $7,500,000

Broadcast Station Net Revenue, 1952

Radio	$500,000,000
TV	350,000,000
Radio Talent Costs	40,000,000
TV Talent Costs	100,000,000
	$990,000,000

Microwave Relay Statistics

No. of stations having:

Construction Permit (exclusive of Bell System and stations in systems under 50 mi)	623
Licensed (exclusive of Bell System and stations in systems under 50 mi)	548
Total	1,171

1171 stations listed above are employed in following services:

		No. of Stations
BA	(Auxiliary Broadcast)	9
CF	(Common Carrier, Domestic Fixed Public)	29
II	(Industrial, Special)	11
IL	(Industrial, Petroleum)	871
IW	(Industrial, Power)	144
L	(Land Transportation, Railroad)	19
PF	(Public Safety, Fire)	5
PH	(Public Safety, Highway Maintenance)	4
PO	(Public Safety, Forestry Conservation)	10
PP	(Public Safety, Police)	69
		1,171

Bell System Microwave Stations

CB&CF—Common Carrier TV & communications Operating	244
Proposed and under construction	47
CF—Common carrier communications (short haul narrowband) Operating	20
Total route miles operating	7264
Total route miles proposed and under construction	1490

PROFESSIONAL ENGINEER GROUPS

As of Dec. 1, 1952 membership in the Institute of Radio Engineers totaled 31,568. Paid-up professional group membership is as follows:

G1—Audio	1608
G2—Broadcast Transmission Systems	332
G3—Antennas & Propagation	980
G4—Circuit Theory	1114
G5—Nuclear Science	1266*
G6—Vehicular Communication	381
G7—Quality Control	272
G8—Broadcast & Television Receivers	699
G9—Instrumentation	1411
G10—Radio Telemetry & Remote Control	1225*
G11—Airborne Electronics	996
G12—Information Theory	572
G13—Industrial Electronics	501
G14—Engineering Management	645
G15—Electron Devices	351
G16—Electronic Computers	1129
G17—Microwave Theory & Techniques	352
G18—Medical Electronics	435*
G19—Communication Systems	596*
Total	11,343**

*No additional monetary assessment over annual IRE dues
**Note that individual members may belong to more than one professional group

Licensed Television and Radio Stations

Total Television Stations Operating*	113
Population Served by TV Programs	100 million
Total FM Stations Operating	582
Total AM Stations Operating	2,367
Total special service stations: marine, aeronautic, railroad, industrial, public safety, mobile, etc.	675,338
Radio Operators Licensed	714,832
Amateur Stations	117,069

*As of Dec. 5—see "Timetable of New TV Stations Coming on the Air," page 49, for 10 additional stations due on air before Jan. 1, 1953

See also Caldwell-Clements Statistics in World Almanac, Encyclopaedia Britannica, National Conference Board Economic Almanac, and "Information Please" Almanac

Ten-Year Radio-TV Trends, 1942-1952, as Shown by Representative Electronic Stocks

	Earnings—$ per Share						Divs.—$ per Share			Price Range				Approximate	
	Fiscal Year ends	1951	1950	Interim Period	Interim 1952	Interim 1951	Consec. Years Div. Paid	Paid 1951	Paid or Decl. Last 12 Mos.	1942-51 High	1942-51 Low	1952 High	1952 Low	Price 10-20-52	Yield %
Admiral	Dec.	4.97	9.73	6 mo. 6-30	1.31	2.12	10	1.00	1.00	39 1/4	2 3/4	32 3/4	24 3/4	31	3.2
DuMont "A"	Dec.	d0.30	2.87m	24 wk. 6-15	d0.001f	0.02	4	0.25	Nil	27	3 3/8	19 3/4	15	17	—
Motorola	Dec.	4.15	7.28a	6 mo. 6-28	1.78a	2.14	11	0.97 1/2	1.50	28 7/8	2 1/4	44 3/4	27 1/4a	44	3.4
Philco	Dec.	3.35	4.50	6 mo. 6-30	1.16	1.58	27	1.60h	1.60	27 5/8	3 7/8	35 3/8	26 5/8	35	4.6
Radio Corp.	Dec.	2.02	3.10	6 mo. 6-30	0.70	1.02	13	1.00	1.00	25 1/4	2 1/2	28 3/4	23 1/4	27	3.7
Sylvania Elec.	Dec.	4.18	5.37	6 mo. 6-30	1.48	2.95	24	2.00	2.00	43 1/2	15 7/8	39 1/8	32 1/4	38	5.3
Zenith (k)	Dec.	10.90	17.22	6 mo. 6-30	2.71	4.83	14	3.00	2.50	71 1/2	8 3/4	86	68	84	3.0

Compiled by *Merrill Lynch, Pierce, Fenner & Beane*

TIMETABLE of NEW TV STATIONS COMING on the AIR

A geographical listing of the 113 new commercial TV stations and 9 non-commercial educational outlets for which "post-freeze" FCC grants and construction permits had been issued through December 5, 1952. Where possible, estimated date for start of telecasting is shown.

STATE AND CITY	CALL LETTERS	CHANNEL NO.	DATE ON AIR
ALABAMA			
Gadsden	*	21	*
Mobile	WKAB-TV	48	December '52
Montgomery	WCOV-TV	20	March '53
ARIZONA			
Tucson	KVOA-TV	4	March '53
Tucson	KOPO-TV	13	*
ARKANSAS			
Ft. Smith	KFSA-TV	22	*
Little Rock	KRTV	17	March '53
Little Rock	KETV	23	*
CALIFORNIA			
Fresno	KMJ-TV	24	May '53
Los Angeles	*	28	*
San Bernardino	KITO-TV	18	October '53
Santa Barbara	*	3	May '53
COLORADO			
Colorado Springs	KRDO-TV	13	*
Denver	KBTV	9	Now on air
Denver	KFEL-TV	2	Now on air
Denver	KDEN	26	Spring '53
Denver	*	20	*
Pueblo	KCSJ-TV	5	March '53
Pueblo	KDZA-TV	3	*
CONNECTICUT			
Bridgeport	WICC-TV	43	January '53
Bridgeport	WSJL	49	February '53
New Britain	WKNB-TV	30	January '53
Waterbury	WATR-TV	53	*
FLORIDA			
Ft. Lauderdale	WITV	17	February '53
Ft. Lauderdale	WFTL-TV	23	March '53
Pensacola	*	15	*
St. Petersburg	WSUN	38	May '53
ILLINOIS			
Belleville	*	54	*
Decatur	*	17	*
Peoria	WEEK-TV	43	March '53
Rockford	WTVO	39	March '53
INDIANA			
Muncie	WLBC-TV	49	*
South Bend	WSBT-TV	34	March '53
IOWA			
Sioux City	KWTV	36	*
Sioux City	*	9	*
KANSAS			
Manhattan (NCE)	KSAC-TV	8	*
KENTUCKY			
Ashland	WPTV	59	July '53
Henderson	WSON-TV	50	*
LOUISIANA			
Baton Rouge	WAFB-TV	28	January '53
MARYLAND			
Frederick	WFMD-TV	62	*
MASSACHUSETTS			
Fall River	WSEE-TV	46	May '53
New Bedford	WNBH-TV	28	February '53
Springfield-Holyoke	WWLP	61	January '53
Springfield-Holyoke	WHYN-TV	55	March '53
MICHIGAN			
Ann Arbor	WPAG-TV	20	April '53
Battle Creek	WBKZ-TV	64	*
Battle Creek	WBCK-TV	58	*
East Lansing	WKAR-TV	60	August '53
Flint	WCTV	28	January '53
Flint	WTAC-TV	16	*
Jackson	WIBM-TV	48	*
Saginaw	WKNX-TV	57	February '53
MINNESOTA			
Duluth	KF-TV	38	February 15, '53
MISSISSIPPI			
Jackson	WJTV	25	December 25, '53
MISSOURI			
St. Joseph	KFEQ-TV	2	August '53
Springfield	KTTS-TV	10	May '53
NEBRASKA			
Lincoln	KOLN-TV	12	February 1, '53
Lincoln	KFOR-TV	10	May '53
NEW JERSEY			
Asbury Park	WCEE-TV	58	Late '53
Atlantic City	WFPG-TV	46	December 20, '52
NEW YORK			
Albany (NCE)	WRTV	17	*
Binghamton (NCE)	WQTV	46	*
Buffalo (NCE)	WTVF	23	*
Elmira	*	24	*
New York City (NCE)	WGTV	25	*
Rochester (NCE)	WROH	21	*
Syracuse (NCE)	WHTV	43	*
NORTH CAROLINA			
Asheville	WISE-TV	62	April '53
Greensboro	WCOG-TV	57	*
Raleigh	WETV	28	April '53
OHIO			
Akron	WAKR-TV	49	Winter '53
Lima	WLOK-TV	73	*
Massillon	WMAC-TV	23	March '53
Warren	WHHH	67	*
Youngstown	WUTV	21	July '53
Youngstown	WFMJ-TV	73	January '53
Youngstown	WKBN-TV	27	*
OREGON			
Portland	KPTV	27	Now on air
PENNSYLVANIA			
Bethlehem	*	51	*
Harrisburg	WHP-TV	55	April '53
Johnstown	*	56	*
New Castle	WKST-TV	45	January '53
Reading	WEEU-TV	33	July 1, '53
Reading	WHUM-TV	61	December '52
Scranton	WTVU	73	January '53
Scranton	WGBI-TV	22	February '53
Wilkes-Barre	WBRE-TV	28	December '52
Wilkes-Barre	WILK-TV	34	January '53
Williamsport	WRAK-TV	36	*
York	WNOW-TV	49	March '53
York	WSBA-TV	43	December '52
SOUTH CAROLINA			
Charleston	WCSC-TV	5	April '53
Columbia	WNOK-TV	67	January '53
Columbia	WCOS-TV	25	Spring '53
SOUTH DAKOTA			
Sioux Falls	KELO-TV	11	*
TENNESSEE			
Chattanooga	WTVT	43	March '53
Chattanooga	WOUC	49	*
TEXAS			
Amarillo	KGNC-TV	4	March '53
Amarillo	KFDA-TV	10	March '53
Austin	KCTV	18	*
Austin	KTBC-TV	7	December 1, '52
Austin	KTVA	24	*
El Paso	KROD-TV	4	December '52
El Paso	KEPO-TV	13	April '53
El Paso	KTSM-TV	9	January '53
Galveston	*	11	*
Galveston	*	41	*
Houston (NCE)	KUHT	8	*
Lubbock	KCBD-TV	11	April '53
Lubbock	KDUB	13	Now on air
Waco	*	34	*
Wichita Falls	*	22	May '53
VIRGINIA			
Lynchburg	WWOD-TV	16	*
Lynchburg	WLVA-TV	13	February 1, '53
Roanoke	WROV-TV	27	December '52
Roanoke	WSLS-TV	10	January '53
WASHINGTON			
Spokane	KHQ-TV	6	Early '53
Spokane	KXLY-TV	4	December '52
WISCONSIN			
Green Bay	WBAY-TV	2	*
HAWAII			
Honolulu	KGMB-TV	9	December '52
Honolulu	KAMI	11	Early '53
PUERTO RICO			
San Juan	WKAQ-TV	2	Late '53

* Information not available at press time.
(NCE) Noncommercial educational station.

Megawatt AM Broadcast Transmitter

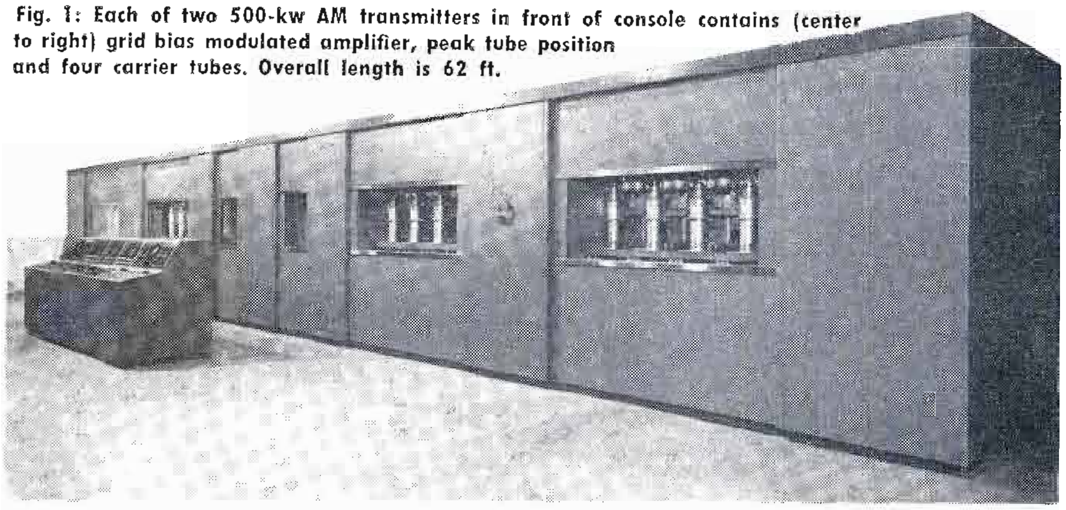


Fig. 1: Each of two 500-kw AM transmitters in front of console contains (center to right) grid bias modulated amplifier, peak tube position and four carrier tubes. Overall length is 62 ft.

Dual high-power units boast 4,000,000 watts peak power output. Triodes in final amplifier provide power gain of 33

By JAMES O. WELDON,
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4212 S. Buckner Blvd., Dallas 10, Texas

THE description of an AM broadcast transmitter having a carrier power of 1,000,000 watts highlights, several interesting design features. These transmitters, designed for operation in the standard broadcast band between 540 KC and 1600 KC, are being delivered to the U. S. Department of State for use in the Voice of America program.

Aside from the fact that this transmitter has an output power, which so far as is known, exceeds that of any standard band AM broadcast transmitter yet constructed, there are several other features which may be of special interest.

1. A high efficiency, linear power amplifier which has a power gain of 33 using triode tubes.
2. All of the metering, tuning controls and power control have been centralized on a console type of control and tuning unit.
3. A newly developed high power triode with a thoriated tungsten filament and a high transconductance is used.
4. The overall conversion efficiency from power source to antenna is slightly better than 50% at carrier condition and rises to approximately 54% with 100% tone modulation.
5. Completely separate 500-kw transmitters are used with outputs combined to obtain a power to the antenna of 1,000,000 watts.

Fig. 1 shows the two 500-kw transmitters located to the left and right of the center unit. The overall length of the equipment shown is 62 ft., and the height is 9.5 ft. On each side of the center unit a single tube is used as a grid bias modulated amplifier to drive the final amplifier. To the left is Power Amplifier No. 1 and to the right, Power Amplifier No. 2. Each of these uses four Machlett Type ML-5682, 250-kw power tubes for the peak tube position of the Doherty amplifier, and four more for the carrier tube position. The inner group for each amplifier is the peak tube position, and the groups of four at the ends are the carrier tubes. The units at the extreme ends house a porcelain pipe assembly and an air blower which supplies air to the grid and filament seals of the tubes, and also supplies air for ventilating various compartments of the transmitter.

Four-Tube Assembly

Fig. 2 is a closer view of an assembly of four tubes. This particular assembly is the carrier side for transmitter No. 2. This was taken prior to the installation of the front doors and trim. It shows the porcelain pipe used to carry water to and from the tubes, the assembly of four tubes, the grid equipment above, and the four filament transformers in the upper compartment with filament busses extending down to the tubes.

Fig. 3 shows the plate shelf with a single tube installed. A better view of the socket is obtained here, and in this connection, the method of changing tubes is of interest. After removing the filament and grid rings, it is only necessary to turn the tube approximately 30° in the socket, after which it can be lifted out. The tube itself weighs about 50 lbs. An "O" ring gasket is used in the socket which seals the water when a tube is inserted. This type of mounting provides a very quick change feature which is of course desirable where a number of tubes are used in the transmitter. Behind the tubes are the plate parasitic traps and the plate lead extending to plate blocking capacitors in the rear compartment.

Upper Portion of Tube

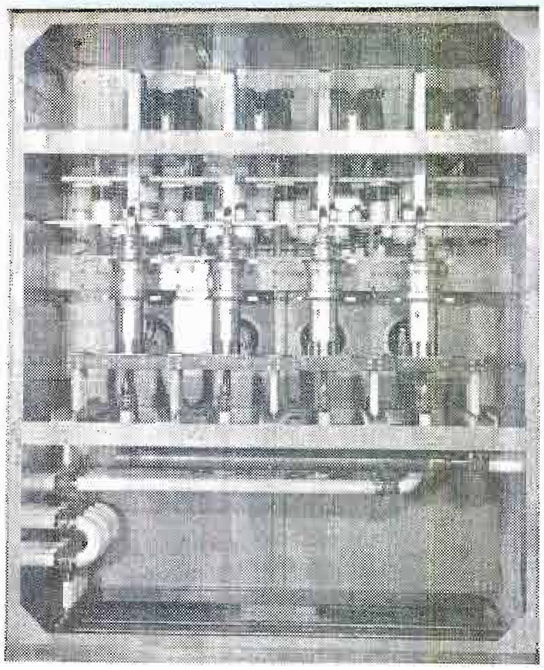
Fig. 4 is a view of the upper portion of the tube, showing the filament bypass capacitors, grid tank capacitors which are connected grid to ground in this position and the individual grid r-f chokes. Two grid leads are used in connecting to the grid ring, mainly for the purpose of reducing inductance in the grid lead. The ball gaps from grid to plate (the plate ball gap is visible in Fig. 3) were used during tests but are not furnished with the equipment as they have been found to be unnecessary. The grid to cathode gap is installed but the bias circuit is protected by thyrite protectors, one of which is visible in this view, and no arcing has been experienced on the gap from grid to cathode. The hooks are provided merely as a convenience in hanging the filament rings to each side when the tube is being changed.

Fig. 5 is a rear view of one of the power amplifiers before the installation of the doors and trim. At the center in the lower compartment is the output tank inductor which is water cooled. To the right in the lower compartment is the inter-plate coil, which forms the series element of the π network, providing the impedance inversion between peak and carrier tubes. And further to the right, is a coil in the position of a carrier tube tank inductor. Water is circulated into the ground potential end of this coil, through the interplate coil and down through the output tank inductor to ground potential so that no insulating pipe is necessary in the inductor cooling. Above on the right we have the neutralizing inductance. Inductive neutralization is used for both the peak and carrier tubes. There are four blocking capacitors and four individual plate r-f chokes. Above in the air duct we have the individual plate current limiting resistor for each of the four tubes, a bias bleeder and the grid load resistors. Following that duct to the left we have grid bias load resistors for the peak tube bias rectifier, followed by current limiting resistors for the peak tubes, and the same assembly of r-f chokes, plate blocking capacitors and neutralizing coil for the peak side. Below this shelf is the peak tank capacitor which serves in the Doherty system as the output tank capacitor, consisting of five pressurized gas capacitors, all variable and driven by a common line shaft which is turned by the motor drive housed in the box in the right-hand corner. In this compartment there are thermocouples used in connection with the grid load current meter, some devices for obtaining a sample of voltage for neutralization, and an interlock device in connection therewith. The coil in this compartment and the large coil outside here comprise a sampling system for the operation of a carrier cutoff circuit in case of arc-over in the output circuit of the transmitter.

Phantom Antenna

Fig. 6 is an interior view of the phantom antenna, which consists of resistance elements in four porcelain pipes, each of which is 5 ft. long, a capacitor for tuning out the inductive reactance of these resistor elements, the phantom resistor having a phase angle of about 45° at 1600 KC, and of course lower at the lower frequencies. A flow meter measures the

(*Continued on page* 112)



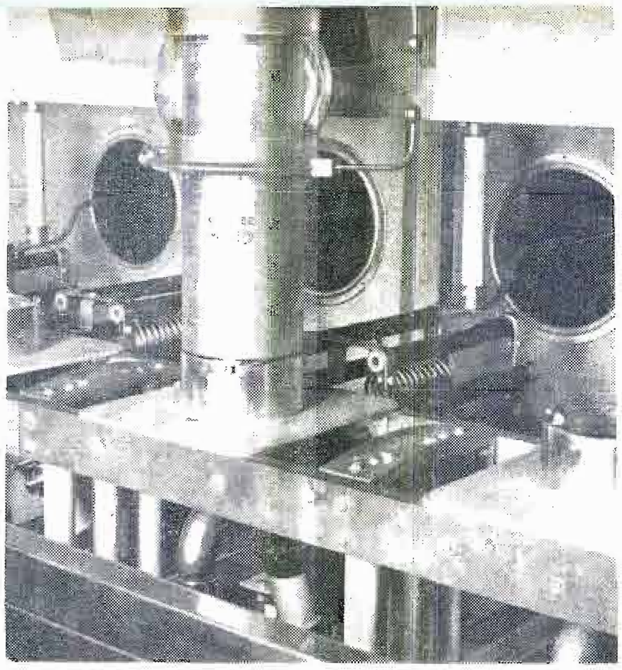
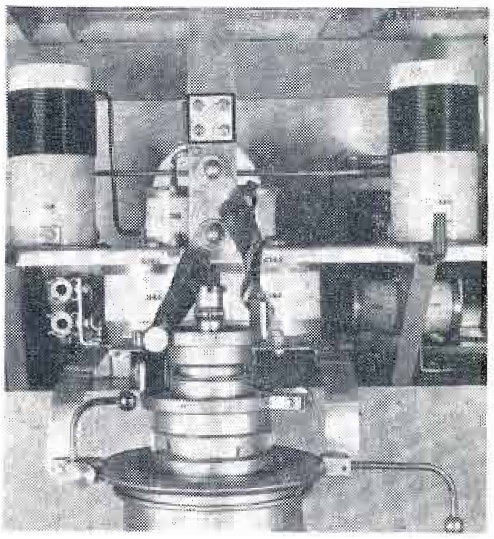


Fig. 2: (l) Four-tube carrier assembly. Fig. 3: (r) Easily removed tube on plate shelf



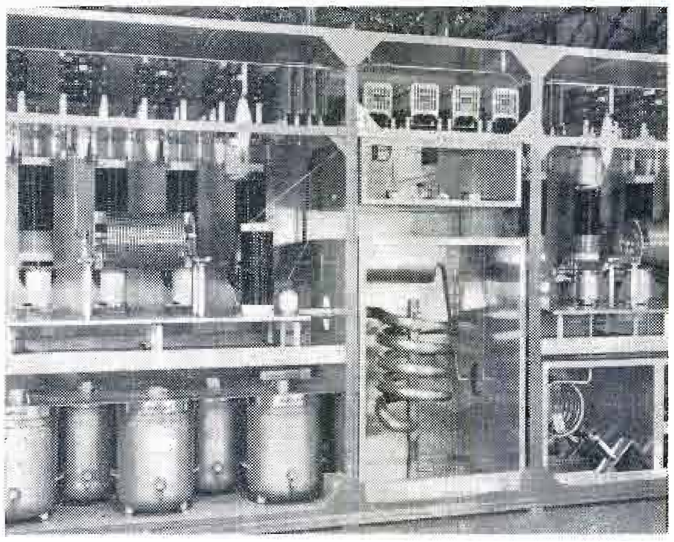
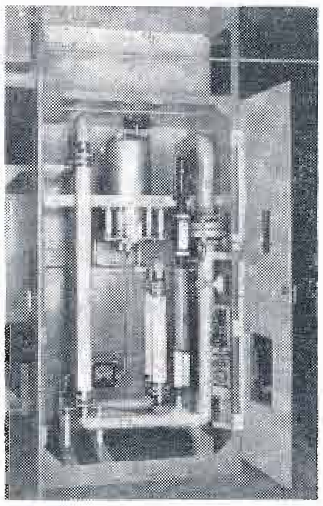


Fig. 4: (l) Upper part of tube shows capacitors and chokes. Fig. 5: (r) Rear of power amplifier



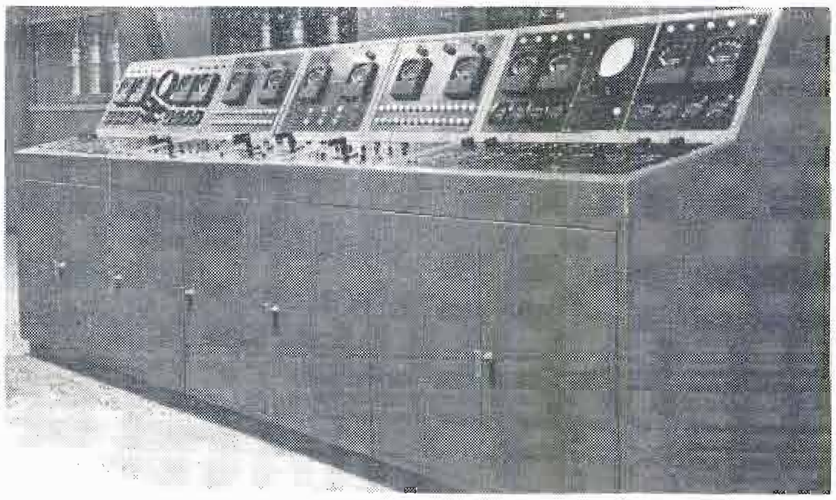
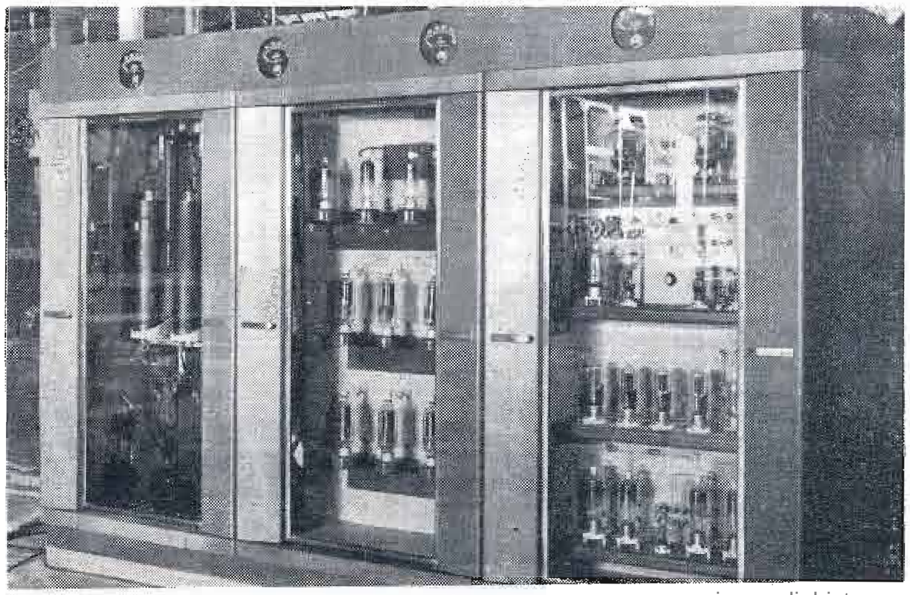
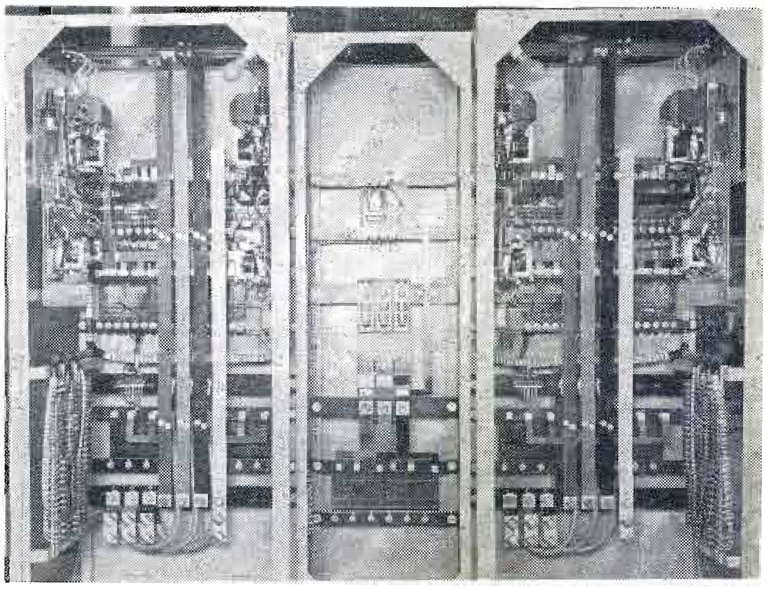


Fig. 6: (l) Water-cooled phantom antenna. Fig. 7: (r) Centralized metering and control console

Fig. 8: (l) Three-unit assembly has (l to r) 15-kv rectifier, bias rectifier, and audio and r-f drivers. Fig. 9: (r) 230-v. distribution system





Resistor Temperature Coefficients

Recent tests on 1% units indicate temperature superiority of deposited-carbon resistors over composition type. Pyrolytic-borocarbon units promise to surpass time-stability of wire-wound resistors

By FLOYD A. PAUL
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California Institute of Technology
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THIS paper cites the changes in resistance with temperature of 1% pyrolytic-deposited-carbon resistors and a metal-film resistor. A brief discussion of deposited-carbon resistors is given, together with a description of the test and the testing method used in determining temperature coefficients. Curves showing temperature coefficients are included. Mention is made of a new pyrolytic carbon resistor that contains boron.

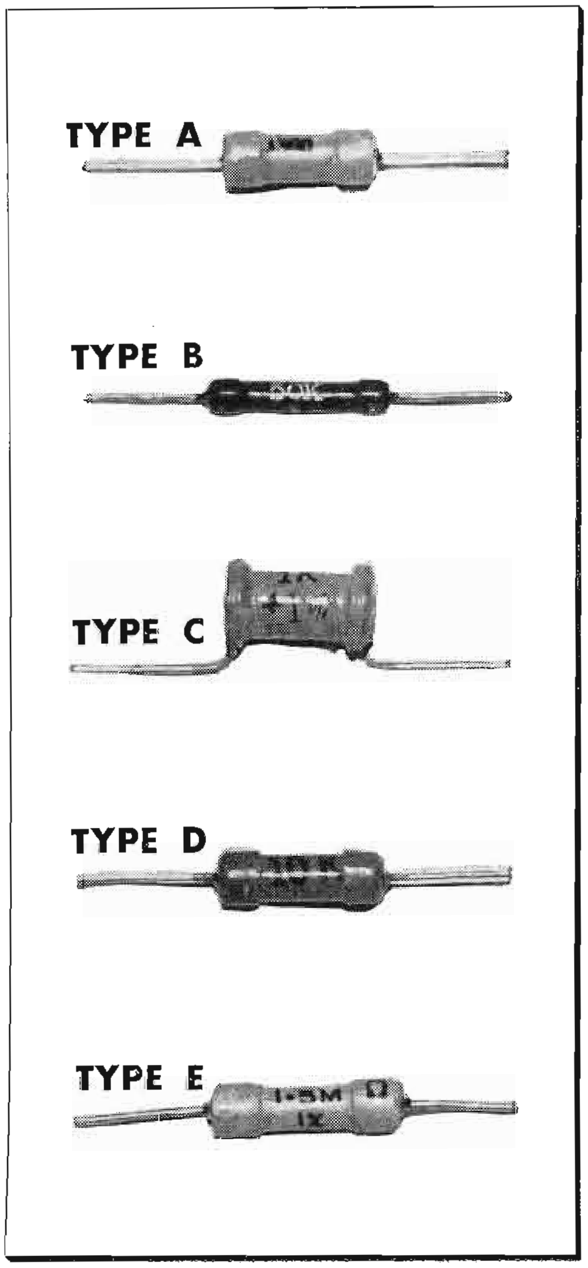
The presence of a hydrocarbon gas or vapor in a heated oven causes a thin carbon film to be deposited on a suitable core or refractory base. A resistor thus formed is called a deposited-carbon resistor or pyrolytic-carbon resistor.

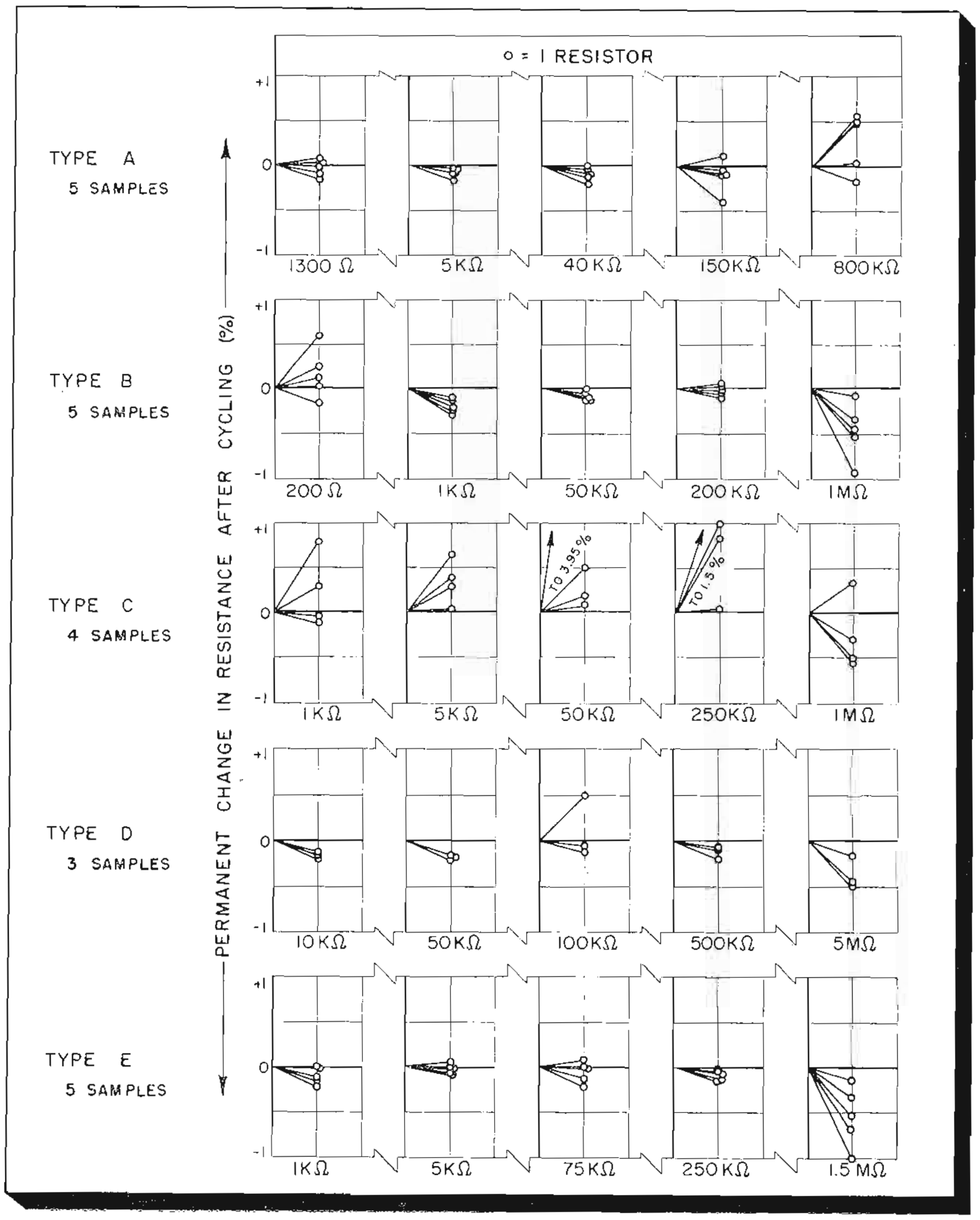
A test was made to determine the temperature coefficients of five types of 1% resistors. Four were pyrolytic-film (commonly called deposited-carbon) resistors, and one was a metal-film resistor. A total of 110 resistors was used in the test.

Table I lists the types of resistors, the values used in this test, the quantity of each value, the kind of film each resistor is composed of, and the wattage of each resistor. The resistors used are shown in Fig. 1.

The test was conducted in a two-day period. On the first day a heat run was made. All 110 resistors were soldered to terminal strips and placed in the temperature-controlled oven. Connecting leads were brought out through the oven door and soldered to a specially prepared switch box so that any one resistor could be selected and checked during the test. The first resistance measurements were made at room temperature (20°C) since it was con-

Fig. 1: (l) Five resistor types used in tests. Fig. 2: (r) Residual resistance changes for five resistor types caused by heat cycle





venient to read 20°C incremental steps from this temperature. Each temperature setting was allowed to stabilize at least 20 minutes, and resistance readings were taken with an accurate impedance bridge. Thereafter, in 20°C steps, resistance readings were taken until 120°C was reached. The resistors were allowed to cool overnight, and on the following day all resistors were measured at 20°C. Residual resistance changes were noted.

Second Half of Test

The second half of this test was performed with dry ice. After starting at 20°C and cooling the oven in 20°C steps, resistance readings were taken. A period of at least 20 minutes was allowed for the temperature of the oven to stabilize before resistances were measured. The lower limit of the test was −20°C.

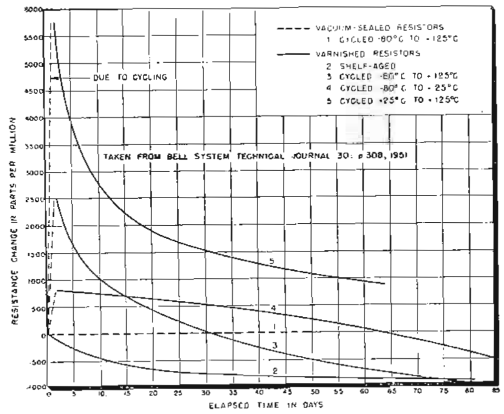


Fig. 3: Aging effect of thermal cycling

After the first half of the test heat run, residual resistance changes were noted. These are permanent changes of resistance due to environmental conditions such as temperature cycling, aging, and humidity tests. The residual changes are plotted in graph from in Fig. 2, which shows the percentage by which each resistor changed after the heat cycle. Heat cycling at the factory during the curing process when varnish is applied as a protective coating causes stresses to be set up that cause resistance changes. Grisdale, Pfister, and van Roosbroeck have reported[1] the following:

"Stresses set up in the carbon films due to the greater thermal expansion of the core produce changes in the resistance of the films. The stresses set up in the films by expansion or contraction of the protective layer do likewise. Figure 21 illustrates the fact that stresses set up during curing of the varnish change subsequently with time in such a way that the resistance decreases, approaching an asymptotic limiting value. If the resistors are cycled in temperature, the immediate result is an increase in resistance followed by a slow decrease towards the initial value."

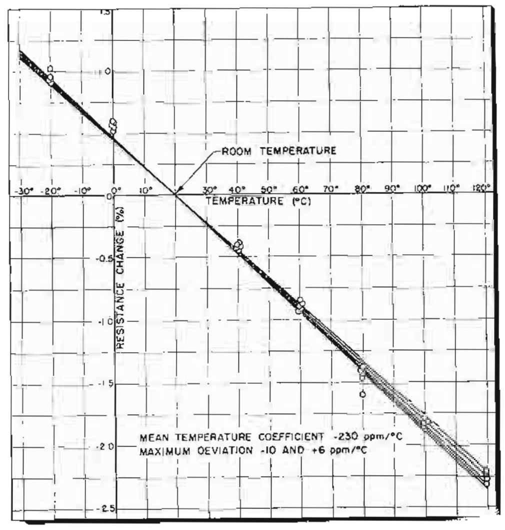


Fig. 4: Temperature-resistance change curves

"Fig. 21" in the above quote refers to a graph showing resistance aging of varnished pyrolytic carbon resistors as influenced by thermal cycling and time. It is reproduced as Fig. 3 in the present article.

It is believed that thermal cycling (similar to factory cycling) of these pyrolytic - carbon resistors might produce aging curves similar to those in Fig. 3. The intensity of resistance change would probably be less. The resistance changes after thermal cycling and time aging of the resistors in this test are given in Table II. It can be seen that the mean resistance change of groups of resistors after 60 days is more negative than immediately after the heat cycling. Hence these data indicate a negative change in resistance following a heat cycle. After the cold cycle no data were taken.

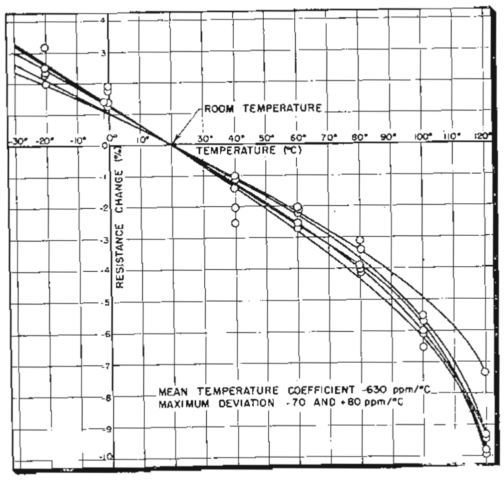


Fig. 5: Temperature-resistance change curves

Resistance Change

Figs. 4, 5 and 6 show resistance change (in percent of original value) versus temperature (°C) for three values for the type "E" resistor. The original room temperature, 20°C, was taken, and all the curves are drawn through this point. Temperature limits of −30 and +120°C are the extremities of the curves. On each of these figures are stated the mean temperature coefficients in parts per million per degree centigrade and the maximum deviation of any one resistor from this mean value in ppm/°C. These temperature coefficients T_c (in ppm/°C) were calculated from the following formula:

$$T_c = \frac{\Delta r \times 10^6}{\Delta t \times r}$$

where Δr = change of resistance (in ohms) between 20 and 70°C, r = original value of resistor (in ohms), and Δt = 50°C (70°C—20°C).

Fig. 7 shows the mean temperature coefficients of each type of resistor plotted against film resistance. These

(*Continued on page* 121)

TABLE I

Description of Resistors Used in Test

Type	Values Used in Test (ohms)	Number of Each Value	Type of Film	Wattage
A	1.3K, 5K, 40K 150K, 800K	5	carbon	¾
B	200, 1K, 50K 200K, 1M	5	carbon	½
C	1K, 5K, 10K 250K, 1M	4	metal	½
D	10K, 50K, 100K 500K, 5M	3	carbon	½
E	1K, 5K, 75K 250K, 1.5M	5	carbon	½

TABLE II

Comparison of Resistance Changes After Aging of Resistors

Type	Value (ohms)	Number of Resistors	Change of Mean After Heat Cycling 20 to 120°C (%)*	Change of Mean After Aging for 60 Days (%)*
A	40K	5	−0.04	−0.24
B	50K	5	+0.07	−0.14
C	50K	4	+1.22	+0.67
D	50K	3	−0.17	−0.34
E	75K	5	−0.06	−0.22

* These percentages are with respect to original values.

High Quality Radar Picture

Bright display equipment provides TV pictures of airport surveillance radar information together with mapping and ADF signals. Graphecon storage tube converts PPI radar to standard TV scan

By R. T. PETRUZZELLI
Television Transmitter Div.
Allen B. DuMont Labs.
Clifton, N.J.

BEFORE presenting the technical details of the picture display unit itself, it seems advisable to discuss briefly the radar equipment with which the bright display system will function.

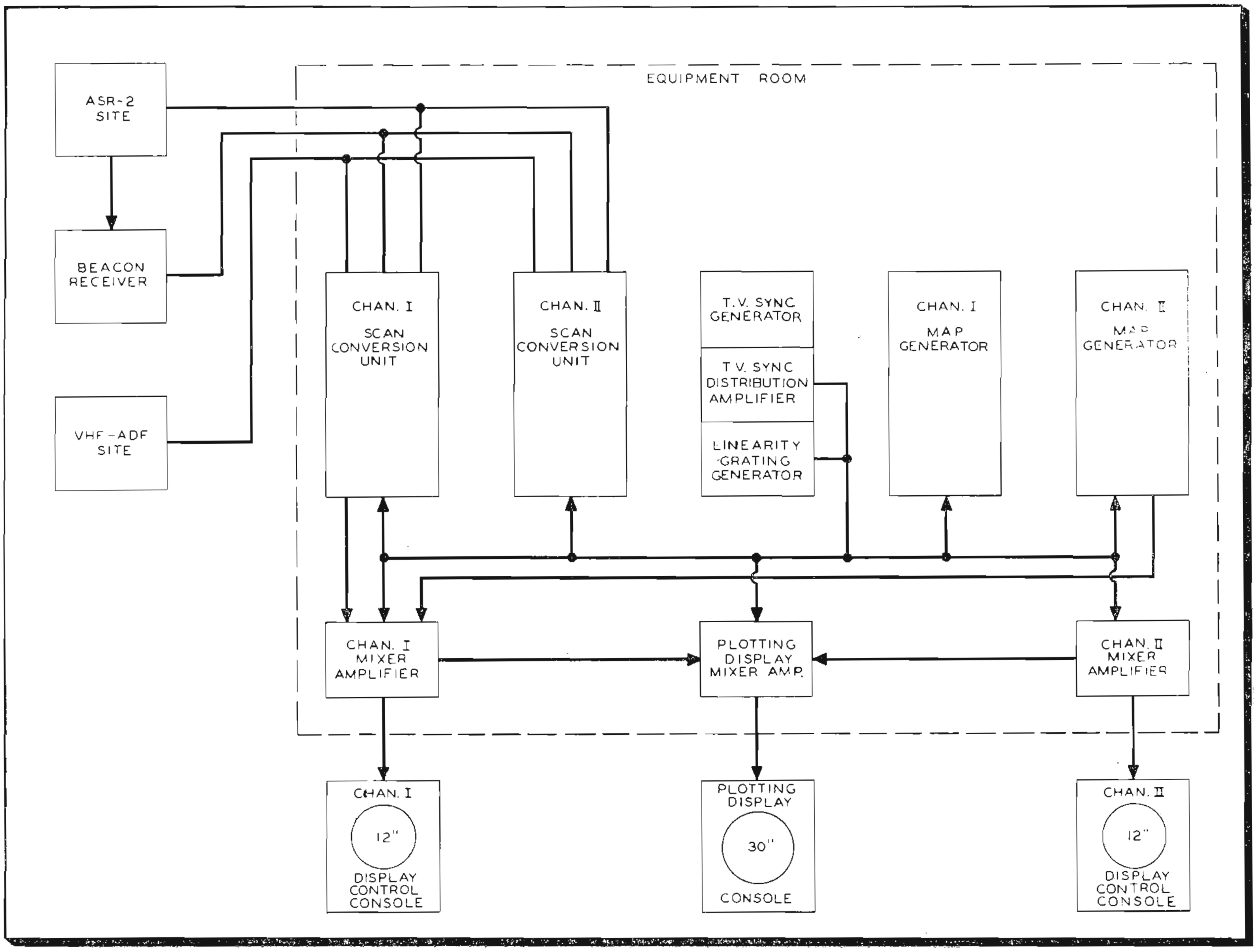
The ASR-2, Airport Surveillance Radar is a PPI (Plan Position Indicator) radar yielding range and azimuth information of aircraft in the general vicinity of an airport. It operates at a frequency of 3000 MC and has a maximum range of 60 mi. covered in five ranges: 6, 10, 20, 30, or 60 mi. The antenna scan rate is 25 rpm and the antenna beam width is 2.25°. The radar pulse width is 1 μsec with pulse repetition frequency of 1200 pps. The radar provides for both normal and M.T.I. (Moving Target Indicator) presentation together with beacon signals.

The ASR-2 together with another independent radar, the PAR, comprise what is commonly known as Ground Controlled Approach (GCA). The PAR differs from the ASR-2 in that it is a precision short range radar used to direct an aircraft (from the ground) along a prescribed course and glide path on its final descent to the airport runway.

The ASR-2 Bright Display Equipment is an electronic display system providing bright TV pictures of airport surveillance radar information together with TV mapping information and ADF (Automatic Direction Finding) signals. It functions to provide a combination of the above signals on a bright display console at a brightness level sufficient for operational use in an airport control tower where high ambient light levels might be encountered. Contingent upon operational experiences and evaluation, this type of equipment could be used to replace normal radar and ADF indicators now in use.

The operation of the ADF may be described as follows: when an aircraft communicates with the control tower, an automatic VHF-ADF receiver takes a bearing on the plane and transmits this bearing information (in the form of electrical signals) back to the radar indicator. When the radar operator depresses

Fig. 1: Primary sections comprising TV display of airport radar are scan conversion units, map generators, mixer amplifiers and display consoles



Display Unit

the ADF switch, the normal radar display is interrupted for a very short time while an ADF strobe line is written on the tube. The strobe line originates at the ADF site (which usually does not coincide with the radar transmitter site) and passes through the target, thus indicating to the control tower operator which plane is in communication with him.

Four Major Blocks

Referring to the block diagram of Fig. 1 one may observe that neglecting the multitudinous control circuits, the system may be reduced to four major blocks: the scan conversion unit, the map generator, the mixer amplifier, and the bright display console. The BDE (Brightness Display Equipment) is composed of two channels, each of which terminates in its own bright display console. The channels are independent and therefore the two display units may be used to monitor different areas surrounding the airport.

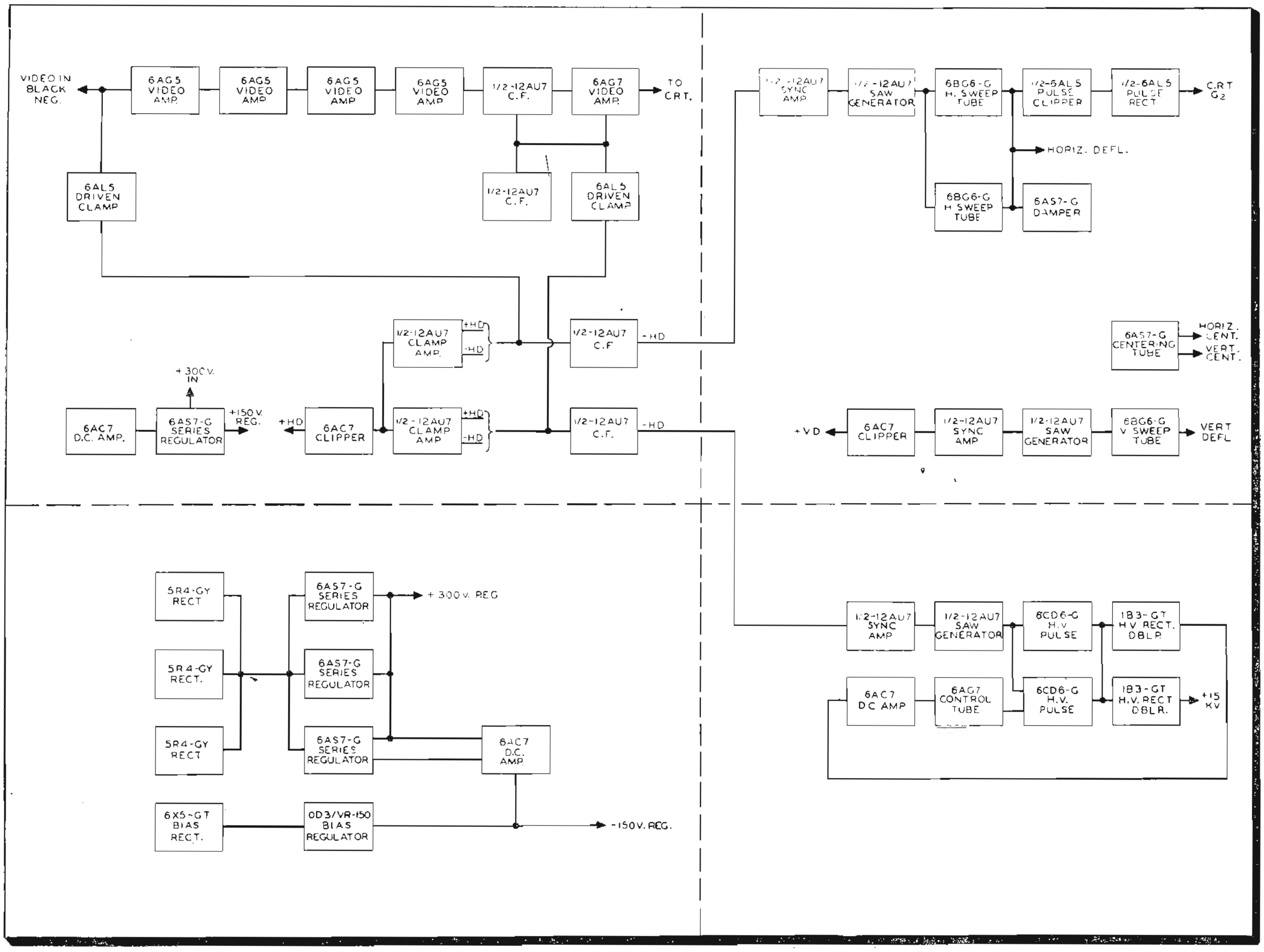
The four basic blocks listed above are required for each channel. In addition, there are certain units which are common to both channels of the BDE. Among these common units are: the TV synchronizing generator to generate signals for timing of TV sweep circuits; sync distribution amplifier to feed the above signals to the various units where they are required; the linearity grating generator which is used as a reference standard to set or to check periodically the linearity of the numerous TV time bases; a rack-mounted picture monitor for checking the output of the scan conversion units and the map generators locally; and a rack-mounted waveform monitor used for setting levels of TV signals and general trouble shooting. In its entirety, the dual channel BDE consists of eight relay racks of equipment plus two 12-in. display control consoles and a 30-in. direct view plotting display console. The display control consoles (see Fig. 2) incorporate all of the controls for the radar set normally found on the original radar indicator. The plotting display console, however, has no control over the radar set and can merely switch its own mixer amplifier to accept the output signals from either channel.

Graphecon Storage Tube

The heart of the scan conversion unit is the graphechon storage tube shown in Fig. 3. It is the link in the system which allows us to convert from the normal PPI radar scan to the standard 525-line, 30-frame TV type scan with a 1:1 aspect ratio. As a result of the graphechon storage and rapid TV writing rates, a continuous bright picture is obtained.

The graphechon tube is about 18 in. long and contains a two-sided storage target placed in the middle of the tube between two diametrically opposed electron guns. The target consists of a fine wire mesh supporting a thin aluminum film on the writing side, and a thin film of insulating material on the reading side. The normal scanning of the low velocity reading beam holds the insulator surface (of the target) at near ground potential. The aluminum film is normally held at a nega-

Fig. 2: Block diagram shows how display control console incorporates all controls for radar set normally found on the original radar indicator



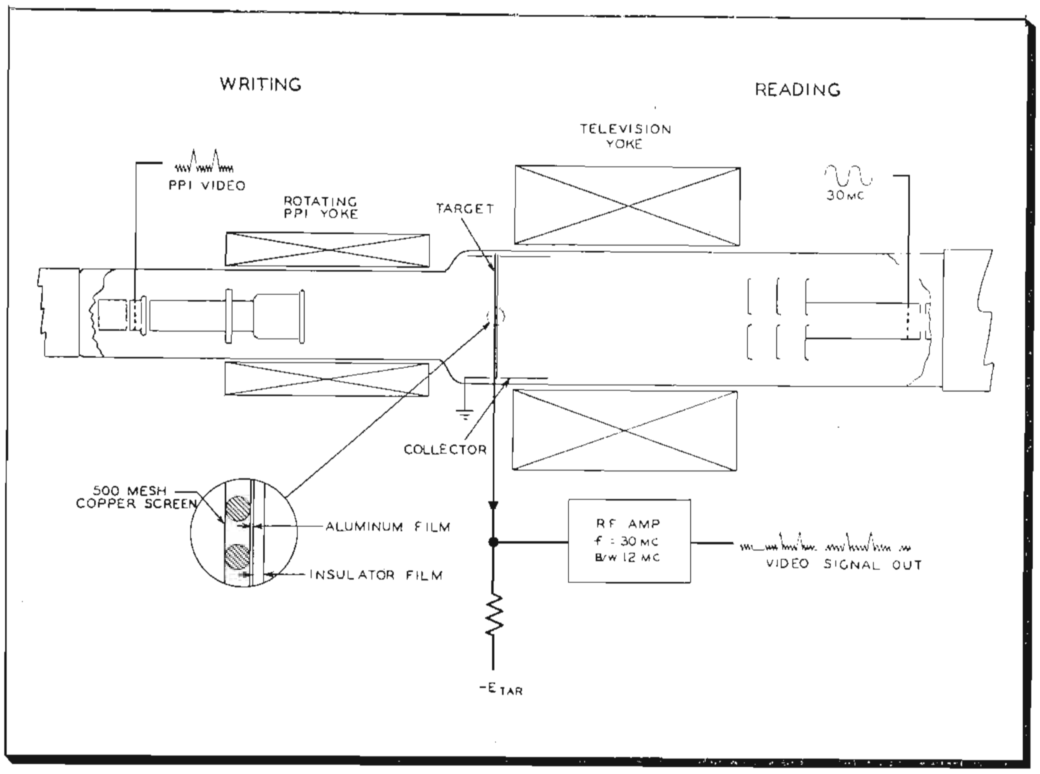


Fig. 3: Graphecon storage tube converts from PPI radar to standard TV scan with 1:1 aspect ratio

tive voltage. When the high velocity writing beam is turned on by a target signal appearing at its grid, it penetrates the aluminum film and charges the insulator surface down to the negative target voltage. Due to secondary emission, a signal voltage is developed across the target load impedance when the reading beam passes over a point which has been so charged. The rate at which this charge is removed (or storage time) is determined by the reading beam intensity.

Since the writing and reading signals appear together across the target load when it is scanned simultaneously, a method of effecting a separation of the two must be used. This can be done by modulating the control grid of the reading gun at an r-f rate and coupling the target to an r-f amplifier.

Map Generator

The map generator is a TV flying spot scanner with a map selector system which operates with the radar range changing switch to give the proper map for each range. It provides five normal center maps (one for each range), and 10 off-centered maps for the six-mi. range off-centered by one radius, yielding ten 12-mi. sectors.

In operation, a raster on a special short persistence cathode-ray tube is focused through a lens system on a map transparency behind which is located a photoelectric cell. The signal output of the photocell is then passed through a video amplifier which is compensated to correct for the phosphor decay time of the flying spot scanner tube.

Independent Level Control

The mapping signal is then mixed with the detected output of the scan conversion r-f amplifier in the TV mixer amplifier. The mixer amplifier provides independent level control of both radar and mapping signals. In addition, it adds blanking signals, sets pedestal levels, and feeds three output cathode followers to distribute signals to the display consoles and the picture monitor.

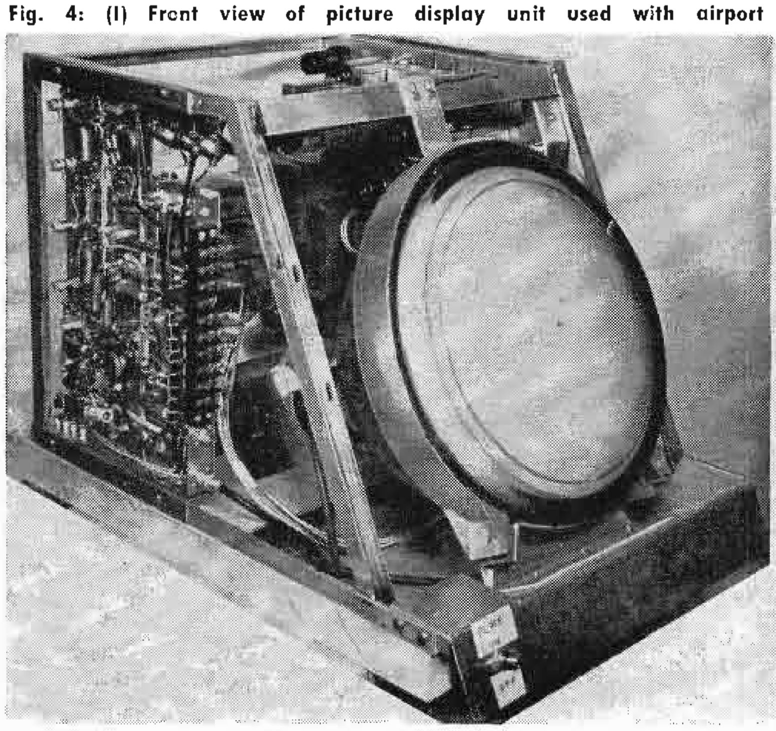
The front view of the picture display unit is shown in Fig. 4.

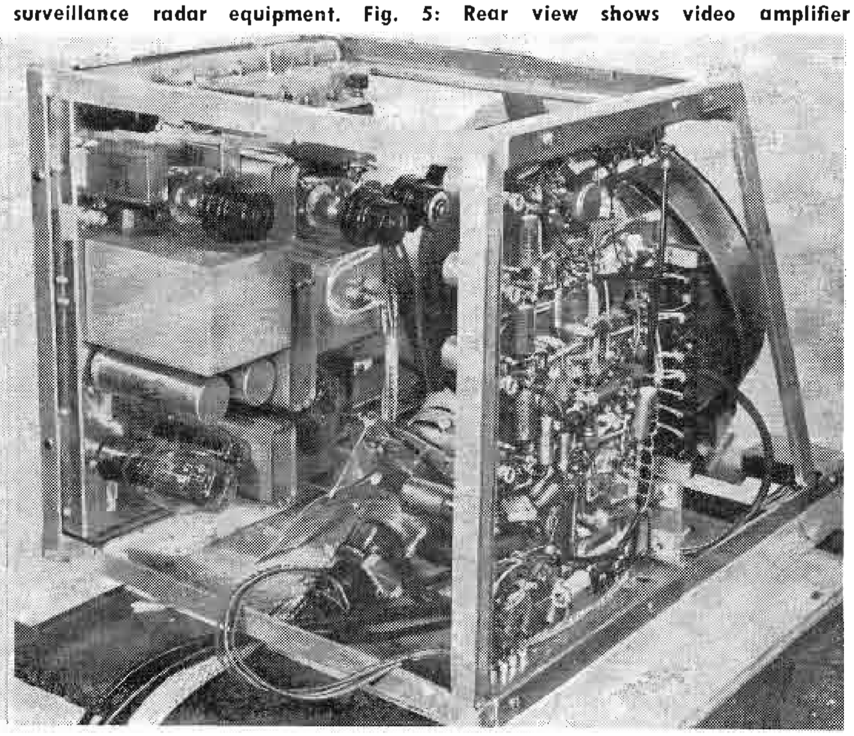
Sweep Circuits

In order to obtain a highlight brightness of 60 foot-lamberts and still use a gray face-plate CRT, it was necessary to employ an aluminum-backed picture tube in the display unit. This does not represent the best situation regarding small area contrast (i.e., high resolution), but for this particular application it does represent a good compromise. The use of permanent magnet focusing results in highly stable operation.

In order to avoid the common vertical sweep problems encountered when vertical output transformers are employed, it was decided that we use an already developed Du Mont yoke having high impedance vertical coils for direct drive vertical deflection. Through the use of this yoke, the problem of obtaining the required vertical deflection linearity

Fig. 4: (l) Front view of picture display unit used with airport surveillance radar equipment. Fig. 5: Rear view shows video amplifier





has been greatly reduced. This yoke was designed by our Research Div. for use in a Universal Color Scanner now being manufactured by the Transmitter Div. Very good overall focus is provided through choice of proper winding distribution.

Centering control circuits used in most commercial TV equipment employ low resistance, high wattage, wire-wound potentiometers to introduce a dc centering current. Operationally, these circuits are often unsatisfactory from the standpoint of "noisy" or "dirty" controls causing "break-up" of the raster during the process of centering or under vibration. The use of a direct-coupled vertical output circuit has made possible an improved type of centering system. In a directly driven circuit it is only necessary to buck the average or dc component of the yoke current. The yoke is connected to the plate of the output tube, with a choke from plate to B+, and the yoke return is made to the cathode of a cathode follower centering tube. Centering is accomplished by varying the grid bias of the cathode follower, thus eliminating the flow of heavy centering currents through the potentiometer. A similar circuit has been designed for horizontal centering.

The horizontal deflection circuit is a standard high efficiency controlled triode damper output circuit.

Range Rings

The system linearity specifications require that the circularity of range rings on the display unit CRT (with a minimum 11-in. display) be within one-eighth of an inch. These requirements have been successfully met through the use of high quality deflection components and conservative derating of tubes and components in the deflection circuits.

The rear view of the display unit, Fig. 5, shows the video amplifier which is used in the display unit. It is essentially a three-stage shunt peaked video amplifier with cathode peaking used in the output stage. In the interest of stability and good frequency response, the amplifier tubes are run with considerable degeneration as a result of unbypassed cathode resistors. The high frequency response is essentially flat out to approximately 8 MC (3 db point) and there are no detectable peaks in the response curve. In addition to the three tube amplifier, two additional unity gain stages have been included. These stages employ cathode peaking to compensate for high frequency losses in a long coaxial cable leading to the equipment.

In preference to ordinary dc restorers, driven clamps are used to re-establish dc levels. Two double diode driven clamps are used in the amplifier. The first is used as a low-

(*Continued on page* 100)

1953 Spectrum of *FCC FREQUENCY ALLOCATIONS*

See Large Chart in Six Colors Sent as Editorial Supplement to This Issue

THE spectrum of frequency allocations as assigned by the Federal Communications Commission is of course fundamental to the work of all radio, television and electronic engineers in designing or installing equipment where any radiation is involved.

Until the present time in the post-war period, uncertainties with respect to final allocations and delays in ratification by the countries concerned, have made it inadvisable to attempt to prepare a comprehensive spectrum chart of the FCC frequency allocations in force.

Now, however, such a tabulation has been completed with the aid of FCC officials, and a large chart in colors has been reproduced to be sent as a supplement with this issue of TELE-TECH—the first such chart to be published in many years. As noted on the chart itself, only one section remains to be implemented and this is expected to become effective during 1953.

During the second World War national and international frequencies were taken by all and sundry and as countries fell and rose again, the allocation table was useful only to the extent that it served to show what conditions *were once*. In 1947 the first post-war frequency allocation convention was held in Atlantic City, N.J., and the foundations of today's worldwide plan were laid. Now, after long consideration by all the governments, and various modifications, most of its provisions have been implemented.

The frequency allocation of greatest interest to engineers in North America is that of Region 2 of the 1947 Atlantic City Convention, i.e. that part of the world encompassing the United States. The Convention divides the world into world-wide, regional and local allocation areas. In region 2 the FCC allocates frequencies for use in America by the various services subject to conformity with the terms of NARBA. Our TELE-TECH Spectrum Chart shows these services broken down into as many minor categories as possible, consistent with legibility.

In some cases it was necessary to combine a number of similar minor services into one group to avoid a multitude of very narrow frequency divisions. However, the user who requires *precise* frequency band information can use the Spectrum Chart as a general tool to locate the various bands in which his proposed service can operate, and then refer to Part 2 of the FCC Rules and Regulations (and the applicable modifications issued since December, 1950) to determine the *exact* frequencies available.

A point often overlooked by the casual observer, and even the interested engineer who only rarely has occasion to deal with frequency allocations, is that the actual *policing* and enforcing of world-wide frequency plans is done by the individual countries concerned and violations by neighbors can only be referred to the government of the offending country and, for purely moral suasion, to the Frequency Registration Board at Geneva. In individual countries the enforcement agencies can, in most cases, use their allocated radio frequencies in any desired manner to get the most use out of each band. For instance, recently, the FCC proposed changes in the allocation structure of the 450-460 MC band which is used mainly for mobile work. These changes involved only the pairing and use of certain frequencies for mobile and base stations within the 450-460 MC band. Therefore, international approval was not required because the prime purpose of the Atlantic City Convention allocation was not changed.

Many other proposals and changes will doubtless be suggested from time to time, and if any of these are made final by the Federal Communications Commission any necessary changes in the information appearing on the TELE-TECH Spectrum Chart can easily be made by writing in the new data.

JOHN H. BATTISON,
Contributing Editor

Pressure Microphone

Technical design details of type BK-1A, developed especially to have sensitivity and frequency response equivalent to boom microphones. Mechanical shock, air current, and studio set noises present special problems

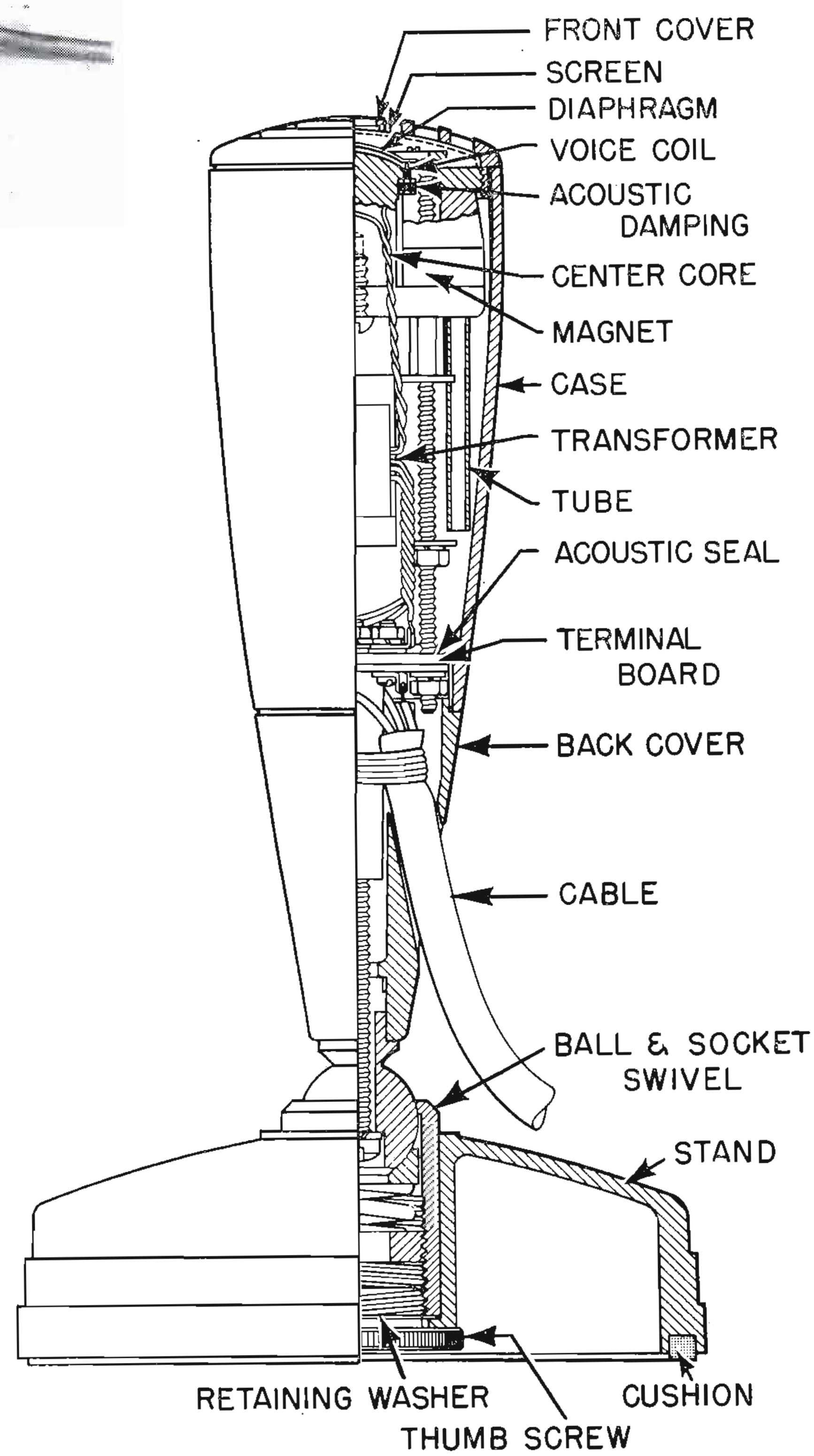


Fig. 1: (Left) Photo of new model BK-1A pressure microphone. Fig. 2: (Right) Cross-sectional view shows construction detail

By L. J. ANDERSON
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MICROPHONES used in TV are subject to a great deal more handling and in many cases rougher handling than in broadcast service. This condition necessitates the use of microphones which are extremely rugged in construction. Microphones are moved about during programming, sometimes rapidly. They must therefore be insensitive to air currents and mechanical shock. Stage sets are often noisy and for some conditions directional microphones are highly desirable in order to obtain an adequate signal to noise ratio. In many programs the microphone must either be entirely out of the picture or cleverly concealed.

Microphones of good uni-directional characteristics have become fairly standard for the boom applications, while unobtrusive non-directional models lend themselves more readily to concealment. However, the slender models of this type are rather low in output level,

for TV and Broadcast Service

except when used for close talking. There is, therefore, a need for a rugged pressure type microphone having a sensitivity and frequency response equivalent to that of the boom microphones for use in TV as well as in broadcasting.

The design of such a microphone presents many interesting problems, the solutions of which are based on experience, experiment and calculation. Since the problems are best discussed on the basis of an actual example, the newly-designed RCA Type BK-1A Pressure Microphone shown in Figs. 1 and 2 is used as an illustration.

A moving coil system[1] was chosen for the transducer because of the relatively high output levels obtainable for a given size and weight and because of the inherent ruggedness. The theory is relatively simple. The value of the generated voltage may be obtained from the following expression:

$$e_o = Bl\ f_m/g_m \qquad (1)$$

where B = airgap flux density
l = length of conductor in airgap
f_m = the driving force
g_m = the mechanical impedance of the moving system
e_o = the generated voltage

B and l are of course independent of frequency and the response-frequency characteristic of the microphone will be obtained by evaluating f_m/g_m as a function of frequency.

Effect of Case Dimensions

For sound waves where the dimensions of the case are small compared to a wavelength

$$f_m = A_d p \qquad (2)$$

A_d = effective area of the diaphragm
p = free-field sound pressure

For higher frequencies, because of diffraction effects[2], the sound pressure on the front of the microphone will rise with increasing frequency above the point at which the dimensions of microphone become an appreciable part of a wavelength. For a cylindrical shape, the pressure rise, for normal sound incidence on the end of the cylinder, reaches a maximum of 10 db at the center when the diameter of the cylinder is equal to a wavelength. Beyond this point the pressure falls to zero when the diameter is twice the wavelength. Actually the diaphragm occupies a small area rather than a point, at the center, and the diffraction effect is less drastic than the above data indicates.

The directional properties of the microphone are also a function of the diameter and, to some extent, the modification of the cylindrical body, both as to shape and finite length. In general, a 2-inch diameter microphone will be non-directional to about 1000 cycles and increasingly directional above that frequency. Listening tests have repeatedly shown that for microphones having such directional characteristics a rise in the axial response-frequency characteristic of about 4-6 db in the range from 2000 to 10,000 cycles is desirable. This being the case, a 2-inch diameter will be maximum

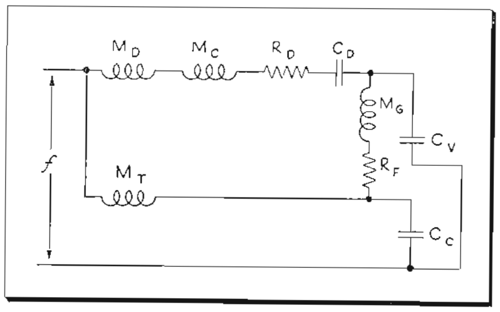

Fig. 3: Electrical analogue BK-1A microphone

for which f_m will remain within useful limits from 50 to 10,000 cycles.

The minimum diameter which the case may have will largely be determined by the specification established for the low frequency response and the output level. Smaller case diameters mean stiffer diaphragms and less space for magnet materials, other things remaining equal. For the type BK-1A Pressure Microphone under consideration, the low frequency cut-off was set at 50 cycles, and the effective output level at —53 dbm for a sound pressure of 10 dynes/sq. cm. Using presently available materials it is not possible to meet these specifications with a microphone much less than 2 inches in diameter.

Evaluation of g_m

Since f_m plotted with respect to frequency differs for all practical purposes from e_o by a constant, the microphone will have the desired response-frequency characteristic if g_m is made a constant with respect to frequency. This is accomplished by coupling to the diaphragm acoustic elements as shown in the equivalent circuit, Fig 3.

The problem is complicated by the many variables and calculations[3] which are both difficult and time consuming. For adjustments to the system and evaluating the results, the electrical analogue is an ex-

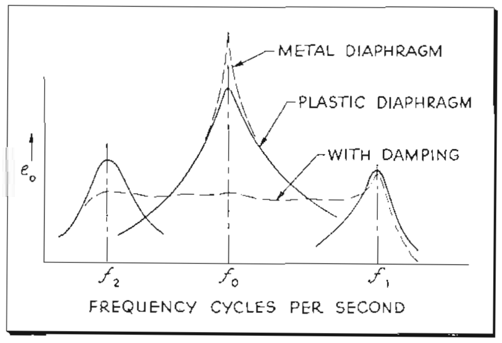

Fig. 4: Theoretical response characteristics

tremely useful tool and may actually be set up using electrical components which are variable to the desired degree. The following general criteria can however be stated. The stiffness of the diaphragm edge C_d and the combined mass of the coil and diaphragm M_c+M_d must be correlated to resonate somewhere within the frequency range between 500 and 1000 cycles if a flat response characteristic to 50 cycles is to be attained. The space immediately behind the diaphragm must be made sufficiently small to introduce an acoustic stiffness C_v into the system which will resonate with the diaphragm and voice coil mass, M_d+M_c at the highest frequency which is to be reproduced.

Low Frequency Response

The low frequency response is obtained by connecting a tube M_t from the outside of the case to the case volume C_f. In general, the low frequency range, once the diaphragm size is fixed, will be determined by the case volume and tube dimensions. If the case volume is reduced below a certain value it will not be possible to secure the desired low frequency range regardless of the tube dimensions chosen. The tube is terminated under the front screen of the microphone in order to prevent wind excitation such as might be caused by moving the microphone or talking close to it. Finally, damping is introduced by closing the annular air gap with an

(Continued on page 94)

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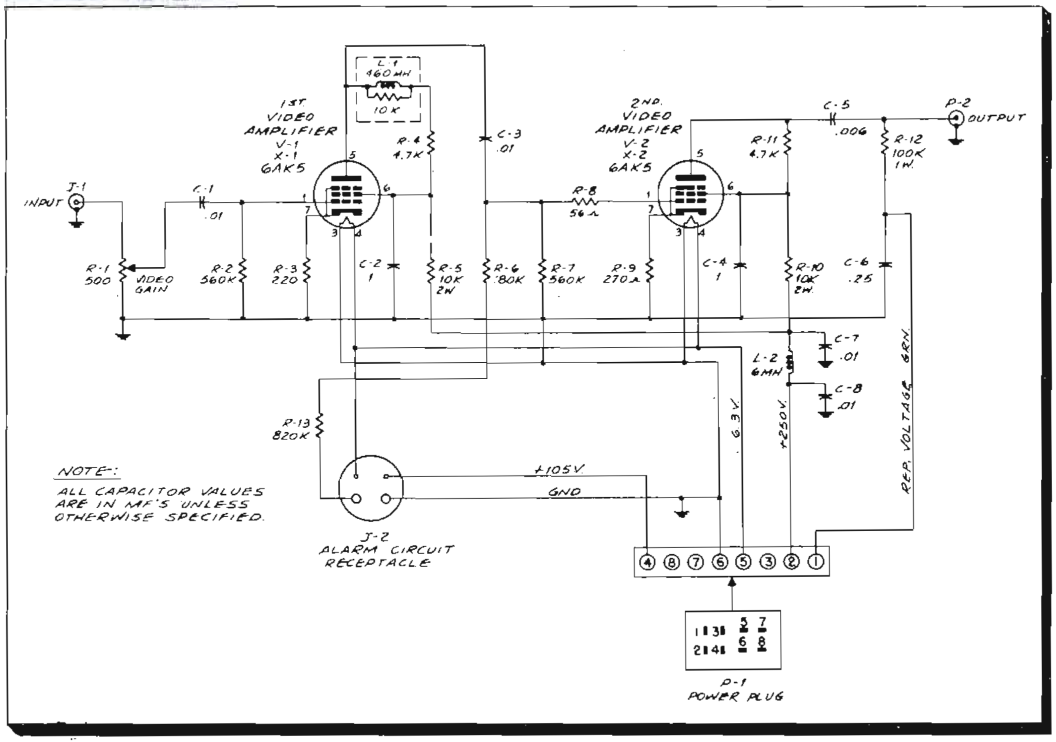
Design Features of a

Many-faceted aspects of systems for pipelines, scribed in detail. Circuit techniques, equip-

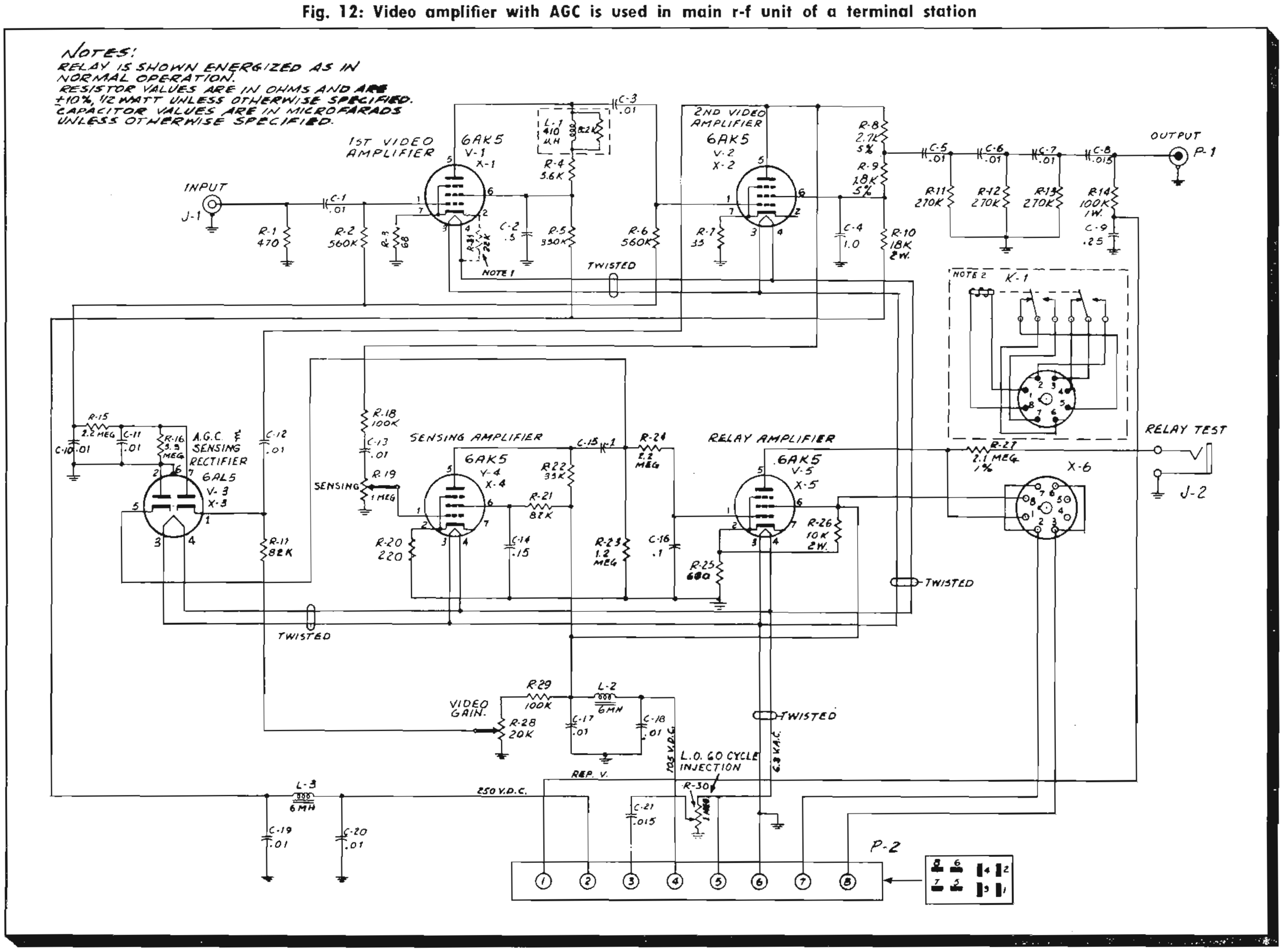
Fig. 11: Simplest type of video amplifier intended for standby or non-switchover units



PART One of this article, appearing in the December, 1952 issue of TELE-TECH, discusses characteristics of microwave frequencies, relay station construction, antennas, plumbing and associated equipment. Part Two (below) describes the video, sweep, AFC, switchover, squelch, power and lighting equipment.

Video Amplifier: Amplifiers are necessary to accept the combined subcarrier output voltages and apply them at a higher voltage and impedance level to the transmitter klystron repeller. A very flat response curve is required so that in successive repeater stations the amplitude of each subcarrier is the same as the others and thereby they all deviate the microwave carrier equally or in predetermined ratios. A group of several successive stations, called a section, usually contains one or two video amplifiers

Fig. 12: Video amplifier with AGC is used in main r-f unit of a terminal station



Microwave Relay

PART TWO OF TWO PARTS

common carriers, government and utilities de-ment functions and design parameters presented

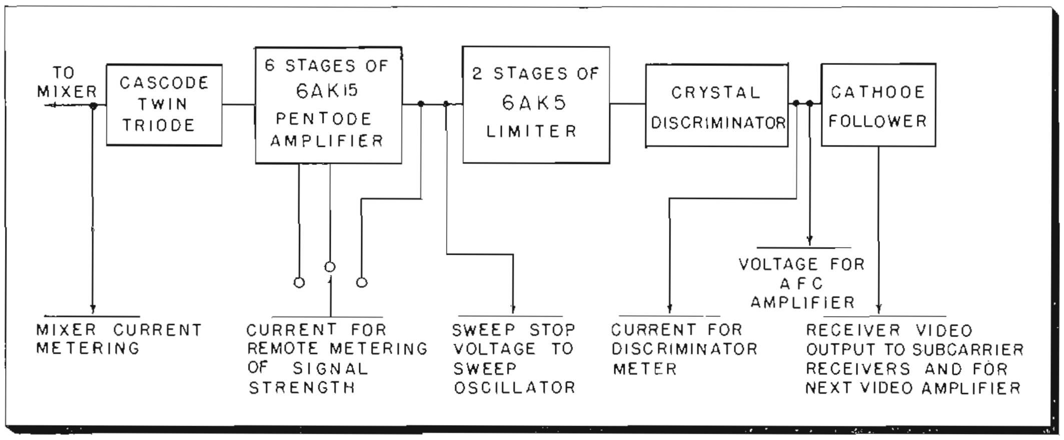


Fig. 13: I-F strip incorporated in FM receiver has center frequency of 75 MC, peak deviation ±3 MC

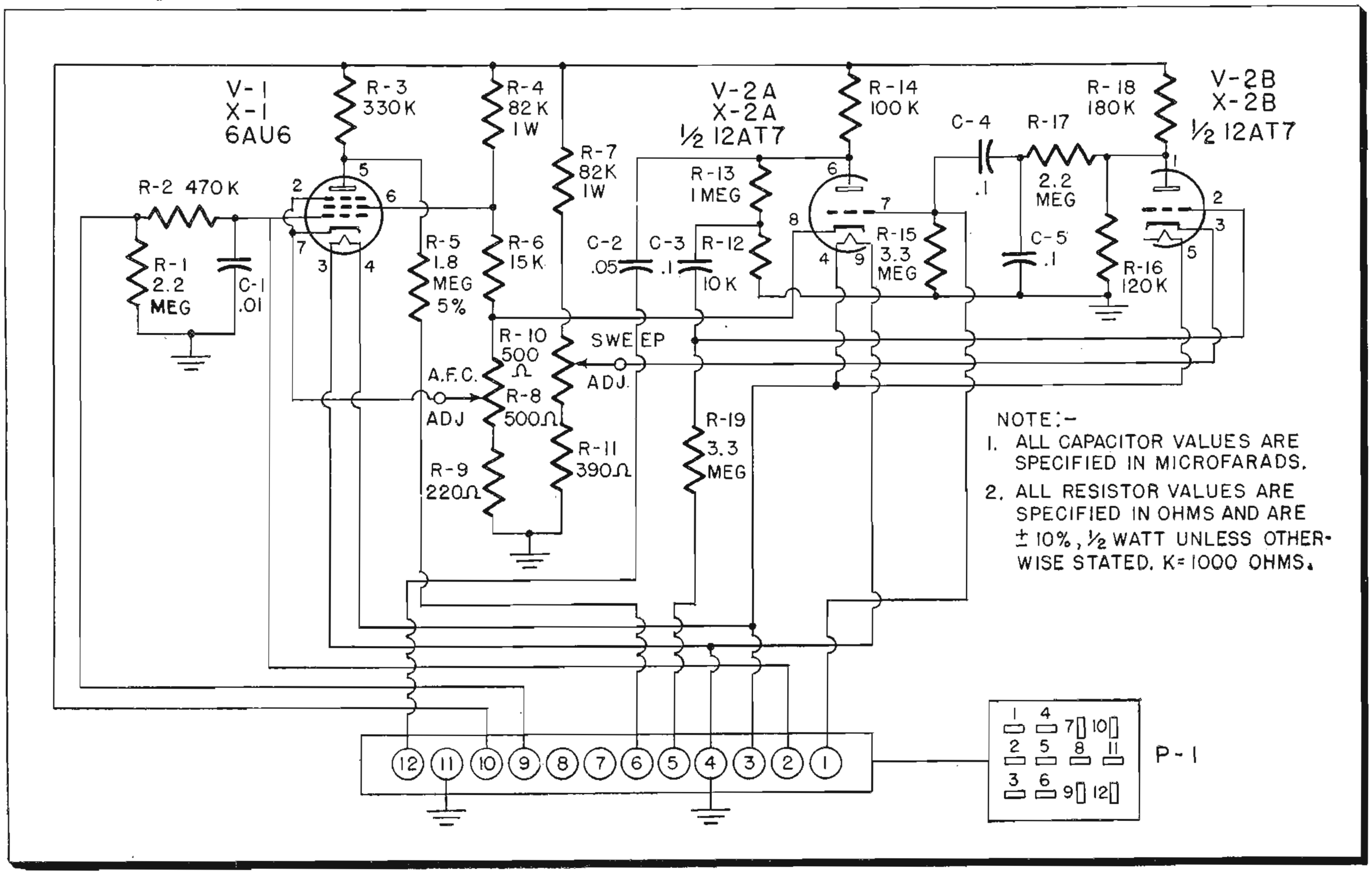
of an AGC type so that a slight drift in modulation depth with time will not be cumulative but will be adjusted by the AGC to a predetermined depth.

(As the nomenclature for broadband modulation amplifiers is not yet settled by the RTMA committee on microwave relays, the word "Video" is used merely to indicate broadband response. Others have used "baseband" or "multiplex channel" to indicate a frequency spectrum from a few cycles to a few megacycles.)

The video amplifier also contains sockets for plug-in accessories. The amplifier for the main r-f unit has receptacles into which may be plugged a sensing circuit so that a failure may be sensed in order to cause a switchover to the standby unit. The standby video amplifier socket accepts an audio frequency oscillator used as an alarm tone to indicate that a switchover has occurred. These alarm tones are coded by the use of various audio frequencies and are received by alarm detectors at section headquarter stations. The microwave relay system requires three general types of video amplifiers, each of which is available with an AGC circuit. The first type, Fig. 11, is the simplest as it is intended only for standby units or non-switchover units. When installed in the standby r-f unit, it generally includes the plug-in alarm to indicate that a switchover has occurred. The second version, used in the main r-f unit of a repeater station, includes sensing apparatus for detecting a failure in any part of the repeater station from the microwave input circuit of the i-f strip through the output circuit of the video amplifier. The third variety, Fig. 12, is shown with the AGC circuit. This is used in the main r-f unit of a terminal station and differs from the main video amplifier of a relay station in that the failure test tone is separately injected from a terminal sensing chassis because there is no preceding i-f strip which must be sensed, or from which the sensing tone may be obtained.

I-F Strip: The receiver circuit is a superhetrodyne with FM detector. Its "i-f strip" includes a cascode input stage, six i-f amplifiers, two limiters, a germanium crystal discrimi-

Fig. 14: Circuit of chassis which feeds the 2-CPS sweep voltage and AFC correction voltage to the local oscillator repeller



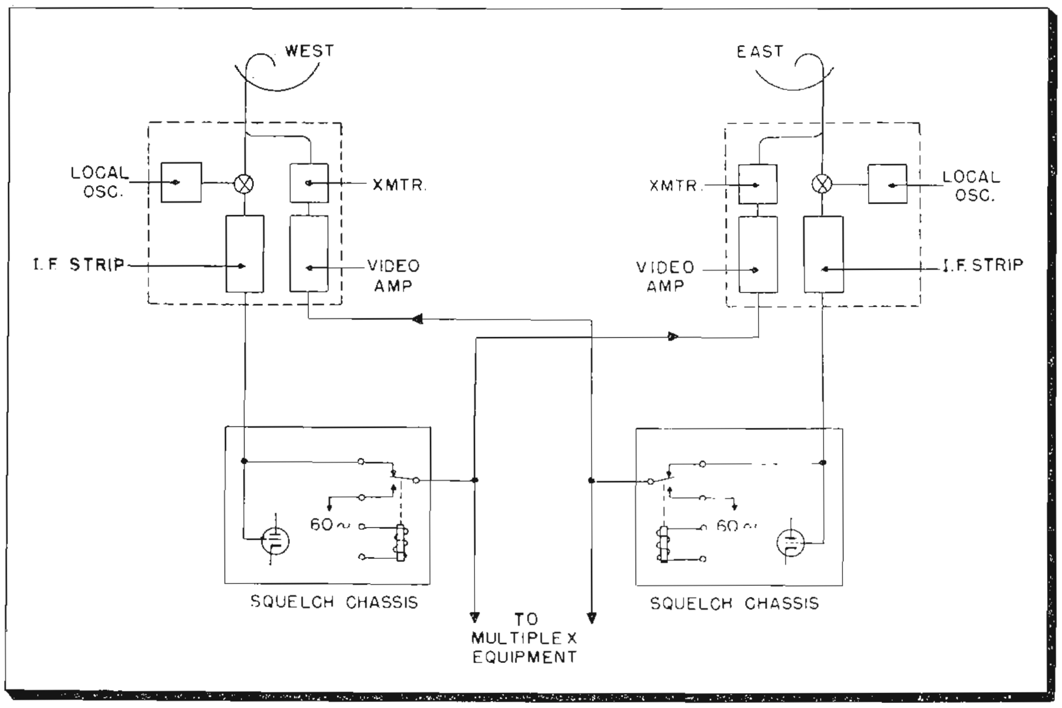


Fig. 15: Where repeaters are grouped, end stations contain a pair of squelch chassis

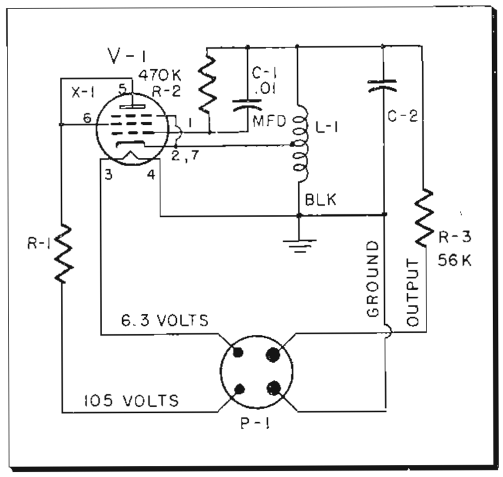
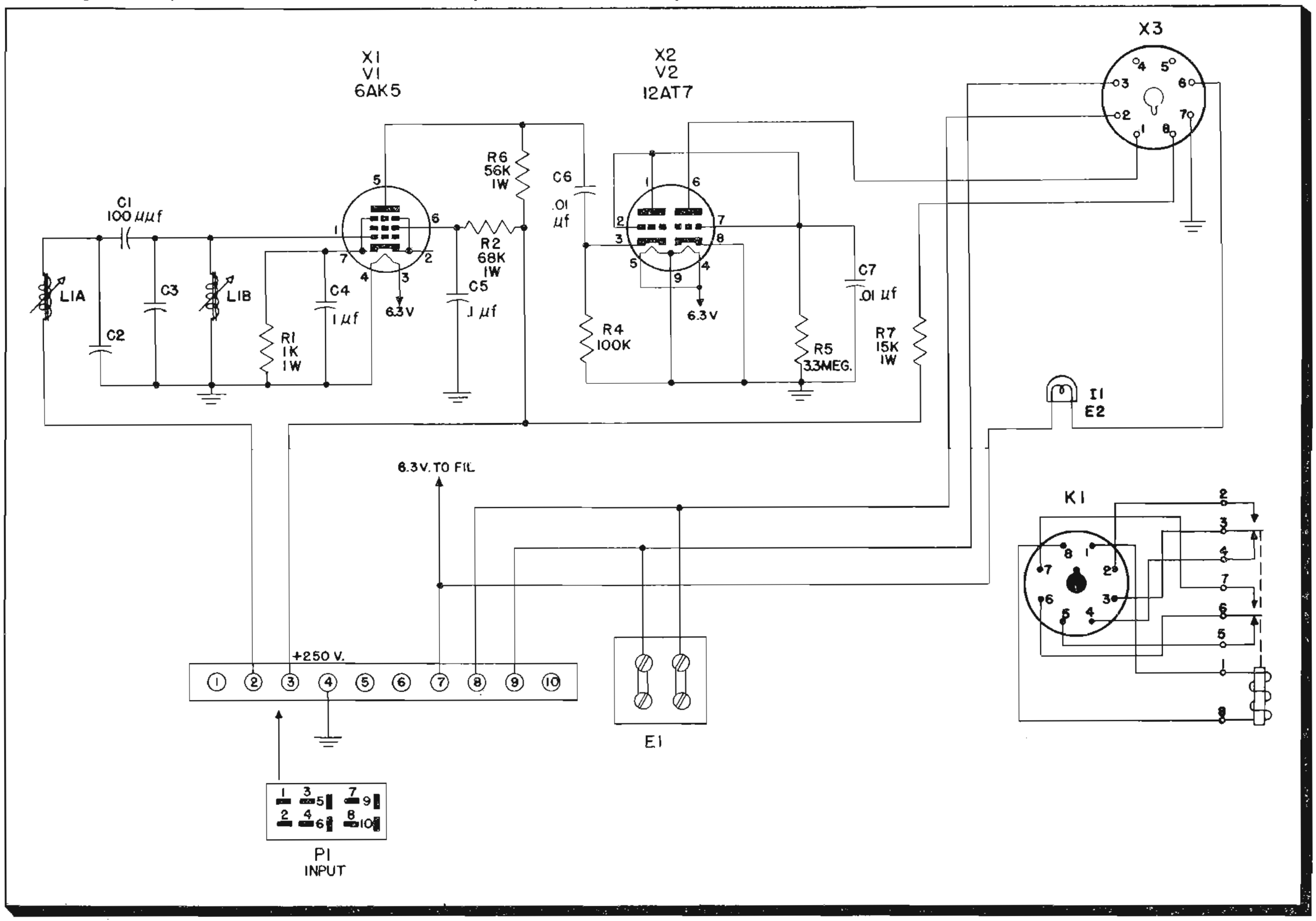


Fig. 16: Alarm transmitter uses coded audio frequencies to indicate cause of the alarm

nator, and a cathode follower, making ten envelopes of vacuum tubes. See Fig. 13. As the design details of this chassis are quite extensive, only its general characteristics will be described herein. The center frequency of 75 MC is normally modulated to a peak deviation of ±3 MC and sometimes more. As it is necessary to pass only the large modulation sidebands, the bandpass is ordinarily between 11 and 15 MC wide at the half-power points. Noise figure for the mixer and i-f strip together is 14 db, with the mixer contributing 10 db. Frequency response of the I-F strip is 3 db down at about 40 cycles and 3 MC and is sometimes of greater bandwidth.

Input and output twin triodes are type 5670, all others tubes being 6AK5's. The gain is 105 db, adequate to cause full limiting on unquieted input noise. The input circuit is adjusted so that all noise in the absence of a signal is symmetrically disposed about the center frequency in order that noise output does not appreciably actuate the AFC circuit. AFC output is taken from the discriminator and is fed to an AFC amplifier for controlling the frequency of the local oscillator klystron. The seventh (last) amplifier feeds a "sweep-stop" circuit which is inoperative when sufficient signal is present and which turns on

Fig. 17: Simplest form of alarm detector has input circuit resonant at particular alarm tone, which is amplified to operate alarm relay



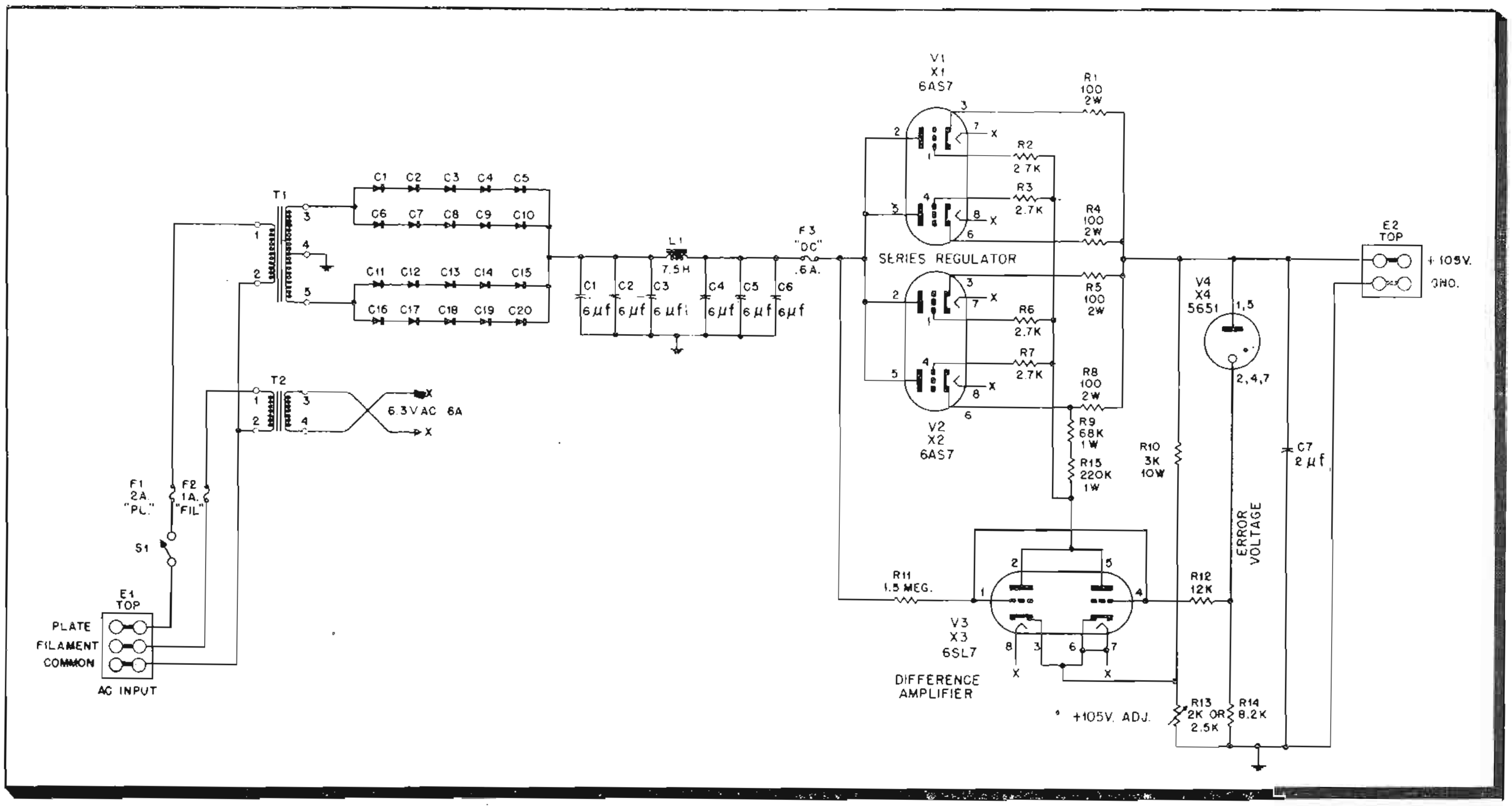


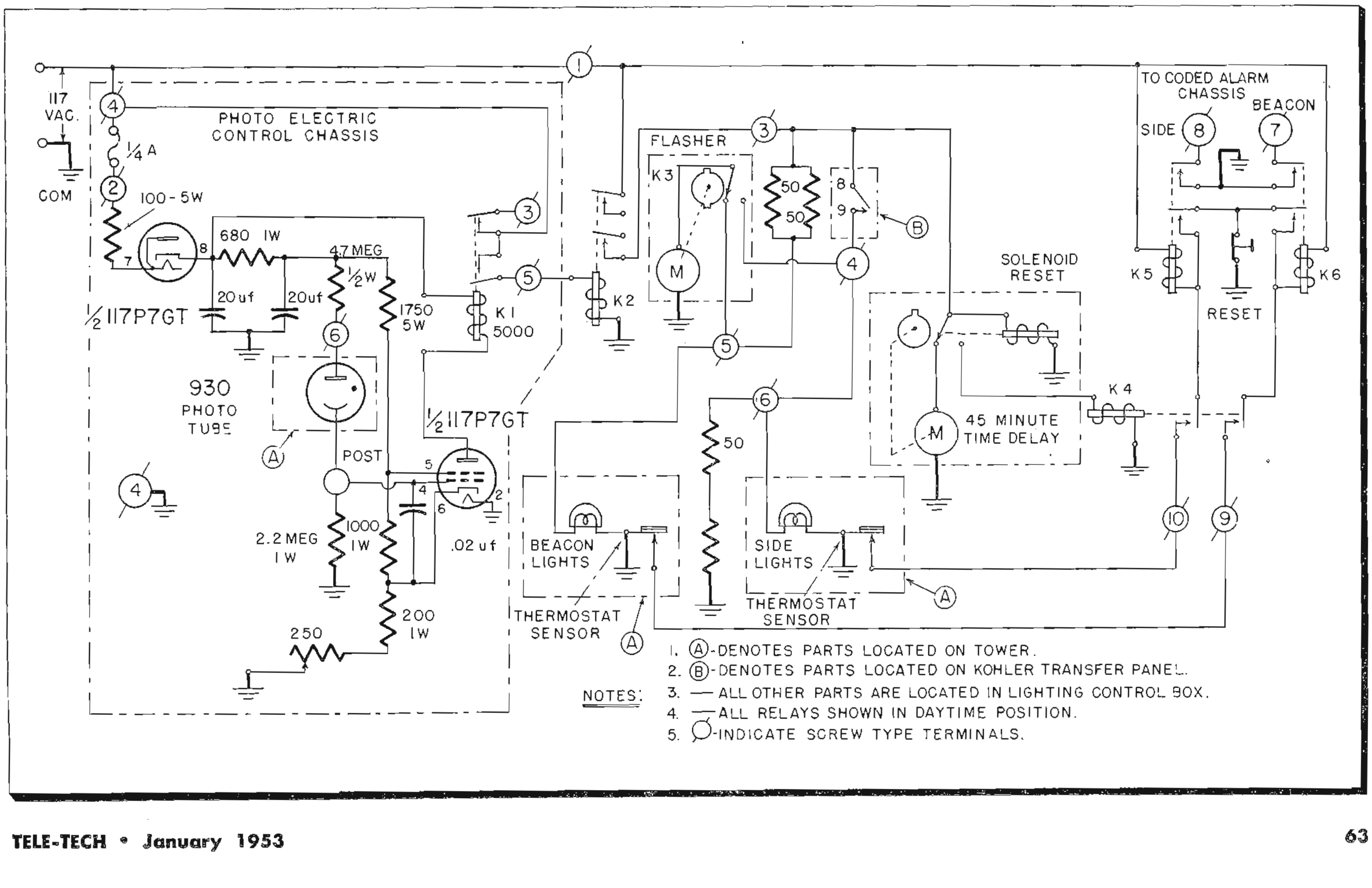
Fig. 18: Schematic diagram of one of the low-voltage regulated power supplies providing 105 volts dc

a 2 CPS sweep oscillator when practically no signal is present, this sweep modulating the local oscillator in order to hunt for a signal. This is convenient for locating the microwave signal automatically and rapidly during any brief warm-up time and after any fade. This application of 2-CPS voltage is indicated to the operator by a 2-CPS motion of the mixer current meter. Bandwidth of the amplifiers is obtained from alternate stages of double-tuned and staggered single-tuned circuits.

Sweeps and AFC Chassis: Fig. 14 shows the schematic circuit of the chassis which feeds the 2-CPS sweep voltage and the AFC correction voltage to the local oscillator repeller. Input to both circuits is obtained from the i-f strip as previously stated. The AFC voltage is adjusted as shown in the schematic circuit to obtain a symmetrical correction with maximum gain so that several megacycles under or over center frequency will cause equal magnitudes of discriminator voltage. The sweep circuit is adjusted to just barely start sweeping when the incoming microwave signal is

(*Continued on page* 136)

Fig. 19: Simplified schematic diagram of tower lighting system for auxiliary power switchover operation



A Printed Circuit Multi-Conductor Plug

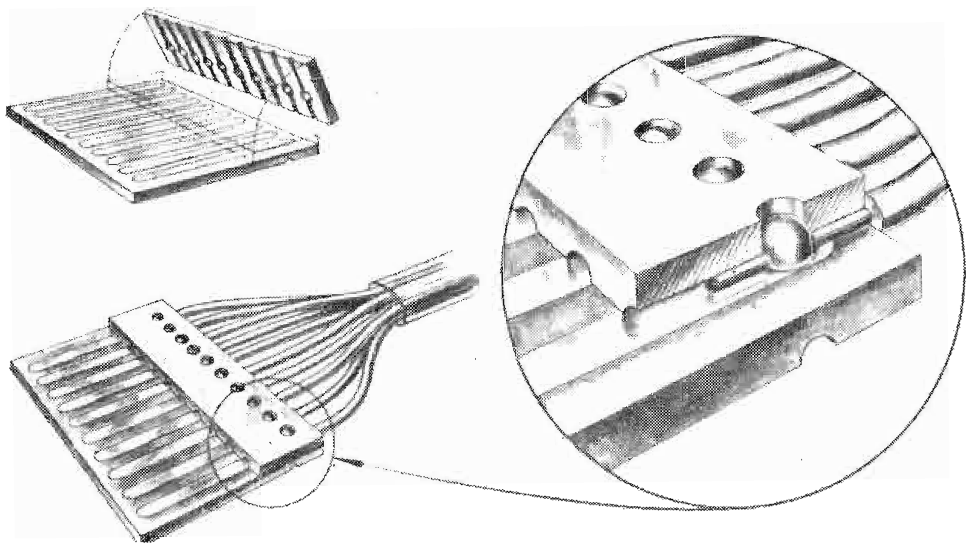


Fig. 1: Exploded view of basic element

Single basic unit is building block for both male and female elements of any size connector ranging from 10 to several hundred conductors. Design permits realization of labor saving potentialities in automatic production of electronic assemblies

By *W. D. NOVAK*, *General Electric Co., Syracuse, N. Y.*

NECESSITY was never more truly "the mother of invention" than in the role she played creating this printed circuit plug. In developing a high speed wire check machine we found it necessary to provide a quick-disconnect device between two banks of printed circuitry which required a 1000-conductor plug. Analysis of the direct labor consumed in hand wiring from printed circuitry to male and female plugs and back to printed circuitry again, showed a prohibitive cost and we were faced with a need for devising something new, or abandoning the project. The solution to the problem came in the form of a multi-conductor plug which had as its mating elements extensions of the printed circuits themselves and required negligible direct labor to assemble. During the construction of early models it became apparent that this same device could be applied to the entire field of multiconductor plugs, and within a single design provide both male and female elements for inter-connecting:

a) Printed circuitry to printed circuitry

b) Printed circuitry to conventional wiring

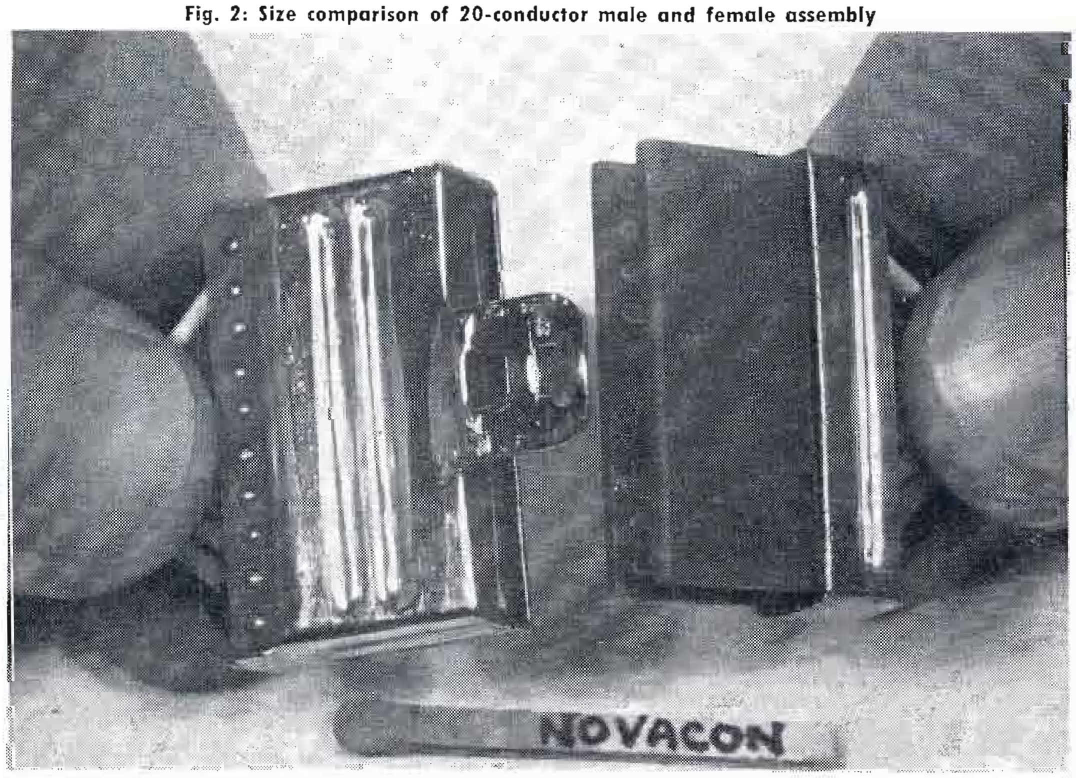
c) Conventional wiring to conventional wiring

Thus it was that a new connector was born and, borrowing from the Latin, appropriately named "NOVACON" meaning "new connector."

Fig. 1 shows an exploded view of the basic element. At the left is the 10-conductor printed circuit pattern, the cover plate formed by an insulating strip with vertical holes to align with the ends of the printed circuit conductor strips, and lateral grooves which form a recess between the cover plate and the printed circuit. When the two have been laminated together with a thermal-setting adhesive, the basic element is formed. The magnified view of one termination shows the method by which wires are fastened to the printed circuit pattern. The wire is inserted in the grooved recess between the cover plate and the printed circuit conductor and a small slug of solder placed in the hole above the wire. Melting of the solder can be accomplished with soldering iron, carbon pencil, or even mechanized for assembly line techniques by use of a small induction heating loop to fuse all ten connections at once. In the instant that the fluid solder is forming an electrical connection between the wire and printed circuit conductor, it is also conforming microscopically with the shape of the transverse hole which, when it solidifies, is the means for mechanically anchoring the wire. Solder is quite weak in tensile strength but surprisingly strong in shear and it is this shear strength that is used to greatest advantage in the termination shown.

Fig. 2 shows one form of the NOVACON plug that is beginning to show signs of becoming a popular design. It is a 20-conductor male and female assembly which is small

Fig. 2: Size comparison of 20-conductor male and female assembly



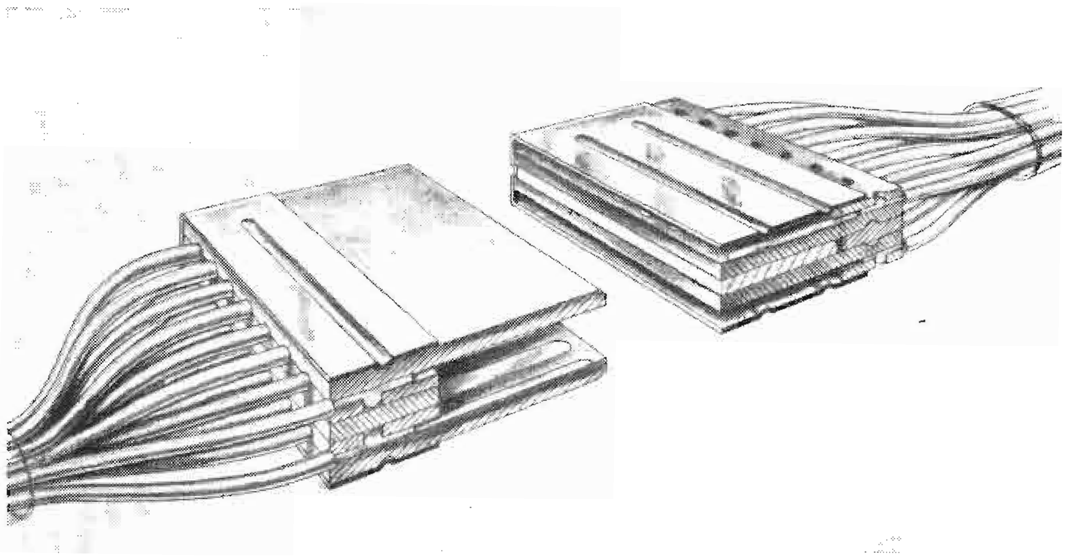


Fig. 3: Cross sectional view of 20-conductor plug assembly

and compact as the contrast with a conventional paper match verifies.

Fig. 3 shows a cross-sectional view of the 20-conductor male and female assembly. Note that all of the ten conductor basic elements in both male and female assemblies are identical. This feature has been carried through every design to enable both manufacturer and user to stock one basic element and a variety of compression devices. By this method the manufacturer is able to supply a wide range of plug sizes but maintain only an inventory of the basic element. By the same token, the user is able to assemble his own combinations as needed, or repair any existing installation by replacing only the basic element which has been burned or broken rather than the entire assembly.

The small latch which projects over the male cover plate forms a lock mechanism which prevents the male and female elements from being separated unless the lock is released. By placing the thumb beneath that latch and raising it slightly the male and female elements may be separated easily. To allow ready access to the connections for electrical measurements, the female element has its terminations exposed to provide test points when the plug is mounted in a chassis or cabinet. All of the metal and textolite parts associated with this design and later designs have been deliberately planned as punch press operations to make fabrication as economical as possible.

Assembly Connections

The grooves in the back of the two 10-conductor elements forming the male assembly coincide with similar grooves in its metal enclosure, and in the female assembly with the extruded bit of insulation between them. The white band in the center of the two 10-conductor elements forming the female assembly is silicone rubber, and the steel enclosure with its lateral grooves is the means for applying compression. When the male assembly is first inserted into the female assembly its elements slip readily into that space between the female elements and their steel enclosure because there is at least 0.010 in. clearance between the mating parts at this point. During this part of the insertion the ends of corresponding printed circuit conductors are permitted to overlay each other without interference. When the outside forward edges of the male elements meet the longitudinal ridges in the steel cover plate of the female assembly, something must give way or the insertion could proceed no further. At this point the silicone rubber is compressed and the insertion proceeds past one or more similar ridges with further compression being exerted. Thus when the male and female assemblies are fully united, we have passed through a series of compressions and wiping actions of the full area of all female printed circuit conductors over their respective male conductors.

Disassembly of Plug

This plug may be disassembled with a screwdriver, penknife, or a coin. In the male assembly removal of the center insulating separator will cause the unit to fall apart in your hands. The female assembly may be completely dismantled by lifting two small metal tabs at the back corners of the metal enclosure.

Fig. 4 shows the 20-conductor plug mounted on a chassis. The male element has been withdrawn and

Fig. 4: 20-conductor plug mounted on chassis

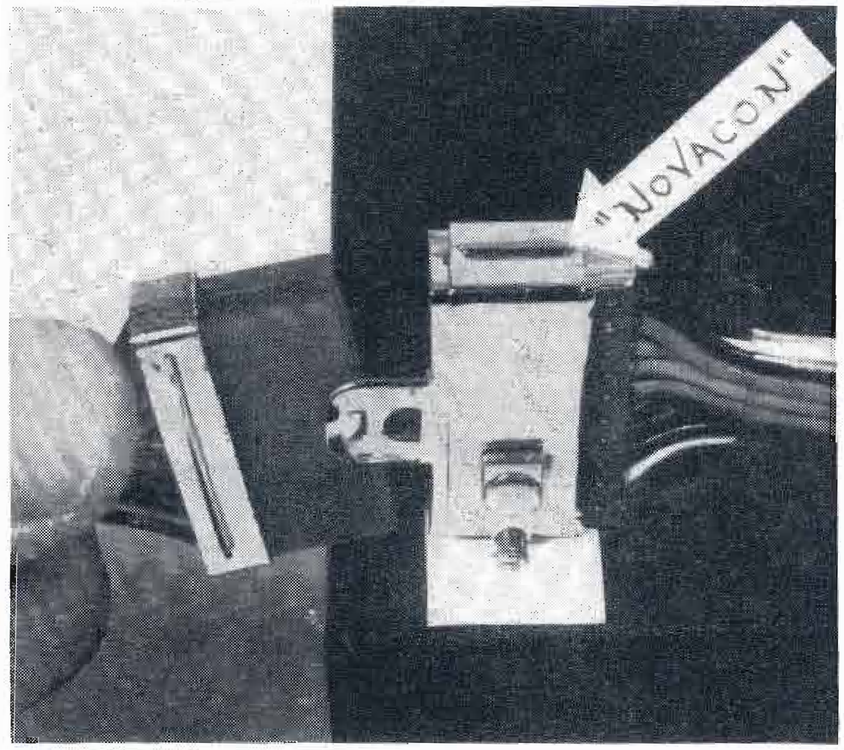
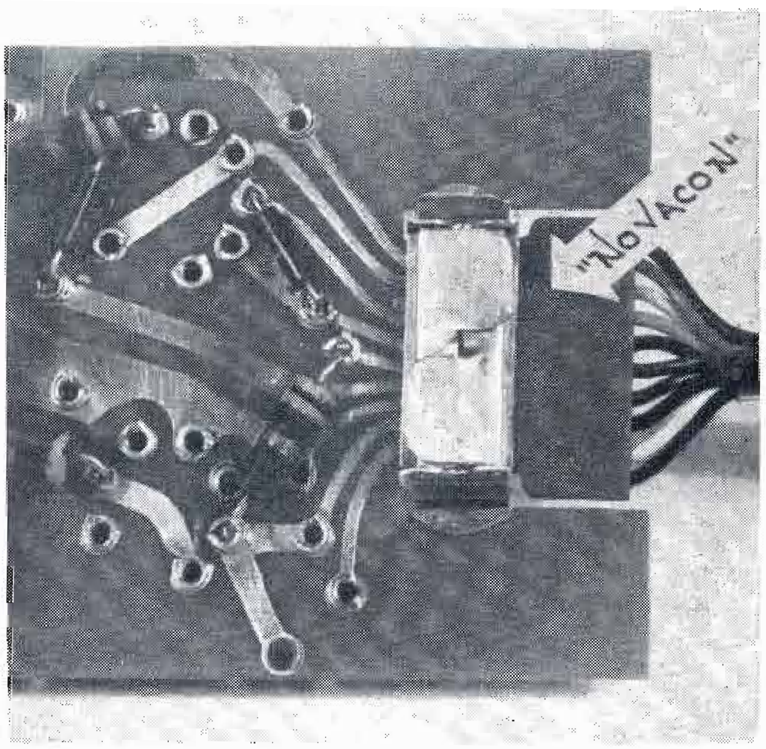


Fig. 5: Closeup of plug using wire to printed circuit



the manner in which the operator is holding it demonstrates the correct position for the thumb to release the locking device. This plug design was subjected to a test in which the male and female assemblies were pushed together, continuity checked and then pulled apart. The cycle was repeated more than 3,800 times before a single continuity failure was detected. More than 12,500 push-togethers were completed without causing physical damage to the printed circuit conductors.

Wire-to-Printed Circuit

The earliest work done in the development of this plug had as its objective the placing of a group of parallel printed circuit conductors in contact with a corresponding group of parallel printed circuit conductors and pressing the two together in such a way as to achieve contact resistance between mating conductors of an order comparable with that of conventional multi-conductor plugs. In so doing we were attempting to create a connector in which the two opposing parameters of contemporary plug design, i.e., contact resistance and separation force, would no longer be related.

We found that it could not be done by placing the corresponding patterns together and squeezing them in a vise. It had to be a vise which was capable of allowing for dimensional differences in laminate thickness, adhesive thickness, copper thickness and plating thickness, even though these variations were in the order of tenths of a thousandth of an inch and might occur in cumulative effect on immediately adjacent conductors. Sufficient pressure must be applied to all mating conductors regardless of these dimensional variations. Fig. 5 illustrates one of several different ways in which this has been accomplished. A typical printed circuit sub-assembly has been fabricated from 1/16 copper-clad textolite, and its conductors brought out to match those of the basic 10-conductor element. A piece of flat beryllium copper spring stock is formed into a curved shape and deflected by two small toggle levers in such a manner that it exerts vertical pressure upon the conductors but is capable of flexing along its length to compensate for dimensional variations in the printed circuit conductors. The 1/16 copper-clay textolite, or thinner, will respond to this flexing spring pressure, or to the deformation of the silicone rubber, even with conductors 1/16 inch on centers. Thicker copper-clad laminates would not flex as readily and did not give the desired results. (Slotting the laminate between adjacent conductors and individual spring figures has been used successfully and is best applied to widespread flat plug configurations and to the heavier laminates.) Note that here again all parts have been deliberately designed for punch press fabrication and its attendant economy.

Now we step into an entirely new field, a field in which the printed circuit plug should have tremendous potentialities. It is in the form of what we have called a "plug-mounted" sub-assembly, and should have almost unlimited application to unitized construction in our computers and other large electronic equipments. Fig. 6 shows a small model which simulates a six-tube transistor sub-assembly which uses the printed circuit board to form the interconnection of the components, the mounting of the components and the means of plugging the entire assembly into a main frame. This unit would be readily removable, even expendable. Cast in resin it would require no further packaging and could be treated much the same as a plug-in relay or vacuum tube. One can visualize how hundreds of such plug-in units for binary scalers would be stacked in computer panels, and when trouble shooting indicators narrowed down to a single unit, it could be immediately replaced.

Printed circuit sub-assemblies such as the one shown may be adapted to completely automatic methods of assembly which would virtually eliminate hand labor from their fabrication. *But unless means of interconnecting the sub-unit with the main frame are designed into the printed circuitry, the savings of "going automatic" in assembly operations will be squandered by the hand labor costs of termination operations.* It is in this role that we feel the NOVACON plug provides a great step forward.

Sealed Terminations

The design in Fig. 7 was created to demonstrate how the same 10-conductor basic element used in all the preceding applications could be made to form a hermetically sealed termination. The female element of the push-together type was chosen since its steel enclosure could be most readily converted to a deep drawn flange which might be soldered into the can of the sealed device which it would serve to electrically terminate. Instead of soldering the wires directly into the printed

(Continued on page 106)

Fig. 6: Plug mounted sub-assembly

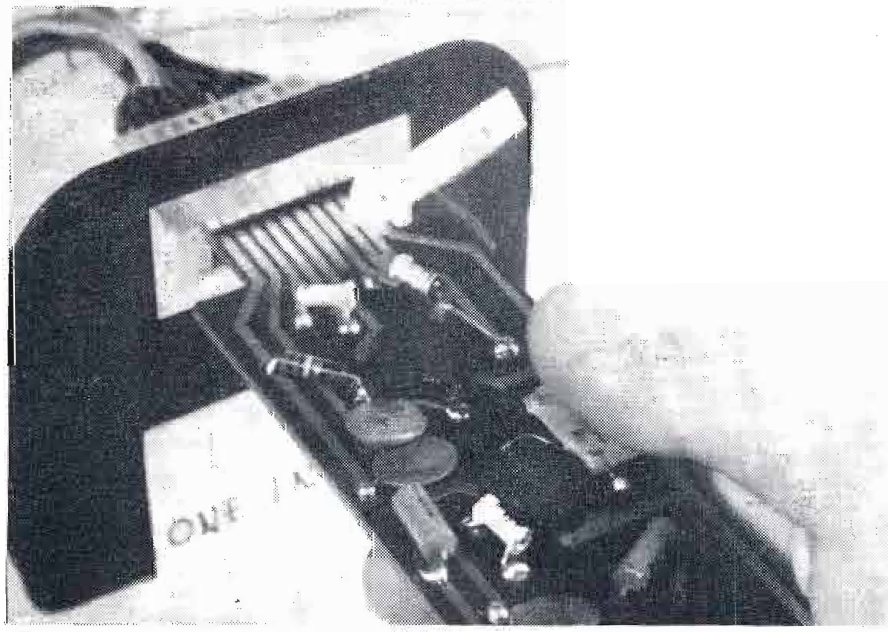
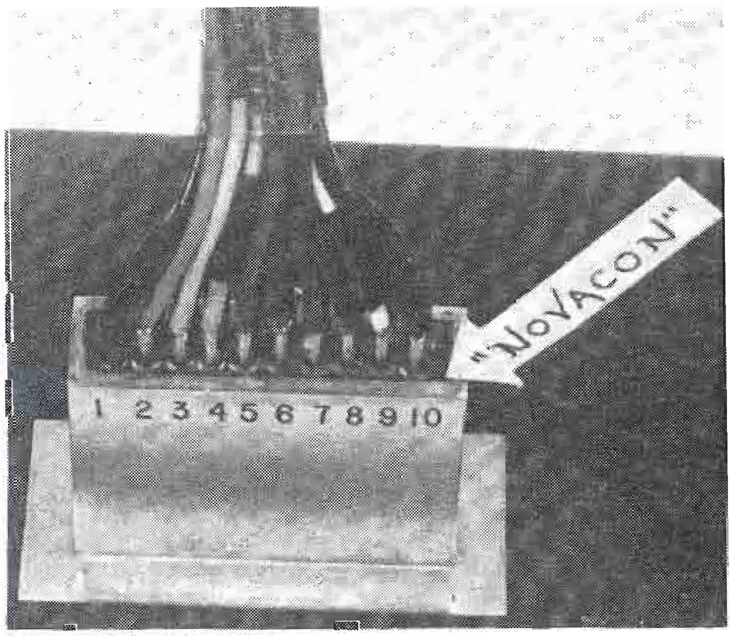


Fig. 7: 20 conductor hermetically sealed



Page from an Engineer's Notebook

Number 17 — Coupling Loop Design

A nomograph for use in the design of series or shunt tuned coupling loops, untuned loops, or conventional type tuned circuits for specific values of tuned impedance

By KEATS A. PULLEN

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TUNED coupling loop design must be based on the desired line impedance and the preferred series or shunt Q. After the line impedance and Q are known, line a is drawn from the proper impedance level on data line 2, line impedance data line, to the correct value of Q on data line 5, the Q data line.

Required Reactance

The required value of reactance is read on data line 4, coil or capacitor reactance. Line b is drawn through the intersection of line a and data line 4 and the desired frequency on data line 1, frequency-megacycles. Line b crosses data line 3, capacitance μμf, and data line 6, inductance-μh, at the required values of capacitance and inductance respectively.

Untuned Coupling Loops

Design of untuned coupling loops is accomplished in the same manner as for tuned loops. Experience has shown that a broad optimum occurs in untuned loop design. This optimum centers around a Q of one.

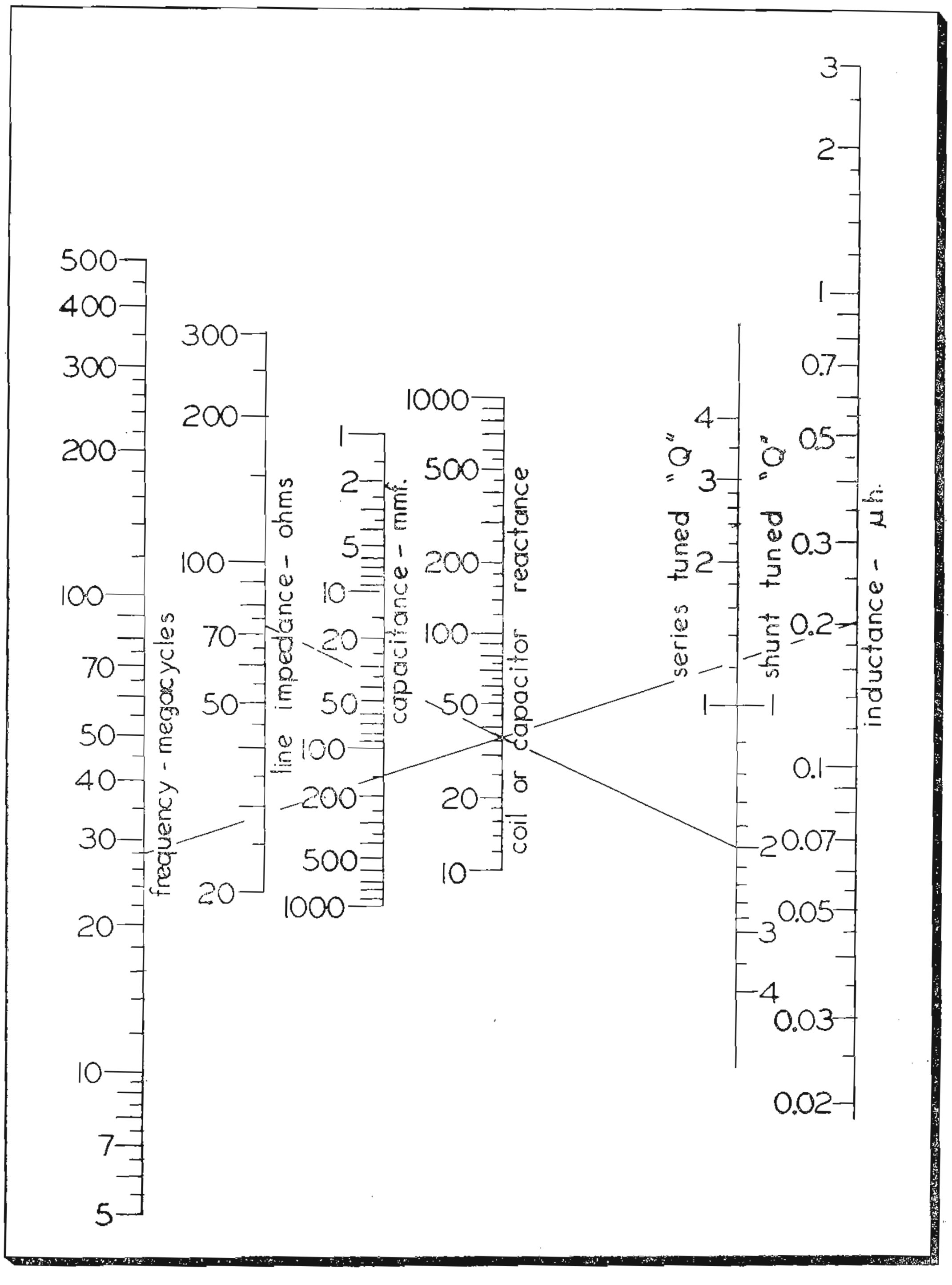
Minimum coupling for a given set of operating conditions can be obtained at a Q design of one. Actually fairly satisfactory operation with but little increase of required coupling can be obtained by choice of a Q between a shunt Q of two and a series Q of four.

Using the chart to establish a desired impedance tuned circuit, for application in an RF amplifier, for example, requires first the choice of the desired Q and tuned impedance level. A 6AK5 tube normally should be used with a plate circuit having a 2000 ohm tuned r-f impedance. If a coil Q of 100 and a frequency of 50 mc were required, a capacitor of 150 μμf capacitance and a coil of 0.06 microhenries inductance would be required. Line b passes through these inductance and capacitance values when drawn through 50 megacycles and 20 ohms reactance.

Revealing Combinations

The design frequency range may be changed by a factor of ten if both the capacitance and inductance are changed in inverse manner by factors of ten. An increase of frequency by ten times requires a reduction of the values of inductance and capacitance to a tenth. Other rescaling combinations are also possible.

Data lines 1 to 6 referred to in text are read consecutively from left to right



CUES for BROADCASTERS

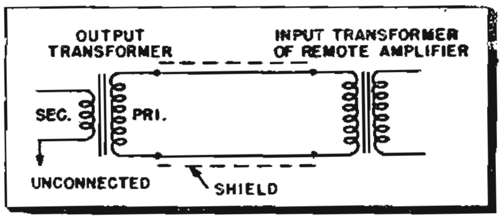
Practical ways of improving station operation and efficiency

Eliminating Hum in Low Level Circuits

JAMES JARAD, Chief Engineer, WJPS, Evansville, Ind.

WE were troubled considerably with hum getting into our low level circuits. We spent quite a lot of time trying to improve shielding and re-orienting input transformers, etc., all with very little success.

The next step was to locate the source of the hum. To do this we devised a very simple, but exceedingly effective gadget. We fastened an old output transformer to the end of a broom handle and connected the primary of the transformer, by means of a piece of shielded mike cable and a suitable plug, to the input of one of our battery operated remote amplifiers. Then, using the transformer and broom handle combination as a probe, the meter on the remote amplifier as a visual indicator and the headphones for an audible indication, we were able to locate the sources of hum very quickly. In a matter of minutes, we were able to determine that our trouble was caused by an "inter-com" with a poorly shielded power transformer, and an unshielded power line that had been fastened to the outside wall of our control room and was actually only a few inches from the turntables.



Hum probe mounts on end of broom stick

A battery operated amplifier was chosen because of the likelihood that considerable interaction would have been experienced between the "probe" and the power supply of an ac operated amplifier.

Remotely-Controlled Tape Recorder

EDWARD BOYLE, Chief Engineer, WBOB, Galax, Va.

STARTING and stopping rack-mounted Magnecord tape recorders from the operator's position without purchasing high priced remote control equipment is a problem facing many small radio stations. We solved this by installing a two-way switch at the operator's position, and one on the rack near the recorder, which is connected to the motor power circuit.

It is only necessary to disconnect one lead from terminal #5 on the terminal strip located just to the left of the Jones plug on the tape transport chassis. Connect one side of the two-way circuit to terminal #5 and the other side to the lead that was removed from the terminal.

This makes it possible for the operator to cue up the recorder in advance and at the flip of a switch at the operator's position to start and stop the recorder without delay.

$$$ FOR YOUR IDEAS

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double-spaced text is requested. Our usual rates will be paid for material used.

Continuous Tape Recording

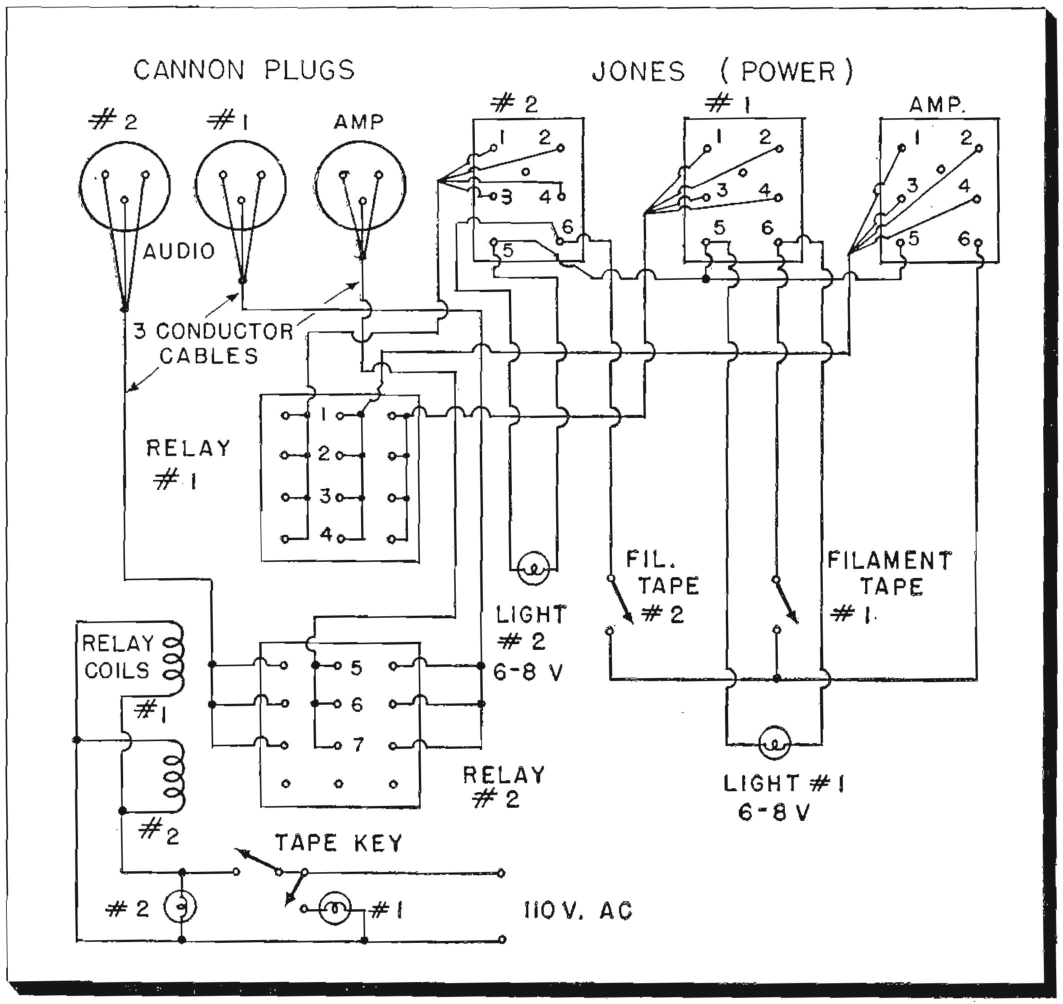
JOE TOHER, WACA, Camden, S. C.

AT WACA we ran into the problem of running two tapes from one amplifier without breaking the program. Some sports shows run for two or three hours. It does not sound professional to stop a Steeple Chase Horse Race and put on a record while the tape is changed. A chassis was made, using three Jones plugs for power, three cannon plugs for audio voltage, and a switching arrangement. Now we can easily change from one tape to another.

The tapes on both recorders are cued up before program time and both filament switches are turned on to keep the tapes hot. When the key is thrown to tape #1, tape #1 is on the air. When the cue for the ending of tape #1 is heard, the key is thrown to tape #2, and tape #2 is on. This system can be used for any length show by cuing and marking the tapes before hand. This switching arrangement costs about fifteen dollars to make.

Tape #1 is always on when the

Continuous tape reproduction and recording can be achieved by this switching arrangement



key isn't on tape #2 because one of our recorders is portable and the other is mounted permanently in our console. All we do is plug in both tapes and amplifier leads into the switch before the recording, cue up the tapes, and then throw the key to whichever tape is wanted.

Reducing Noise in Remote Amplifiers

HAROLD REED, Chief Engineer, WOL, Washington, D. C.

IN making noise, distortion, and frequency measurements on a number of Western Electric type 22D remote amplifiers it was found that the noise level and distortion were considerably higher when the two #47 meter lamps in the VU instrument were turned on. These amplifiers are equipped with a toggle switch for the filaments, and a separate switch for the meter lamps which are wired in parallel.

The noise output below program level in this apparatus is normally around -50db and the distortion of the order of 0.5% at 400 cps. These figures could be approached when a battery power supply was used or when the ac supply was connected and the meter light switch in the "off" position. When the lamp switch was thrown "on," the noise reading increased 17 db, to -33 db below program level, and the distortion read 2%, an increase of 1.5%.

In endeavoring to improve this condition it was discovered that one of the ac leads (red-green) to the lamps in M1 was running parallel to and laced in with other wires going to D3.2 a wafer type switch serving in dual capacity of VU attenuator switching and plate-filament checks on the same meter. Further, this lead passed by the first and second stages of the amplifier. This wire was unsoldered from D3.2 and removed from the laced cable. To reduce the ac field it was twisted around the other (red) lead running from the lamp in M1 to the switch D2 and connected to the ac supply lead (red-black) near the filament switch D1. When this change had been made the noise and distortion figures approached the specifications for the equipment—or were better—with or without the meter lamps burning.

Although the average increase in noise level was about 17 db with the meter lamps on, one amplifier of a newer series seemed to have been improved by the manufacturer in that the noise was only 4 db higher with the lamps burning. This 4 db increase was also eliminated by the above modification.

Studio Microphone Switching Circuits

GEORGE WOJAK, WOPA, Oak Park, Ill.

MANY stations have at one time been faced with the problem of switching microphone circuits to cover more than one studio. At WOPA we use a Raytheon RC-11 console which provides two microphone inputs in each of two studios, and a fifth microphone for control room use. For many programs two microphones in a studio are not sufficient. This difficulty was overcome by switching unused microphone inputs from one studio to another.

This was conveniently accomplished by running each console microphone input to a switch box mounted alongside the console on the operating desk. For this switch box, a steel utility box was used and in it were mounted four switches. Each of these switches was a four pole double throw anti-capacity type.

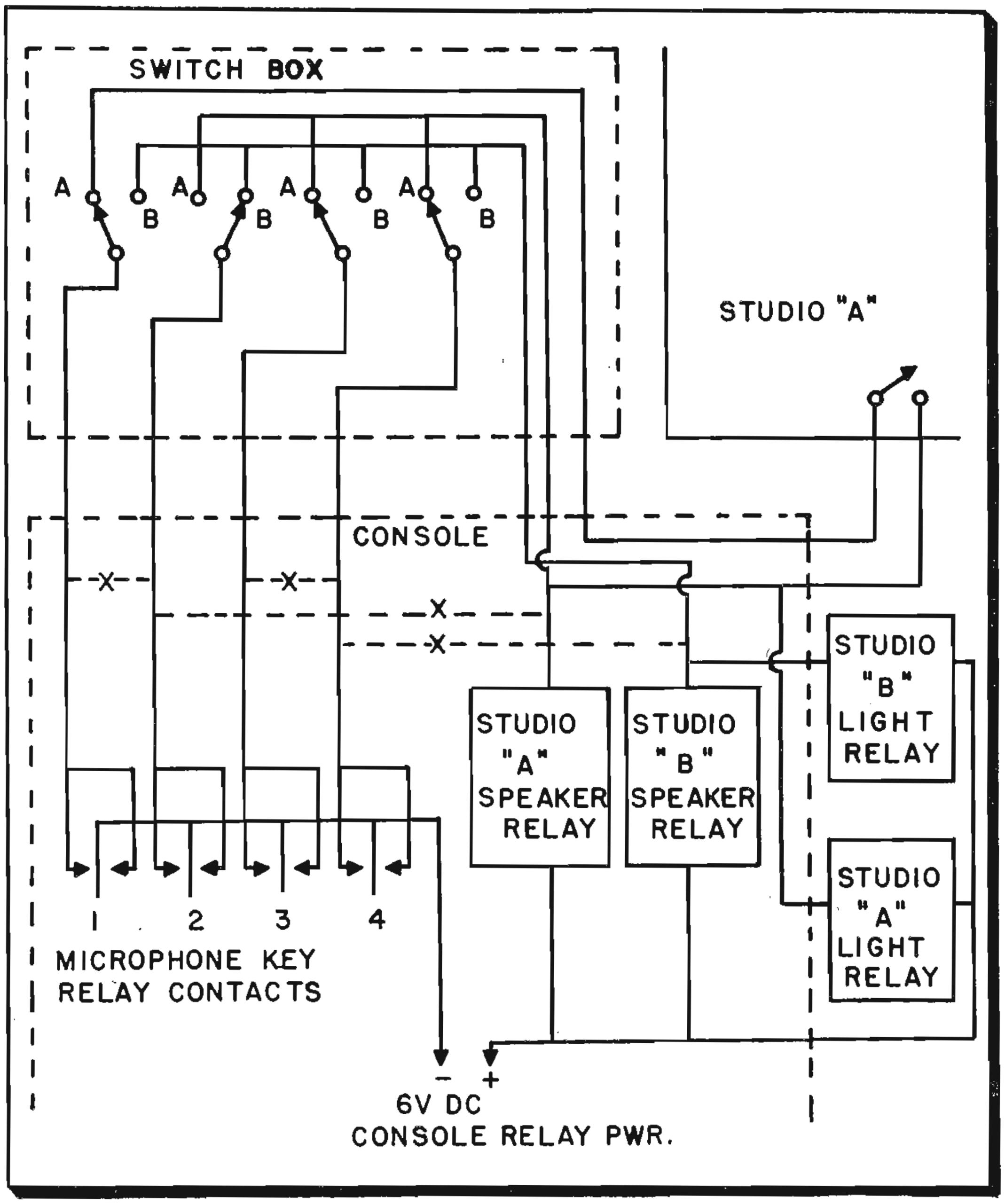
On the first two sets of contacts on each switch, the microphone line from the console is connected. In one position, the line from the console is connected to Studio "A" and in the other position to Studio "B." The third set of contacts on each switch are used to switch the relay circuits of the console. At present, the fourth set of contacts on each switch is not used. A possible use for these contacts would be indicating lights if desired. If lights are used they should be energized with dc to prevent hum pickup in the microphone lines.

Since the setup of the microphone line contacts is normal, only the relay switching contacts are shown in the diagram.

For relay operation, a seven wire shielded cable was run between the console and the switch box. Four of the wires in this cable are connected between the four microphone switches in the console and the four switches in the switch box. Two more of these wires run from the switch box to the studio speaker and "On the Air" light relays. The seventh wire is run to Studio "A" as explained later in the text. Only the

(*Continued on page* 92)

Switcher box multiplies number of microphones available in any studio with unused studio outlets



TV Horizontal Deflection Design

A practical system analysis showing how physical design requirements for most efficient output transformers may be achieved

PART ONE OF TWO PARTS

By
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THE problem of designing a TV deflection system requires a workable bridge of knowledge between established theory and final equipment performance. This article presents a practical method of applying transformer theory to the design of an efficient TV horizontal output system.

Many times, a given system would have performed with greater efficiency regulation and linearity, if more information on "flyback" transformer design were available. The approach of using a multi-tapped transformer to obtain optimum circuit conditions is widely applied. While this method may have its merits, limitations remain with respect to coil configurations and wire size which prohibit full optimization to be realized. For example, because of fixed tertiary conditions, a lower efficiency or primary-secondary turns ratio must be maintained to stay within retrace requirements.

However, all these considerations and compromises can be met beforehand on paper, enabling optimum conditions to prevail and eliminating the need for winding numerous transformers to obtain a desired result.

Detailed Procedure

The following is a step-by-step procedure in which typical requirements for a 17-in. CRT and circuit conditions are used to obtain proper turns ratios and other transformer considerations. In the process, extent of the compromises required for maximizing primary and secondary turns ratio, coefficient of coupling, efficiency and wire size along with minimization of distributed capacitances will be evaluated.

Requirements of a typical system using a 6BQ6 driver tube:

$B+$ @ 117 v. ac input = 250 v.
HV = 14 kv with Pix (120 μa)
E_{bs} = 550 v.
I_{bs} = 0.010 amp.
P_{scr} = 2 watt max.
$\hat{e}_p$ = 4500 v max.
Retrace = 8.3 μsec max.
Linearity = 3%
P_d = 8.5 watts max.
Transformer Heat Rise = 55°C max.
Deflection should be sufficient at 105 v ac input, 225 v. B+

Procedure: A minimum coefficient of coupling is assumed which is the least that can be tolerated if sufficient deflection with a minimum power input is to be obtained.

$$K_{min} = 99.5\%$$

The next consideration is the yoke inductance to be used. While this can be of almost any value, a compromise is made between the greatest inductance commercially available (to have a small peak-to-peak current demand for a given ampere turn product) and the maximum total inductance allowable in the secondary circuit to stay within retrace requirements and the maintainance of as high an efficiency as possible. Of the yokes commercially available, 13.5 mh and possibly 24 mh will meet these requisites.

$$L_y = 13.5 \text{ mh}$$

Another consideration is efficiency in terms of the coefficient of coupling and secondary-to-yoke ratio (L_s/L_y). This is arrived at through investigation of network theory.

Thus for a T network terminated by a given inductance (L_y) the series and shunt losses of this network (transformer) can be minimized by having a high coefficient of coupling and ratio of secondary inductance to terminating inductance (L_y). This in effect means that for a given power input, the power expended in the transformer should be the least possible. Hence, a major portion of this input power is available for the yoke.

Thus the following expression for efficiency is derived.

$$\eta = \frac{K}{1 + (L_y/L_s)} \text{ (Assuming a high reactive to resistive ratio)} \quad (1)$$

Now stipulate a desired efficiency the choice of which is the practical result of the various compromises such as wire size, coil dimensions, turns ratio, etc. η = 80% appears to suffice.

Since L_y has been selected and K has been assumed it becomes necessary to determine L_s so that η = 80% can be acquired from equation (1).

$$\eta = \frac{K}{1 + L_y/L_s}$$

$$\eta = KL_s/(L_s + L_y)$$

$$L_s = \eta L_y/(K - \eta) \quad (2)$$

Using the previous constants to determine L_s,

$$L_s = 55.3 \text{ mh}$$

Tolerances of energy requirements that must be considered are:

Blanking............... 5%
Yoke.................. 3%
Retrace................ 3% including filament of HV rectifier tube.

These tolerances include allowance for oversweep to provide low line deflection.

Using the following yoke constants as

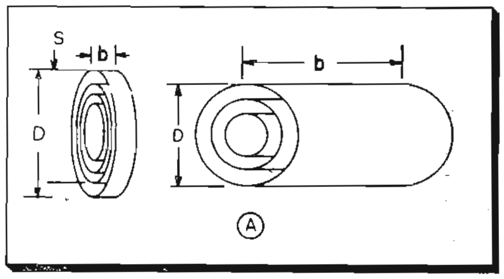


Fig. 1: Dimensional sketch for determining the total distributed capacitance of windings

an example (these are usually what can be expected),

L_y = 13.5 mh
I_{yp-p} = 772 ma for normal raster at 14 kv, 65° (Refer to Table I)
I_{yp-p} = 858 ma utilizing tolerances
R_y = 18 ohms
Yoke C_d = 14 $\mu\mu$f
$C_{hor-ver}$ = 76 $\mu\mu$f
Yoke Q = 35 at 60 kc, without leads
Yoke Z = 178,038 at 60 kc
Yoke L/R = 843.7 μsec
T_s = 54 μsec

$$\text{Yoke } E_{1y} = LI/T_s = (0.0135 \times 0.858)/0.000054 = 214.5 \text{ v.}$$

With yoke information substantially complete circuit conditions can be derived on an energy basis.

One further consideration is the driver tube conduction period which can be accurately determined as will be shown later but at present will be considered as 54% of T_s.

$$\mathcal{E}_y = 0.5\, L\, I_y^2 \quad (3)$$

The energy in the yoke during the driver tube conduction period is shown to be

$$I_y = 858 \times 0.54 = 463 \text{ ma}$$

$$\mathcal{E} = 1446.9\ \mu\text{joules}$$

Next, the energy required on the primary side of the transformer, which is the energy to be supplied by the driver tube, is computed.

$$\mathcal{E}_{pri} = \mathcal{E}_y/\eta = 1446.9/.8 = 1808\ \mu\text{joules} \quad (4)$$

Now decide what peak plate current is to be used. This is determined after establishing the minimum plate voltage at zero grid volts.

$$\hat{I}_p = 220\text{ ma}$$

Then the inductance required to store the energy needed;

$$L_b = \mathcal{E}_{pri}/0.5\ \hat{I}_p^2 \quad (5)$$

$L_b = 1808/0.024 = 75.3$ mh load inductance

L_p, the primary inductance, can now be derived.

$$L_p = \frac{L_b}{1 - \left[\frac{K^2}{1 + L_y/L_s}\right]} \quad (6)$$

$$L_p = 75.3/(1 - 0.7958) = 368.7\text{ mh}$$

Hence a ratio between primary inductance and load inductance of a tolerable minimum is established.

$$L_p/L_b = 368.7/75.3 = 4.89$$

The reason for a minimum L_p/L_b ratio is the increase of $\hat{I}_p$ due to the shunting effect of L_p across L_b.

$$\hat{I}_p = \sqrt{\mathcal{E}_{pri}/0.5\ L_b} \quad (7)$$

Using the previous example

$L_{b1} = L_{b1} = (L_pL_b)/(L_p+L_b) = 62.5$ mh and

$$\hat{I}_p = 240\text{ m/a}$$

The inductance ratio is $L_p/L_s = 6.667$. This is 11.74% more than would be required if the transformer had unity coupling instead of $K = 99.5\%$. And, of course

$$N_p/N_s = \sqrt{L_p/L_s} = 2.58$$

Boot strap current consists of:

Vertical output circuit..... 0.008 amp
Vertical oscillator circuit... 0.001 amp
Horizontal discharge circuit 0.001 amp

$$I_{bs} = 0.010\text{ amp}$$

If the system was loss-free, the damper and driver tubes would have equal duty cycles and the driver-to-damper turns ratio (N_p/N_d) would equal 1:1. But since finite Q's exist and current for the vertical system is usually derived from the "boost," hence damper circuit, equations have to be developed which will take into account these factors to determine the proper turns ratio (N_p/N_d).

Finish of Trace

The peak current existing in yoke transformer at finish of a trace is

$$\hat{I}_{yf} = I_y\,[1 + 1 - \eta]$$
$$\hat{I}_y = 0.5\ I_{yp-p}$$

The peak current existing in yoke and transformer at start of trace.

$$\hat{I}_{ys} = \hat{I}_{yf}\,(\mathcal{E} - {}^{(\pi/2Q)})\eta - I_{bs} \quad (10)$$

Therefore,

$$N_p/N_d = \hat{I}_{yf}/\hat{I}_{ys} \quad (11)$$

The following circuit Q's are measured values, but actual values may readily be calculated by determining the resistances reflected into the yoke circuit and using the expression, $Q = R/\omega L$.

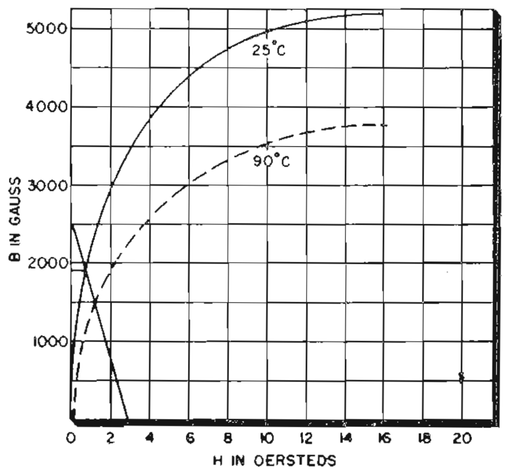


Fig. 2: Graph for calculating operating flux density from the iron B-H characteristics

If $I_{bs} = 0.017$ amp and a sawtooth winding is used, circuit $Q = 10$

If $I_{bs} = 0.010$ amp and a sawtooth winding is used, circuit $Q = 11$

If $I_{bs} = 0.017$ amp and no sawtooth winding is used, circuit $Q = 11$

If $I_{bs} = 0.000$ amp and a sawtooth winding is used, circuit $Q = 12$

If $I_{bs} = 0.000$ amp and no sawtooth winding is used, circuit $Q = 13$

Peak Plate Pulse

Beside normal "flyback time" considerations, blanking type of horizontal oscillator used, etc., thought should be given to the peak plate pulse on the driver tube for a given turns ratio.

SYMBOLS USED IN MATHEMATICAL FORMULAE

A = Cross-sectional area of core
b = Coil width
B_{ac} = AC flux density
B_{dc} = Flux density resulting from dc in winding
B_m = Peak flux density (B_{dc} and B_{ac})
C = Height of winding above form
C_d = Distributed capacity of coil
C_l = Capacity existing between outermost layers of coil
CMA/I_{av} = Circular mil area per average current
D = Total coil diameter
$\hat{e}_d$ = Peak damper voltage (damper tube) during retrace period
$\hat{e}_{dn}$ = Peak pulse on heater of damper tube
$\hat{e}_{ly}$ = Peak voltage across yoke during retrace
$\hat{e}_p$ = Peak plate voltage (driver tube) during retrace period
E_{bs} = Boot strap voltage
E_k = Driver cathode voltage
E_{lb} = Voltage across load inductance during trace
E_{l-in} = Inductive voltage across linearity control
E_{ly} = Voltage existing across yoke during trace period
E_p = Plate voltage of discharge tube
E_p ÷ Plate voltage of discharge tube
E_{scr} = Driver screen voltage
f = frequency
$\mathcal{J}$ = Winding factor
G_r = Gear ratio
H = Gilberts/l or oersteds (Magneto-motive force per length of magnetic path)
HV = High voltage
I_{bs} = Boot strap current (current required by vertical output)
I_d = Average damper tube current
$\hat{i}_d$ = Peak current of damper tube
I_k = Cathode current (average)
$\hat{i}_p$ = Peak plate current of driver tube
I_p = Plate current of driver tube
I_{scr} = Driver screen current
I_y = Yoke current
$\hat{i}_y$ = Peak yoke current
$\hat{i}_{yf}$ = Peak current existing in yoke and transformer at finish of trace
I_{yp-p} = Peak-to-peak current in yoke during trace
$\hat{i}_{ys}$ = Peak current existing in yoke and transformer at start of trace
K = Coefficient of coupling
l_g = Length of air gap
l = Length of magnetic path
L_b = Load inductance (inductance reflected in primary with yoke across secondary)
L_e = Leakage inductance
L_{ep} = Leakage inductance referred to primary
L_{es} = Leakage inductance referred to secondary
L_s = Inductance of secondary
L_t = Inductance of secondary and yoke in parallel
L_y = Inductance of yoke
M = Mutual inductance
N = Number of turns
N_d = Turns of damper
N_{HV} = Turns of high voltage winding
N_p = Turns of primary
N_s = Turns of secondary
P_{scr} = Screen dissipation — driver
P_d = Driver plate dissipation
Q = Q of secondary circuit
R_h = Resistance of primary at operating temperature
R_c = Resistance of primary at ambient temperature
R_y = Yoke resistance
S = Space between outermost layers
t_a = Ambient temperature
t_r = Temperature rise
T_d = Damper tube conduction period
T_{dr} = Driver tube conduction period
T_r = Retrace period
T_s = Trace period
δ = Wire size
ε = Dielectric constant
$e^{-(\pi/2Q)}$ = Current decrement factor
$e^{-(\pi/4Q)}$ = Voltage decrement factor
$\mathcal{E}_y$ = Yoke energy
η = Efficiency
μ = Apparent permeability (as measured with no dc flowing in winding)
μ_{ac} = Incremental permeability

HORIZONTAL DEFLECTION (Continued)

To compute the peak voltage across the yoke,

$$\hat{e}_{ly} = \hat{I}_{yf} (\omega L \, e^{\cdot(\pi/4Q)}) \qquad (12)$$

Thus

$$\frac{N_{HV}}{N_s} = \frac{HV}{\hat{e}_{ly}} = \frac{14 \times 10^3}{2 \times 10^3} = 7$$

And

$$\hat{e}_p = \hat{e}_{ly} (N_p/N_s) \qquad (13)$$

When using Eq. (12) and (13), E_{bs} should be added to the pulse.

Transformer Design

Before determining the operating flux densities, incremental and apparent permeability, it would be justifiable to consider the geometric configurations of the various windings. For a high coefficient of coupling, windings should be kept as close to the core as possible, thereby minimizing leakage inductance but increasing distributed capacity.

For the high voltage winding (tertiary), a low distributed capacitance is required and the potential gradiant per layer and between layers should be low. This is controlled by the number of crossovers per turn and winding dimensions.

At this point, it appears advisable to clarify the concept of distributed capacity as a function of the geometric configuration of the winding. The winding can be thought of as having a number of rings, each within the other as shown in Fig. 1a, b.

A very close approximation of the total distributed capacitance, C_d, is

$$C_d = C_l/N_l \qquad (14)$$

C_l = Capacity existing between the two outermost layers.

N_l = Number of layers in winding.

Therefore, it can be seen that the wide coil will have more C_d because of a given area which is divided by fewer layers. C_l can be found from the following formula:

$$C_l = A \, \epsilon/4.45S \qquad (15)$$

$A = \pi D \times b$ (in inches)

S = Spacing between outermost layers (see Fig. 1)

ϵ = Dielectric constant of material

$\epsilon = 4$ for nylon-covered wire and wax impregnation

$\epsilon = 3$ for silk covered wire or varnish impregnation

C_d can be further minimized by reducing the electrostatic potential between each end of the layer. This is accomplished by increasing crossovers per turn or rearrangement of the turns per layer. A change of wire size will help if the dimensional change of the coil which occurs is in the proper direction.

Wire size is determined by the usual circular mil per ampere basis, and the following values are the minimum to be used if a proper compromise between physical size of the winding, heat rise and I^2R losses are to be maintained; that is, 250 CMA per peak current or 750 CMA per average current

The following values of rms and average current are arrived at by consideration of time ratios and waveform factors.

$$I_{p\text{-}avg} = 0.294 \, \hat{I}_p \qquad (16)$$
$$I_{d\text{-}avg} = 0.23 \, \hat{I}_d \qquad (17)$$
$$I_{p\text{-}rms} = 0.37 \, \hat{I}_p \qquad (18)$$
$$I_{d\text{-}rms} = 0.30 \, \hat{I}_d \qquad (19)$$
$$I_{y\text{-}rms} = 0.29 \, \hat{I}_{yp\text{-}p} \qquad (20)$$

Calculation of inductance with a closed magnetic circuit containing ferromagnetic material is covered in various texts.

The procedure to be presented is more or less standard with the addition of various formulae to obtain the necessary information for acquiring the required turns without knowing the incremental permeability.

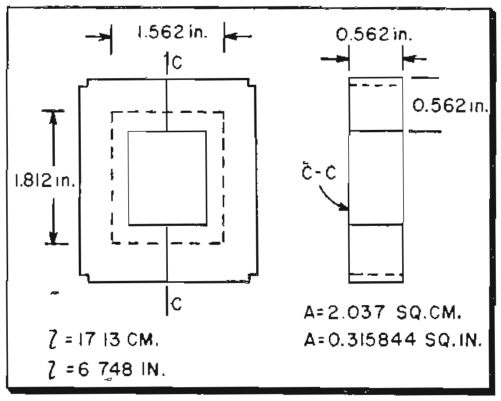


Fig. 3: Approximate magnetic path and dimensions of the standard ferrite type "C" core

The following formulae, using dimensions in cm, will aid in determining operating conditions of the core.

$$B_{dc} = 1.256 \, NI/l_g \qquad (21)$$

$$B_{ac} = \left[\frac{EL_b \, 10^8}{N A}\right] T_{dr} \qquad (22)$$

$$H = 1.256 \, N \, I/l \qquad (23)$$

N in terms of μ_{ac}:

$$N = \frac{L \, l \, 10^8}{1.256 A \, \mu ac} \qquad (24)$$

I_m = magnetizing current

$$I_m = \frac{H \, l}{1.256 \, N} \qquad (25)$$

$$\mu ac = \frac{L \, l \, 10^8}{1.256 \, N^2 A} \qquad (26)$$

Temperature rise of winding:

$$t_r = \frac{R_h - R_c}{R_c} (t_a + 234.5) \qquad (27)$$

R_h = Resistance of primary when at operating temperature

R_c = Resistance of primary at ambient temperature

t_a = Ambient temperature = 25°C

To determine the operating flux den-

(*Continued on page* 104)

TABLE I

L_y	Deflection	HV	I_y rms	$I_{yp\text{-}p}$
10 mh	66°	14 kv	269	920 ma
10 mh	70°	14 kv	327	1,120 ma
13.5 mh	66°	14 kv	226	772 ma
13.5 mh	70°	14 kv	269	920 ma
30 mh	66°	14 kv	158	540 ma
30 mh	70°	14 kv	190	650 ma

Note: I_{yp-p} does not include tolerances.
L_y is a 1 in ferrite yoke.

TABLE II

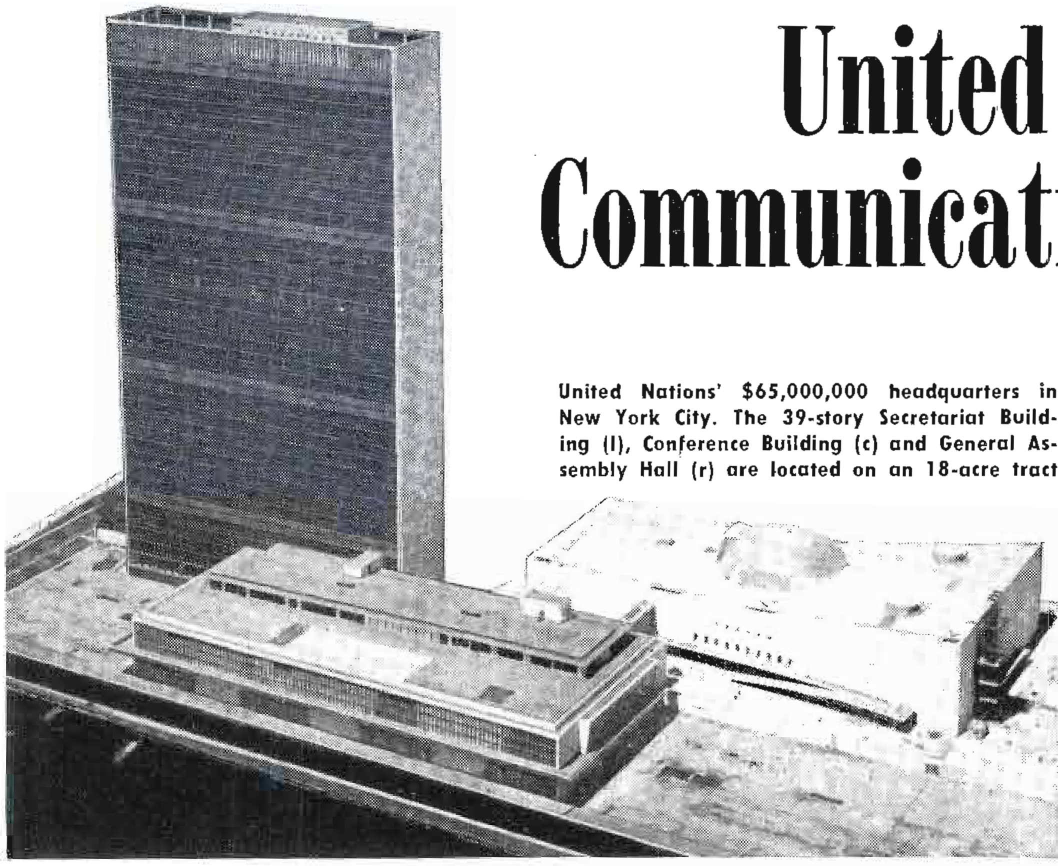
Cam Size b (in.)	Wire Size δ	Crossovers/turn	Turns/crossover	ℱ
0.062	40 SNN 0.0055	6		3
0.062	38 HFSN 0.007	6		3
0.093	38 HFSN 0.007	4–6*		2–3
0.109	38 HFSN 0.007	4–6		2–3
0.125	38 HFSN 0.007	3–5		1.5–2.5
0.156	38 HFSN 0.007	3–5		1.5–2.5
0.687	34 HNN 0.0095		1.5	3
0.687	32 HNN 0.0105		1.5	3
0.750	34 HNN 0.0095		1.5	3
	32 HNN 0.0105			
0.812	34 HNN 0.0095		1.5–2	3–4
	32 HNN 0.0105			
0.875	34 HNN 0.0095		2	4
	32 HNN 0.0105			
1.000	34 HNN 0.0095		2–2.5	4–5
	32 HNN 0.0105			
1.125	34 HNN 0.0095		2.5	5
	32 HNN 0.0105			
1.187	34 HNN 0.0095		2.5–3	5–6
	32 HNN 0.0105			

* 6 crossovers per turn when high-voltage winding is wound over primary.

HNN signifies heavy coating of plastic nylon with a textile single nylon serving.

TABLE III

Wire Size	Cam	Drive Gear	Idler	Cam Gear
30 SNE	812-825	26	1/1	95
31 HFSN	812-825	29	1/1	106
32 HFSN	812-825	32	1/1	117
33 HFSN	812-825	35	1/1	128



United Nations' $65,000,000 headquarters in New York City. The 39-story Secretariat Building (l), Conference Building (c) and General Assembly Hall (r) are located on an 18-acre tract

United Nations Communications Facilities

Headquarters feature impressive equipment installation for radio and TV broadcasting, simultaneous translation, inter-office communications, recording and public address

PART TWO OF TWO PARTS

By H. B. RANTZEN, Director
Telecommunications Services Div., United Nations, New York

PART One, which appeared in the December, 1952 issue of TELE-TECH, describes the UN's overall plans and equipment, control rooms, radio and TV, and recording. Part Two (below) presents the details of conference rooms, simultaneous interpretation, inter-office communication, and overall performance evaluation.

Conference rooms are divided into two halves, one half occupied by delegates and one half occupied by the press and public. In the delegates area there is a large number of microphones and, in addition to the sound reinforcement, delegates can hear direct speech from one another. The requirements for this part of the room are:

A. There shall be no source of sound to which any particular direction can be ascribed other than the speaker.

B. The sound level available to all delegates shall be approximately that of direct speech at close range.

C. It should be possible for delegates to hear simultaneous interpretation in one of the small lightweight plastic earpieces on one ear without being unduly troubled by the sound reinforcement in his other ear.

D. The intelligibility shall be high, of the order of approximately 95%.

In the design adopted for the delegates area, 4-in. loudspeakers have been mounted five or six feet apart and the loudness in them was finally adjusted to about 65 phons; with this loudspeaker arrangement there is substantially no sound level variation over the whole delegates area. It is reasonably certain in all of the larger conference rooms that a very large part of the sound reaching delegates in such a sound field is direct and as a consequence, measurement could be made of the overall frequency characteristic from sound to sound and a network equalizing this was designed and inserted. The loudspeakers were very small and competitively priced, and tests showed that their response consisted largely of energy in a peak around 200 CPS and in a second peak around 2000 CPS.

Speech Intelligibility

Speech intelligibility in the conference rooms was then determined by a technique known as "immediate appreciation testing." In this arrangement, a team of about five people are asked to read in turn a number of simple sentences of eight or ten words each, taken from a newspaper or book while all but the reader write down which of the sentences *are understood in their entirety immediately when heard.* The tests are continued until the rms value of the departures of the actual observations from the grand average corresponds to a 95% probability that actual observations do not deviate from the mean by more than an acceptable amount. For tests carried out this way on conference room 3, for example, using five readers each speaking 25 sentences, the 95% probability point corresponds to a variation of approximately ±6% for an average intelligibility of about 95%. When this test is repeated three times and all of the readings treated as a single test, the results indicated under one set of conditions, an average intelligibility of 95% with a 95% probability that individual intelligibility would not vary from this more than 2%. Tests of this type can be carried out with untrained crews and within a space of a few hours were done with frequency characteristics which were as near flat from 200 to 4000 CPS as could be obtained, and with frequency characteristics rising by 4 db and rising by 8 db. These indicated that no appreciable improvement in intelligibility could be obtained over the straight-frequency characteristic condition. Networks so designed have, therefore, been inserted in all circuits feeding the small table and chair loudspeakers. Tests on the overall conference systems then showed that, at optimum level adjustments, sound appeared to originate in the area fed by the larger loudspeakers mounted over the press and public; the low frequency responses of these latter were then reduced to simulate the performance of the small loudspeakers by adding series capacitors to their circuits, so that under final operating conditions, the only identifiable source of sound in the delegates area is the speaker himself.

In conference rooms and council chambers conditions have to be set up so that delegates have the choice either of listening to what is being said at the meeting with sound reinforcement or to a simultaneous interpretation of what is being said

UNITED NATIONS (Continued)

in a special lightweight hearing aid which hangs on one ear. This latter device has been introduced instead of standard headphones so as to avoid difficulties which have arisen in the past when delegates wearing turbans, or when women with elaborate hair styles wish to use the simultaneous interpretation, as well as to avoid the strain imposed by the continual pressure of earpieces and headbands.

Mutual Interference

Since a plastic earpiece on one ear does not exclude other sounds in the room, it becomes increasingly important when they are used to see that the relative levels of simultaneous interpretation in the earpiece and sound reinforcement in the room are maintained within the close limits necessary to avoid mutual interference. This is very difficult to do with manual operation because the technical operator is responsible, not only for the control of five languages, but also for all of the microphone switching, and a number of other duties.

Attempts have been made extensively in Europe, and to some extent at Lake Success to provide automatic volume control with limiters, and tests with this type of equipment have shown that the following fundamental requirements have to be met:

A. The speed of operation in the downward direction, i.e., the rate of decrease of gain when a peak occurs, should be as great as possible, preferably about one-half millisecond and certainly not more than one millisecond no matter how large the peak.

B. The speed of recovery, i.e., of gain increase, should be such that the ear cannot detect modulation of room noise or speech as a result of it. This means in practice that a maximum rate of change of gain of 10 db per second should be aimed at. If this rate of gain increase is too low, the average level of modulation will be much lower and AVC correspondingly less effective.

C. Change of gain either in the downward direction or the upward direction should not be accompanied by a change in current conditions in the output transformer or by anything else which can produce thump or flutter distortion.

D. The volume range at the input of the amplifier should be at least 30 db, i.e., over this range the amplifier should behave substantially as a distortionless amplifier; with changes of level occurring above the limiting point, the change of output level should be less than one-tenth of the change of level in the input of the amplifier.

E. Non-linearity, when the amplifier is limiting to its maximum extent, should be negligible.

Providing Adequate AVC

If a limiter meeting all these requirements is brought into operation, adequate AVC for most purposes on speech will be provided if the amount of limiting is kept between 5 and 10 db. There are relatively few speakers whose volume falls by more than 15 db below the point to which their speech level is initially adjusted, and this variation will be reduced by

(*Continued on page* 131)

"Adjacent-Channel" Color-Television

"Color-TV Without Problems."

THIS is the title of a recently issued booklet by Station KTLA of Hollywood, Calif., containing an extremely interesting suggestion by Paul Raibourn, vice president of Paramount Pictures Corp., as to how a color television market could be developed without affecting the growth of the present black-and-white television market:

"(1) A cathode ray tube is available of such a nature that it can be manufactured by any cathode ray tube manufacturer by the addition to normal tube of color elements, whose cost is not excessive, and which can be provided by many sources. Chromatic Television Laboratories has announced and demonstrated a cathode ray tube for color television, known as the Lawrence Tube. The Lawrence Tube can be described as a black-and-white picture tube with color elements added, in which simple and adjustable electrical elements determine that the electrons corresponding to a particular color will go to the right place to produce the right color.

(2) The other development may be called "Adjacent Channel Color Transmission." The same kind of thinking—that of adding simple elements, based on known techniques, to the present black-and-white television system is suggested. Adjacent Channel Color Transmission consists of transmitting a black-and-white signal in the same channels as at present. This is the "present" signal. It is transmitted in the same channel and with the same protections as at present. A signal or signals is transmitted in an adjacent channel or in the unused portion of the same channel which determines what color should be shown on the receiver at any moment. This is the color signal."

Since adjacent broadcasting channels are not assigned to the same geographical reception areas such a system would be making use of portions of the frequency spectrum that are presently not used. Thus with color television no major technical problems would be added to either the present set owners, to the broadcasters (other than color synchronizing to his signal), or to the receiver manufacturers.

Adjacent-Channel Interference

With regard to the adjacent channel interference problems which might arise,

"We suggest the experiment of adding to a strong picture signal another and different and relatively weak picture signal the carrier of which is synchronized with the picture signal and an odd number of times ½ the line frequency away from it in frequency.

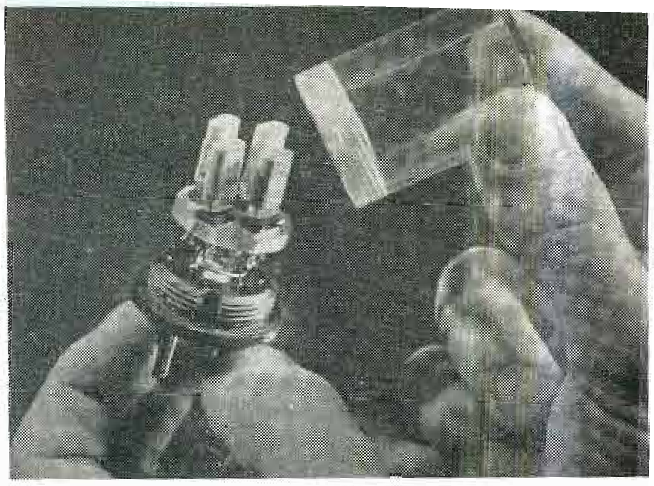
"As long as the carrier frequency of this color signal in this adjacent channel is different in frequency by an odd multiple of one-half of the line scanning frequency of the "normal" black-and-white signal for the channel, and is different in frequency from it by more than one half of the frequency bandwidth of the picture signal transmittable through the amplifiers of the receiving sets, then no interaction or beat pattern will be noticeable on monochrome or color receivers which are functioning in this channel.

"The adjacent channel signal will always be relatively weak because of distance and in almost all cases due to directional effects of receiving antennas. It should be noted that the frequency spectrum has been so allocated that adjacent channel signals are so attenuated within the normal service area of the regular channels that no interference will normally take place."

Employment of such a system would also permit: (a) design of additional chassis for insertion into existing black-and-white receivers for color TV (using Lawrence tube), (b) use of such a chassis in current manufacture to produce either black and white or color receiver, (c) servicemen now in field to make color conversions on existing receivers because of equipment simplicity. With the color signal in an adjacent channel any of the presently known color television systems could be employed and compatibility with presently sold sets would be no problem. With such a system, the total additional cost to manufacturers providing receivers to receive color need not, it is said, exceed $50.

Developmental Transistorized Equipments

15 different items of electronic equipment employing both point-contact and junction type transistors demonstrated at David Sarnoff Research Center. Reduction in power supply requirements, and in size and weight of units are outstanding technical features



Transistor Class B audio amplifier. By using N-P-N and P-N-P junction types need for input transformer is eliminated. Unit operates directly into loudspeaker voice coil also

Staff members of RCA's David Sarnoff Research Center recently demonstrated some of the practical applications of their developmental point-contact and junction transistor types. In all ten different transistor types (seven junction and three point-contacts) will be made available commercially in the near future. Costs, for the latter, initially are expected to range between $14 and $25. Commercially available transistors are: TA-165, TA-166, and TA-172—point-contact and TA-153 junction.

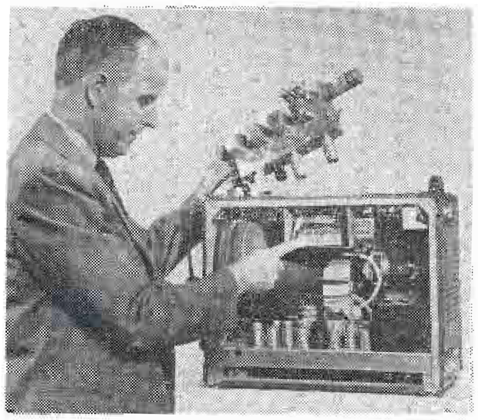
Some of the equipment items demonstrated are illustrated on this page. The complete list includes:

1. Public address system using Class B push-pull power output stage directly coupled to the 12-in. loudspeaker voicecoil. Operates from 22.5 v. battery supply estimated life of 25-50 hours.
2. Personal type radio using only one vacuum tube (converter) enables three fold size reduction.
3. All transistor personal radio which enables 60% size reduction and 3 or 4 to 1 weight reduction. Uses nine transistors.
4. Automobile radio with 11 transistors operating directly from 6-v. supply. Draws less than 1 ampere and produces about 1 watt audio output. Push button tuning is employed.
5. FM radio using point-contact transistor as high frequency oscillator. Operates over 88-108 MC using 11 transistors.
6. Portable spring-motor phonograph whose amplifier operating from 22.5 v. battery will play from 75 to 100 hours.
7. Wireless phono unit which uses one transistor and will operate from self contained battery for 3000 hours.
8. Musical toy oscillator whose single transistor circuit constants are varied by piano keyboard to eight different frequencies to produce a complete musical scale. Radiations are reproduced through standard AM receiver. Operates from 1.35 volts for 5000 hours.
9. Electronic ukelele wherein a small magnetic pickup feeds string vibrations to four transistors to achieve some special musical effects.
10. Transformerless Class B power amplifier producing about ½ watt output.
11. Transistor counter (section of electronic computer).
12. Transistor adder (section of electronic computer).
13. Transistors in Walkie-Lookie sync circuit equipment.
14. Three transistorized circuits in standard TV receiver.
15. Portable battery operated TV receiver employing 37 transistors and no tubes except picture tube. Total power consumption is 14 watts.

Dr. E. W. Engstrom, vice president in charge of RCA Laboratories Div., indicated that the equipment units displayed were merely a preview of things to come, and that considerable time would be required before transistors could be made available in ample quantities and at low cost. Initial equipment designs embodying transistors will probably be mixed. That is, both transistors and vacuum tubes will be employed, with each functioning in its most efficient capacity. Mixed designs will also permit development of hitherto unknown electronic equipments.

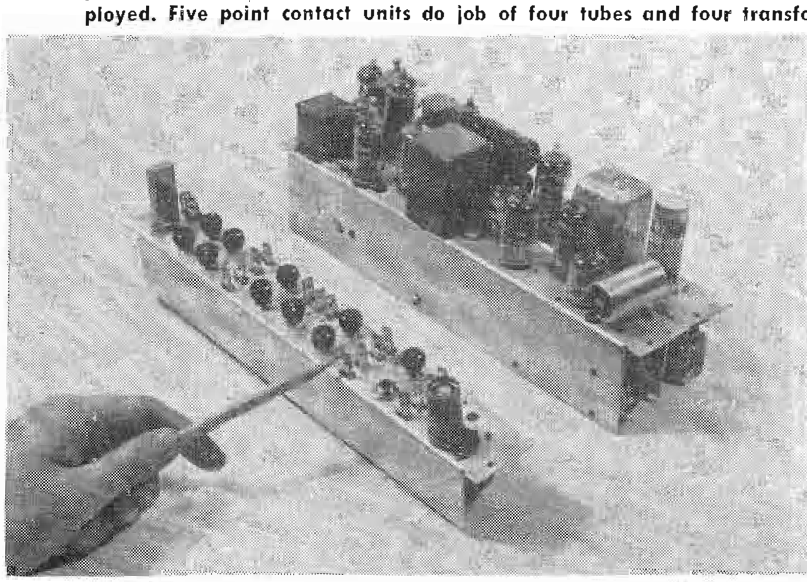
Transistors, in comparison to vacuum tubes, offer certain advantages and have certain disadvantages in circuit applications. Among the advantages are: no warm-up time, operation from extremely low voltage power supplies, elimination in many instances of matching transformer requirements, and small size that contributes materially to miniaturization. On the disadvantage side is the instability at high operating temperatures, which may be ambient or which can develop as a result of high current flow within the unit.

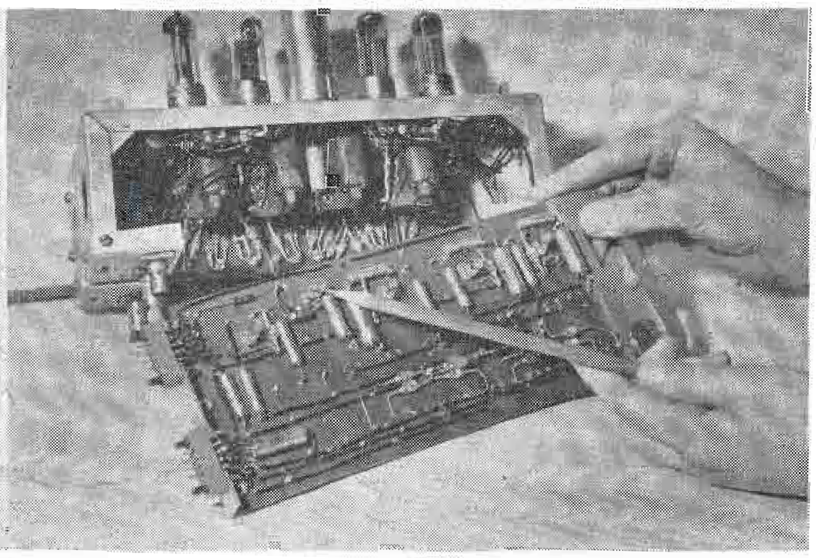
Sync generator unit of industrial TV monitor uses eight point contact transistors to do the work of six tubes and four transformers



Replacing junction transistor in automobile receiver that operates from eleven transistors directly from car's 6-volt storage battery

(Left) 17 point-contact transistors perform functions of 22 tubes in experimental "Walkie-Lookie" unit. Power consumption of back pack unit is reduced by more than one-third. (Right) Drastic size reduction achieved in electronic adder when transistors are employed. Five point contact units do job of four tubes and four transformers at one-fourth the power.—See also "What's Ahead" in this issue





Properties of Junction Transistors

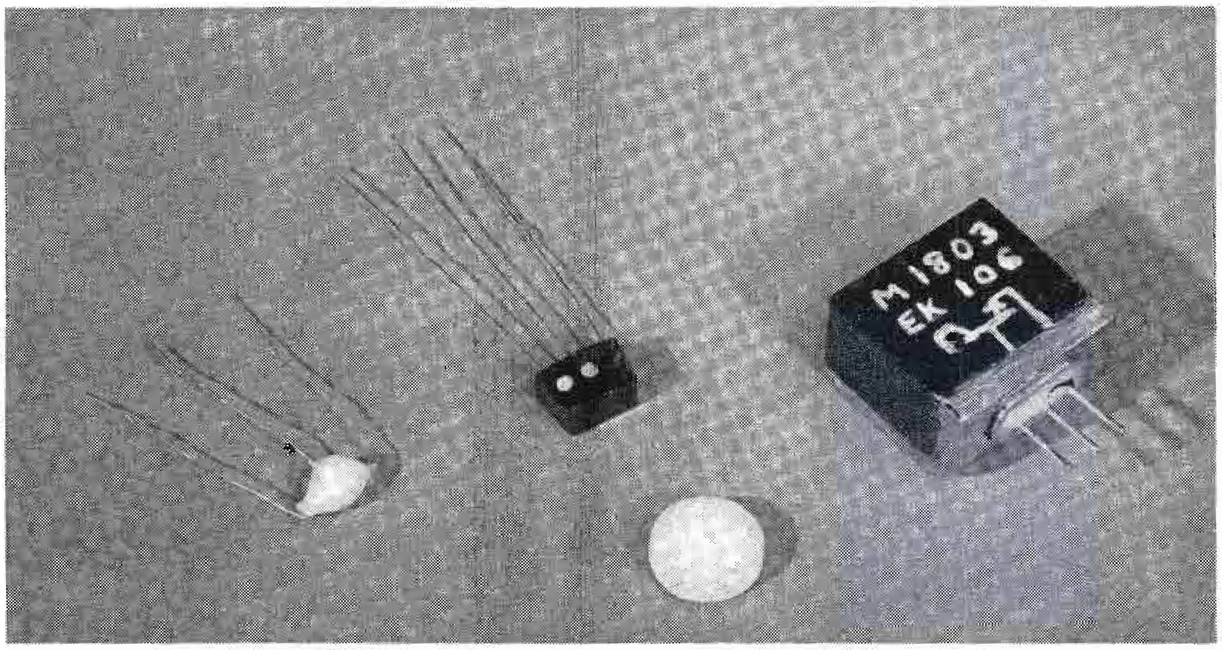


Fig. 1: Three developmental model junction transistors compared in size to an aspirin tablet

Experimental results obtained with developmental n-p-n units indicate how design criteria are based on material properties, physical structure and circuit parameters

By K. D. SMITH

Bell Tele. Labs.
Murray Hill, N.J.

IN the four year period since the disclosure of the point contact transistor by Bardeen and Brattain, the theoretical and practical aspects of transistor design have been carried forward at a rapid pace. The word "transistor" now covers a rapidly expanding field, in which new structures appear most frequently.

The n-p-n junction transistor was announced in July 1951[1] and the characteristics of experimental models have been described.[2] This paper will report results obtained with moderate quantity developmental units, and will consider a few of the design aspects of junction transistors made from single crystal germanium of multiple conductivity type.[3] Some of the factors of importance in increasing the power handling capabilities of junction transistors are mentioned.

Before considering a particular type of transistor, it will be well to establish the family relationships between the various transistor types. Present day transistor triodes may be classed as point-contact or as junction devices. By a point-contact transistor, we mean one in which the transistor is constructed by applying two metal pressure contacts to semiconductor material of a single conductivity type. It is customary to "form" the transistor after applying the metal contacts, but no physical bond is made. Junction transistors are those in which regions of the semiconductor material are of different conductivity type. Usually the wire connections to these regions are welded or soldered "ohmic" connections.

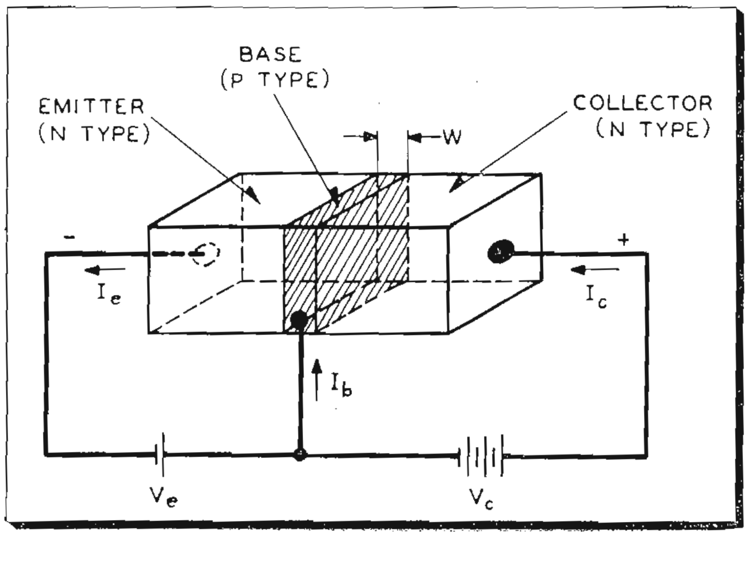
Basic Construction

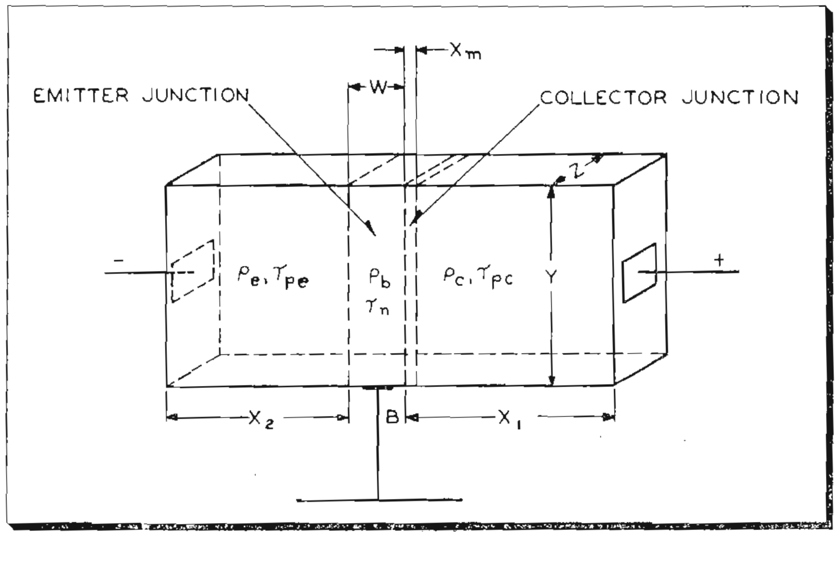
The n and p conductivity regions may be formed during growth of a germanium crystal[3] or local regions of p-type material may be produced on an n-type base by suitable processes.[4] The essential feature of the junction transistor triode is that a thin layer or stratum of one conductivity type separates two regions of opposite type. From a practical standpoint it is of course necessary to make electrical connection to all three regions. A wide range of structural designs is possible, still keeping the same functional configuration. Fig. 1 shows three development model junction transistors, with an aspirin tablet as a size scale.

The transistors to be considered in this paper are shown schematically in Fig. 2; the mode of operation may be briefly described as follows:

The collector-base junction is re-

Fig. 2: (l) Schematic diagram of n-p-n junction transistor. Fig. 3: (r) Material properties considered in transistor design. See Table 1





verse biased by the positive collector voltage, and very little current flows in the absence of emitter current. If emitter current does flow, electrons cross the emitter-base junction into the base, where they are minority carriers, and travel by diffusion. If the base layer is sufficiently thin, most of these electrons will diffuse over to the collector junction and become part of the collector current. The base may be considered as a membrane which is semi-transparent to electrons. The electrons arriving at the collector barrier from the emitter side are drawn through the barrier by the positive collector bias, which at the same time prevents passage of electrons in the opposite direction. The number of electrons injected by the

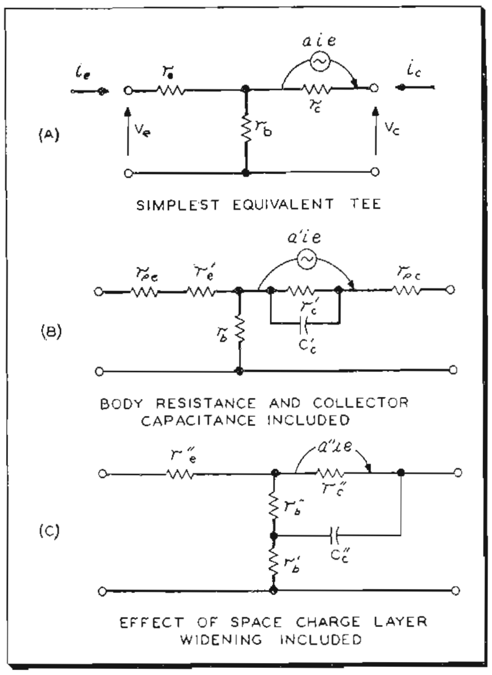


Fig. 4: Equivalent Tee's for junction types

emitter can be controlled by the small forward bias between emitter and base, which allows high power gains to be realized.

The current flowing in the base lead is but a small fraction of that in either the emitter or the collector circuit. In grounded emitter operation, the base may be considered as a positive grid which draws some current, but which controls a much larger current from collector to emitter, giving high current amplification.

The highly simplified operational explanation just presented is of course not suitable for even a first order design analysis. For design purposes it is necessary to know what performance features are important, and how these are related to the design parameters. The design of a device then becomes a series of compromises, in which a practical balance is struck between desirable performance on the one hand, and

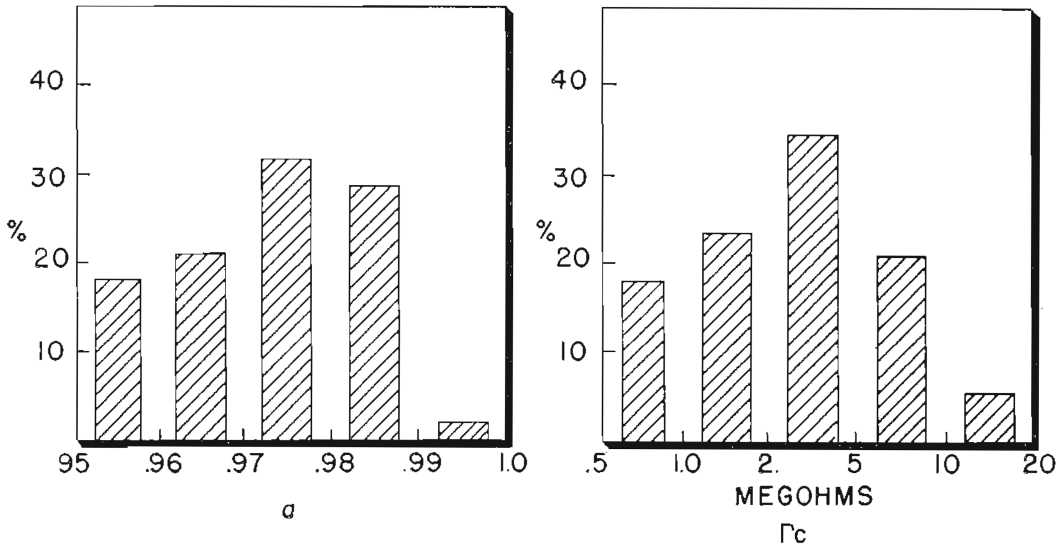


Fig. 5: Distribution of (a) alpha and (b) collector resistance values for 547 M1752 transistors

practical limitations of material and processes on the other. In Table I some of the factors of importance in design are shown in the left hand column, and features of interest in evaluating performance are in the right hand column. While it is beyond the scope of this paper to attempt a complete analysis of the interrelations of the variables listed in Table I, some of the simpler relations will be discussed.

Fig. 3 shows schematically some of the quantities in the left column of Table I. Fig. 4 shows three equivalent circuit Tee representations for the grounded base connection. Characteristics of the various circuit connections, and relations of the terminal impedances to the Tee network elements have been discussed by Wallace and Pietenpol[2] and will not be repeated here.

Four-pole Elements

The simplest equivalent circuit, Fig. 4a, shows three resistive elements and a current generator, and is applicable for first order analysis at low frequency. The r_e arm represents the forward resistance of the emitter junction. If the emitter junction is assumed to have similar properties at all points in the Y-Z plane, and if the current for each elemental area of the junction is the same, then

$$r_e = \frac{kT}{q\,I_e} = \frac{25.9}{I_e\,(ma)} \qquad (1)$$

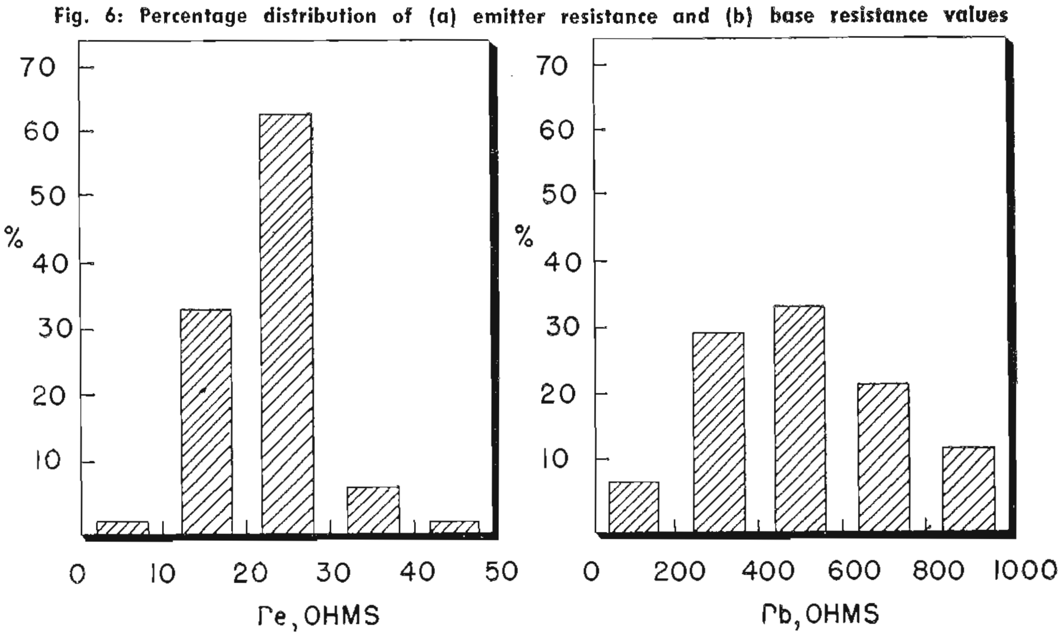
at room temperature, where
k = Boltzmann's constant
T = Absolute temperature
q = Charge of one electron

It may be noted that r_e does not depend on the area of the emitter junction, at least within the assumptions leading to the above equation.

Low Base Resistance

The second element, r_b, is nearly the ohmic resistance of the base layer and base contact, and so depends on the resistivity of the base, ρ_b, and on the physical dimensions and the geometry. For low base resistance, a most desirable feature, the resistivity of the base layer should be low, and the dimension w should be large. It will be seen later that these objectives cannot be met without other sacrifices.

Fig. 6: Percentage distribution of (a) emitter resistance and (b) base resistance values



JUNCTION TRANSISTORS (Continued)

The third element of the simple representation is the collector resistance, r_c. In the simple theory, under reverse bias conditions r_c should approach infinity, since it would be limited mainly by the high but finite surface leakage resistance across the junction. Recent work by J. M. Early[5] indicates, however, that a significant reduction in r_c is caused by narrowing of the base layer as the collector voltage is increased. This effect, which also modifies the r_e and r_b elements, is considered later in this section.

The remaining element in the simple equivalent circuit is the short circuit current gain factor[6], a. Actually the current gain factor used in design is

$$\alpha = \frac{\delta I_c}{\delta I_e}\Big|_{V_c} = \frac{r_m + r_b}{r_c + r_b}, \qquad (2)$$

while $a = r_m/r_c$

Since r_m and r_c for junction transistors may be more than a thousand times r_b, the difference is usually negligible, and it is the short circuit gain, a, which is measured.

The factor α is related to the design parameters by the expression[1,7]

$$\alpha = \gamma\beta\alpha_i \qquad (3)$$

where

$$\gamma = \frac{1}{1 + \frac{\rho_e L_b}{\rho_b L_e}\tanh\frac{w}{L_b}} \doteq \frac{1}{1 + \frac{\rho_e w}{\rho_b L_e}}$$

and $\beta = \text{sech}\,\frac{w}{L_b} \doteq 1 - \frac{w^2}{2L_b^2}$ (when $w << L_b$)

α_i = collector multiplication factor

$\alpha_i = 1$ when ρ_c is very much lower than for intrinsic material.

The quantities L_b and L_e are the diffusion lengths in the base and emitter, respectively, and are related to the minority carrier lifetime and the diffusion constant, as

$$L_p = (D_p \tau_p)^{1/2};\ L_n = (D_n \tau_n)^{1/2}, \qquad (4)$$

the diffusion length being the average distance which a minority carrier will travel in any given direction before recombining, if it has a lifetime τ.

It is evident from (3) that γ can be made to approach unity if $\rho_e << \rho_b$ and if $w << L_e$. Gamma is the emitter efficiency term, that is, the fraction of the total emitter current which is carried by minority carriers into the base region. A fraction $(1-\gamma)$ of the total emitter current is hole current from the base into the emitter, which does not cause any change in collector current.

Transport Term

The factor β is a transport term, being the fraction of total electrons emitted into the base which diffuse across and are collected at the collector junction. A smaller fraction $(1-\beta)$ of the emitted electrons recombine before reaching the collector. In order to make β approach unity it is necessary that $w << L_b$, which can be effected by making w very small or L_b long, or both.

In Fig. 4b the ohmic resistances of the emitter and collector material have been included, and the collector capacitance is shown. The resistance of the emitter and the collector body material may usually be neglected in comparison to the respective junction resistances. The collector capacitance will be of importance except at low frequencies. It depends on the junction area, the rate of change of impurity concentration, and the applied voltage. If the impurity concentration gradient is linear across the space charge layer,

$$C_c = 3 \times 10^{-3} (a/V)^{1/3} A, \qquad (5)$$

where C_c = Collector junction capacitance in $\mu\mu f$

a = The impurity gradient $\frac{d}{dx}(N_d - N_a)$

V = Applied voltage

A = Junction area in cm^2

and if the junction is an abrupt

(*Continued on page* 122)

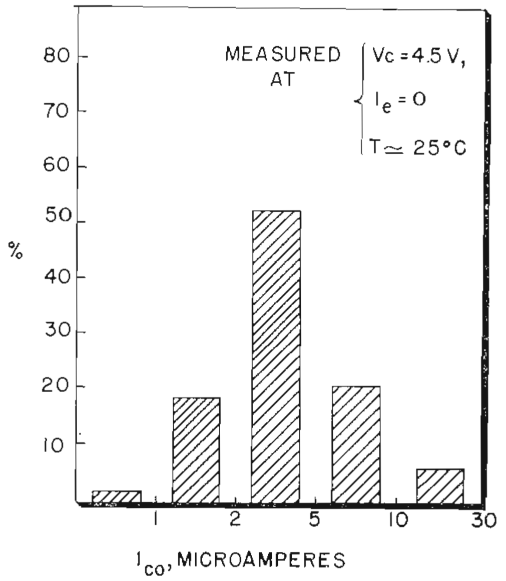


Fig. 7: Saturation current values for M1752

TABLE I: FACTORS OF IMPORTANCE IN DESIGN AND APPLICATION OF N-P-N TRANSISTORS

DESIGN FACTORS			FEATURES OF INTEREST TO USER	
MATERIAL PROPERTIES	Emitter, τ_{p2}	Length of Emitter	EQUIVALENT CIRCUIT PARAMETERS α, r_c, r_e, r_b, C_c	Saturation Current, I_{co}
Collector resistivity, ρ_c	Width of base, w	Lead Arrangement		Temperature effects
Base resistivity, ρ_b	Width of space Charge layer, X_m	Surface protection		Thermal time constant
Emitter resistivity, ρ_e		Packaging		Power dissipation
Minority carrier lifetime in		Thermal Dissipation	Power gain	Reliability
Collector, τ_{p1}	PHYSICAL DESIGN	Physical Size	Current Gain	Life
Base, τ_n	Area of Junction, A		Large Signal Characteristics	Ruggedness
	Length of Collector	PROCESS VARIABLES	Frequency response	Stability
			Noise	Efficiency
			Microphonics	Photo electric effects
			Zener voltage, V_z	Transient effects

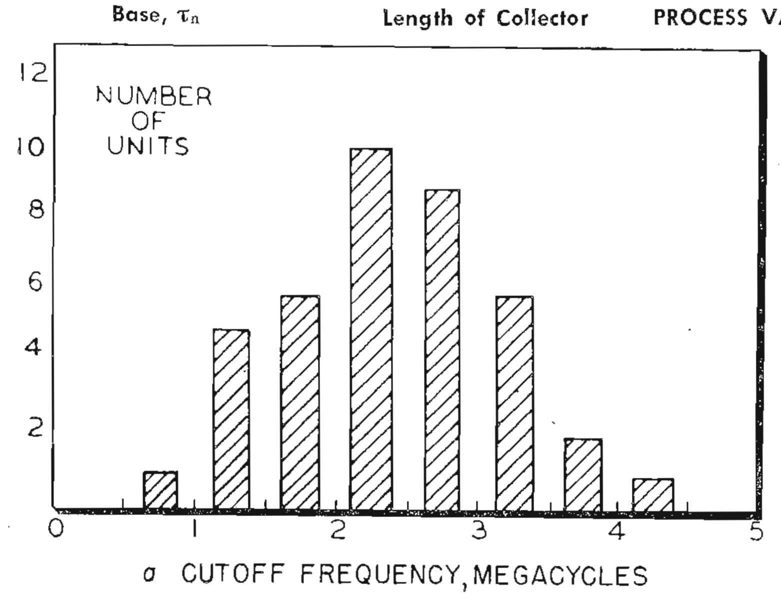
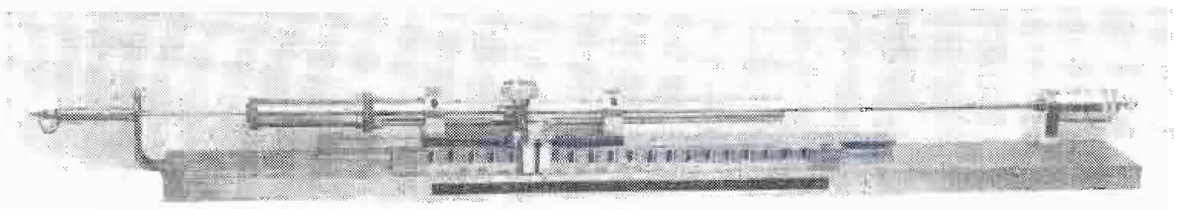


Fig. 8: Alpha frequency cutoff, M1752 type

TABLE II: TENTATIVE TEST LIMITS, M1752 MODEL PRODUCTION

Quantity Measured	*Limits*	*Conditions*
Current Gain Factor, α	$0.95 < \alpha < 1.0$	$V_c = 4.5$v., $I_e = 1.0$ ma, f = 1000 ~
Collector Resistance, r_c	0.5 meg $< r_c$	$V_c = 4.5$v., $I_c = 1.0$ ma, f = 100 ~
Emitter Resistance, r_e	$r_e < 50$ ohms	$V_c = 4.5$v., $I_e = 1.0$ ma, f = 100 ~
Base Resistance, r_b	$r_b < 1000$ ohms	$V_c = 4.5$v., $I_e = 1.0$ ma, f = 100 ~
Saturation Current, I_{co}	$I_{co} < 30\mu A$	$V_c = 4.5$v., $I_e = 0$



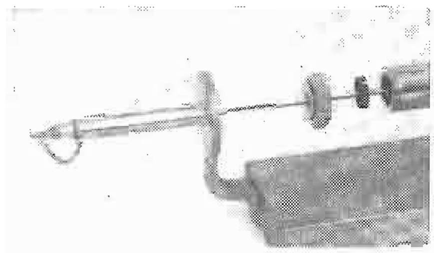


Fig. 1: (l) NBS standard for determining r-f permeability of magnetic materials consists of variable-length coaxial line. Fig. 2: (r) Left side of line shows disk-shaped sample and cap before insertion in line. Line variation for new balance with insert is proportional to material permeability

Calibration of Magnetic Materials

New standards developed at National Bureau of Standards measure r-f permeability and loss factor in 30-50 MC range

A calibration service for determining the r-f permeability and loss factor of magnetic materials in the frequency range between 50 KC and 30 MC has recently been established by the National Bureau of Standards. The primary calibrating standard is a coaxial line of variable length (Fig. 1) constructed to dimensions of extremely high accuracy. The characteristics of magnetic materials, such as the ferrites and powdered irons, are determined in terms of the variation in the length of the line. The Bureau has also developed a secondary standard of calibration that may be simply reproduced and utilized in the manufacture of magnetic materials.

The NBS primary standard of r-f permeability and loss factor was designed by P. H. Haas of the Bureau's high frequency standards laboratory. The method of measurement depends on the change in inductance of an accurately machined coaxial line when a sample of magnetic material is inserted. The variable-length coaxial line is accurately calibrated in 19 1-in. stops and includes a micrometer system that permits the measurement of variations to within 0.0005 in. along the 20-inch range. All machining tolerances were held to ±0.0002 in. The line is made completely from non-magnetic materials to reduce the possibility of extraneous magnetic fields affecting the measurement.

In a typical investigation, a sample of magnetic material is ground into the shape of a coaxial disk that completely fills a section of the space between the conductors of the coaxial line. In the grinding process, all tolerances are ±0.0002 in. The output terminal of the coaxial line is connected to the "unknown" terminal of an r-f bridge suitable for measuring inductance in the frequency range at which the material will be used.

No Sample in Line

First, the bridge is balanced with no sample in the line and the coaxial segment extended to almost its fullest length. The disk of magnetic material is then placed on the center conductor of the line. See Fig. 2. A metal cap holding the disk in place short-circuits the end of the coaxial line. The resulting bridge unbalance is adjusted to the original conditions by a combined manipulation of the resistance reading arm on the bridge and a reduction in the length of the line. The variation in length is directly proportional to the permeability of the magnetic material relative to air and constitutes a primary method of measurement. The difference in resistance readings is a measure of the loss factor of the material and is limited only by the inherent accuracy of the bridge instrument.

The r-f permeameter, as the secondary standard is called, is a modification of an instrument described by G. A. Kelsall,[1] for the measurement of permeability alone at low audio and power frequencies. The principle of operation depends on the change in input impedance reflected into the primary of a transformer by load variations in the secondary. The transformer of the NBS permeameter is composed of a reference toroid and a length of coaxial line; changes in the secondary are produced by the insertion of a toroid of magnetic material into the coaxial line. The changes in the secondary may be measured by a Q-meter, Fig. 3, or r-f bridge.

The NBS r-f permeameter, also developed by P. H. Haas, is machined from 2-in. brass rod into a cylinder with an inner diameter of 1½ in. and a length of about 1¾ in. (Fig. 4, center). Both ends of the line are

(*Continued on page* 117)

Fig. 3: R-F permeameter, a secondary standard, uses Q-meter to measure load variations

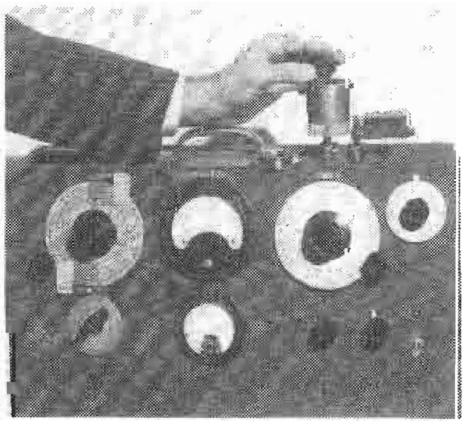
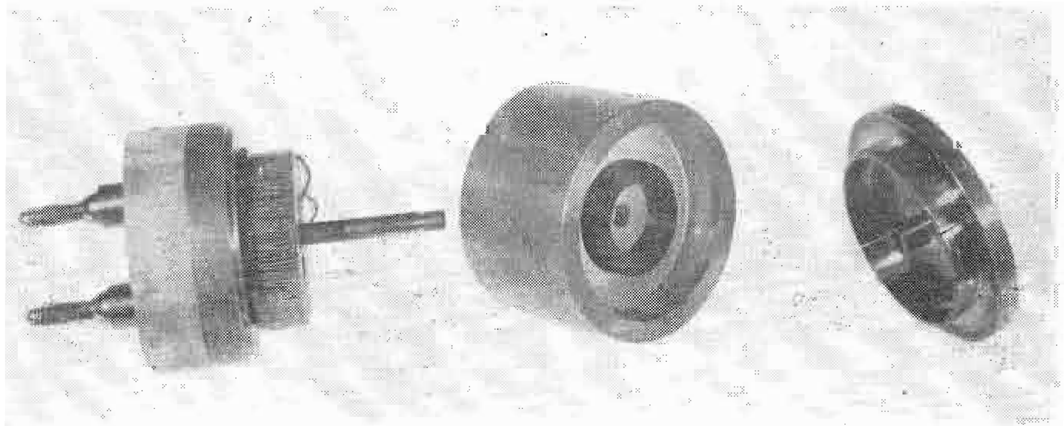


Fig. 4: NBS r-f permeameter is machined from 2-inch brass rod into a cylinder (c) 1.5 in. ID x 1.75 in. long. Top cover (l) admits sample, bottom cover (r) holds reference toroid



WASHINGTON
News Letter

Latest Radio and Communications News Developments Summarized by TELE-TECH's Washington Bureau

NOT TO BE OVERHAULED—With the multi-faceted problems of television as its major task, the Federal Communications Commission in being meshed after the Jan. 20 inauguration of President Eisenhower is not likely to be overhauled like many other Federal Government departments and agencies. In fact since its huge load of television station applications, between 900 and 1,000, which have to receive action, is recognized as so important to the growth of video, the FCC appropriations are not facing the fate of being pared down in the economy program of the new Eisenhower Administration. Besides the expediting of the processing of these thousands of new television station construction permits the FCC has also to determine the status of what educational TV services are in the public interest and to "crack the nut" of motion picture theatre television.

VETERAN FCC CHIEFTAIN—There is every indication that the leadership of the FCC under the new President will be placed in the hands of a veteran in radio regulation—Commissioner Rosel H. Hyde, an Idaho Republican, whose entire career has been spent in that field. He has not only his background of service with the FCC and its predecessor, the Federal Radio Commission, since 1928, but also has demonstrated excellent administrative ability during the past three years when he has served as acting chairman and vice chairman. Immediately after Gen. Eisenhower's inauguration on Jan. 20 there will be one FCC vacancy—that of Eugene H. Merrill, the Utah Democrat who was given a recess appointment by President Truman while he was campaigning in that state. Then the present FCC Chairman Paul A. Walker will retire from government service on or before the expiration of his present term next June 30.

GLOBAL MICROWAVE—Just as TELE-TECH has been advocating through its editorial articles the establishment of the UNITEL microwave global system for telecommunications and television, the U. S. Army Signal Corps and the U. S. Air Force communications commanders in the Supreme Headquarters, Allied Powers in Europe (SHAPE), formerly headed by General Eisenhower and now by General Ridgeway, working with the allied foreign government telecommunications administrations, have planned and are installing extensive microwave radio relay systems crisscrossing all of the western European continental nations. There are six such microwave communications networks ranging from northern Norway to eastern Turkey and U. S. Major General Francis L. Ankenbrandt, Chief Signal Officer at SHAPE stated that NATO now has the backbone of a military communications system, though not enough, but in two years the system will constitute a high degree of communications capability both for military needs and to aid the existing civilian communications systems of Europe.

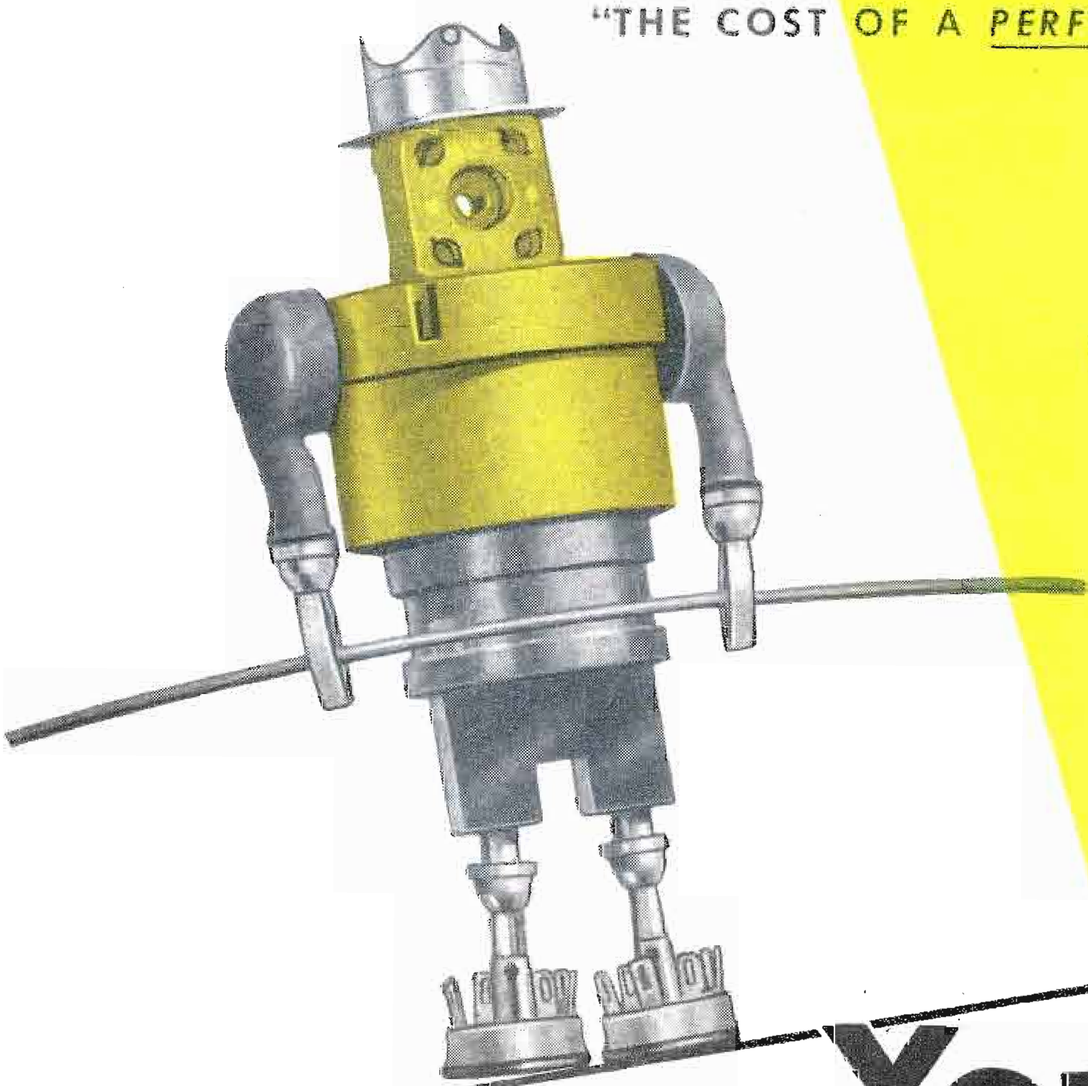
SET ASIDE OPS ORDER—With the inconsistent order of the Office of Price Stabilization which declined to set aside the restoration of price controls on radio-broadcast-television parts and tubes, the Radio-Television Manufacturers Association has moved swiftly and aggressively to obtain a solution against the action of the OPS which the RTMA and the manufacturers of parts and tubes regard as "arbitrary" and contrary to the Defense Production Act and OPS regulations and not supported by the facts of the price situation in this field. The RTMA through its General Counsel and former President Glen McDaniel presented a joint protest of the Association and the manufacturers to Acting OPS Director Joseph Freehill and if this appeal procedure fails the issue will be presented to the courts.

PETROLEUM RADIO EXPANSION—Progress in the value and use of mobile radio communications and of microwave in the petroleum industry presages "an even wider use and expansion of these facilities," the two major radio organizations—the American Petroleum Institute's Central Committee on Radio Facilities and the National Petroleum Radio Frequency Coordinating Association—envision as the result of recent joint planning sessions in Chicago and Washington. The petroleum industry has manifold uses of mobile, microwave and geophysical radio in its production work, offshore and land drilling, pipeline and other land transportation, refinery operations, aviation, maritime and numerous other activities. Because of the extensive operation of its present ten petroleum and natural gas pipeline microwave systems the industry is opposing vigorously the proposal of the motion picture industry for theatre television to obtain the microwave bands now assigned to common carrier communications in which petroleum and other fields of industry are now operating or plan to expand their facilities.

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

"THE COST OF A PERFECT PERFORMANCE IS LOW"



For nearly a quarter of a century Cinch has produced electronic components that were made "standard"—by demand.

YOU WANT THE ORIGINAL...THE *"perfect performance"* ...YOU CAN'T AFFORD A SUBSTITUTE

From the CINCH organization has come many "firsts" in electronic components. Added to these CINCH engineers have developed numbers of metal plastic assemblies for specific needs of set manufacturers and communication systems. Components that by satisfactory performance became STANDARD. The number of CINCH parts in the leading TV and Radio sets, and in communication systems testify to their quality . . . to the reputation of the maker. **CONSULT CINCH!**

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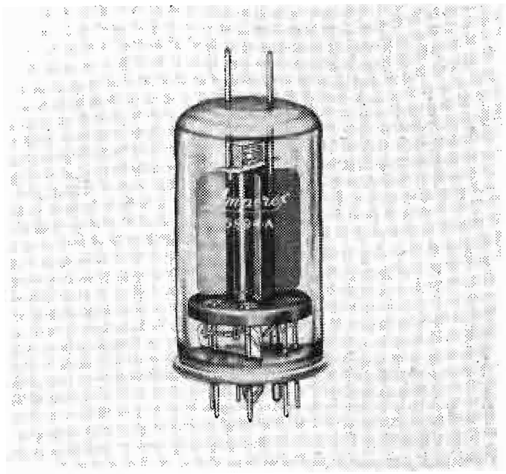
Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

Cinch electronic components are available at leading jobbers—everywhere.

NEW EQUIPMENT

Twin Tetrode

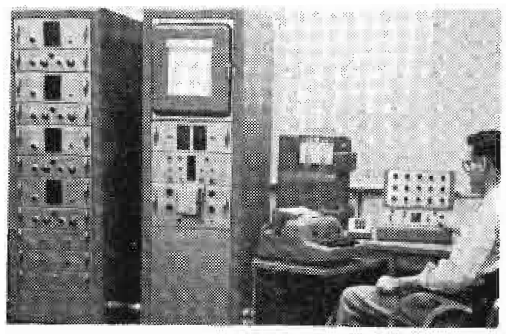
The 5894-A twin tetrode is designed for wide band operation as an r-f amplifier, modulator, frequency doubler or a tripler.



Improved HF performance is made possible because the cathode and grid structure is supported at the top as well as the bottom of the tube. The anode seal strength has been increased by replacing the top section of the tube with a powdered glass seal. With this new construction, the maximum force on the ends of the anode pins perpendicular to the pin axis is about 14½ pounds. With greater force, the pins bend without forming cracks in the glass. Charactertistics in brief: 250 MC, 85 watts output; 500 MC, 45 watts output; filament voltage (series 12.6v.) (parallel, 6.3v.), filament current, (series 0.9a) (parallel, 1.8a)—**Amperex Electronic Corp., 230 Duffy Ave., Hicksville, Long Island, N. Y.**—TELE-TECH

Analog-to-Digital Converter

The "SADIC" (Analog-to-Digital Converter) eliminates the analog plot and directly converts test measurements from



standard pressure pickups, thermocouples, and strain gages to numerical values. These are immediately and automatically typed or printed out on tapes, or they can be punched into standard cards for automatic processing. Numerical measurements indicated by its lighted panels and printed on its readout equipment are accurate to within 1 part in 1000. This 1/10th% validity is coupled with a speed that allows measurements to be sampled as often as once every second. Thus, any device or structure which can reach a semi-stabilized condition, can be tested in actual operation. Flexibility of the system allows any number of measurements to be simultaneously converted to digital form. Although each "SADIC" is used for only one phenomenon, systems of any number of channels may be assembled and expanded at any time.—**Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.**—TELE-TECH

Miniature Thermostat

The VAL 90 is a miniature, hermetically-sealed thermostat ⅜ diameter x 15/16 long. One terminal is the pin of an eyelet hermetic header, the cylindrical brass capsule is the other terminal. A friction couple snap action thermostat, the bimetal is thermally a part of the capsule, hence quite sensitive to changes of temperature. Both the temperature and differential are adjustable. The thermostat can be used without the capsule for on-the-job adjustment. Because of the design, close tolerances in setting and differential are possible without delay in deliveries.—**Valverde Laboratories, Dept. TT, 253 Lafayette St., New York 12, N. Y.**—TELE-TECH

New!

COMPARISON BRIDGE

for Rapid and Accurate

Impedance and Dissipation Factor

Measurements

TYPE 1604-A COMPARISON BRIDGE . . . $335.00

The Type 1604-A Comparison Bridge is a unique, direct-reading impedance measuring device which materially reduces test and measuring time. It enables the rapid and precise measurement of both impedance and dissipation factor of capacitors, resistors and inductive components. A component of a production lot or an appropriate standard is used for comparison against the unknown.

In operation, "Impedance Difference" and "Dissipation Factor Difference" dials conveniently and accurately indicate the degree by which these characteristics differ from those of the selected standard. For real high-speed sorting, the cathode-ray-tube indicator is easily calibrated at the desired tolerance and used to give an instantaneous visual "go no-go" indication. The instrument is completely self-contained; it includes a bridge circuit, internal 1 kc and 5 kc oscillators, a high-gain non-linear amplifier terminated in a CRO visual detector, and an internal power supply.

The Type 1604-A Comparison Bridge —

★ is ideal for checking ganged potentiometers, condensers and inductors that must track each other to very close tolerances

★ is extremely useful for precisely setting and checking the tap of center-tapped windings or for comparing two windings on the same core.

★ permits rapid and reliable adjusting of one variable component to the value of another . . . the approach to balance is continuously and instantly indicated

★ can be used to measure directly small capacitors in the 1 $\mu\mu f$ range.

★ In laboratory, shop or production line the Comparison Bridge will prove invaluable for adjusting, selecting and pairing components within given tolerances.

FEATURES

Two IMPEDANCE DIFFERENCE Ranges — *0 to ±5% range for accurate comparisons — 0 to ±20% for checking components within the common ±10% and ±20% tolerances*

Accuracy of Impedance Measurements

	Resistance	Capacitance	Inductance
1 kc:	$2\Omega - 20M\Omega$	$50\ \mu f - 50\ \mu\mu f$	$500\ \mu h - 250\ h$
5 kc:	$4\Omega - 4M\Omega$	$2\ \mu f - 50\ \mu\mu f$	$200\ \mu h - 10\ h$

For these impedances, accuracy is ±0.1% for the 5% switch position.

DISSIPATION FACTOR DIFFERENCE
- **Range** ±*.015 at 1 kc; ±.0 75 at 5 kc*
- **Accuracy at** *1 kc: ±(.0005+2% of impedance difference)*; *5 kc: ±(.0025+2% of impedance difference)*

CRO Visual Detector — *horizontal band of light is used as the indicator — highly non-linear detector amplifier keeps indication on scope over wide ranges of unbalance — continual resetting of gain control is eliminated.*

Zero Adjustment — *adjustable index mark on scope can be offset and locked to compensate for deviation of the standard from the desired nominal value — permits use of any component as a standard*

Dimensions — *12" x 14¼" x 10"*; **Net Weight** — *22½ lbs.*

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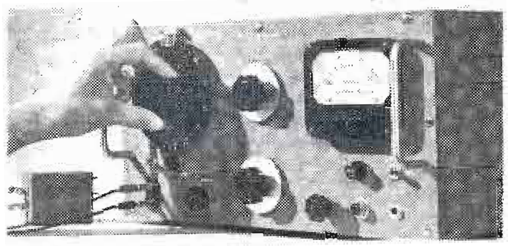
Admittance Meters ☆ Coaxial Elements ☆ Decade Capacitors ☆ Decade Inductors ☆ Decade Resistors ☆ Distortion Meters ☆ Frequency Meters ☆ Frequency Standards ☆ Geiger Counters ☆ Impedance Bridges ☆ Modulation Meters ☆ Oscillators ☆ Variacs ☆ Light Meters ☆ Megohmmeters ☆ Motor Controls ☆ Noise Meters ☆ Null Detectors ☆ Precision Capacitors ☆ Pulse Generators ☆ Signal Generators ☆ Vibration Meters ☆ Stroboscopes ☆ Wave Filters

Wave Analyzer

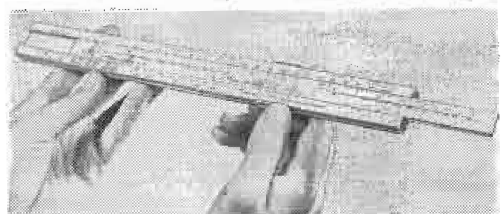
Analysis of the frequencies and amplitudes of signal components in a complex wave form is accomplished simply and di-



rectly with the model 121 wave analyzer. A novel two-attenuator design permits a wide range of measuring amplitudes without the introduction of instrument distortion. Signal components are read directly on a 4-in. indicating instrument calibrated in decibels. Voltage calibration is accomplished with an internal 100-KC injection oscillator, and a listening jack is provided for monitoring the signal being measured. It has an input level range from +42 dbm to −70 dbm at a 600-ohm impedance level. Input impedance is 10,000 ohms in the pass band. Selectivity is such that 100 cps off resonance the response is 3 db down; 200 cps off resoance, 10 db down; 500 cps, 30 db; and 1,000 cps, 45 db. Measuring accuracy is ±2 db and spurious components are at least 50 db below signal fundamental. Operating from a 105- to 125-v. 50/60 cps source, the set consumes 80 va.—**Sierra Electronic Corp., 817 Brittan Ave., San Carlos, Calif.**—TELE-TECH

Signal Range Calculator

A VHF-UHF television signal range calculator quickly helps determine signal coverage due to change in transmitter output



power; change in antenna height; or change in channel frequency. It shows the approximate Grade "A," Grade "B" and "Principal City" coverage for all VHF and UHF channels. Coverage radius is read directly, and with one rule setting, for stations operating with effective radiated powers from 10 kw to 1000 kw, and for antenna heights up to 3000 ft. Effective radiated power is shown in kilowatts, and in decibels above one kilowatt. This handy new calculator readily shows the approximate field strength in microvolts-per-meter for distances up to 100 miles from a TV transmitter. It is only necessary to use the "Grade A" or "Grade B" limit for reference and then add or subtract the number of decibels indicated by the rule setting. A handy conversion chart is provided on the back of the rule. DBK to KW conversion scale, and DBU to microvolts-per-meter conversion. Copyrighted and designed exclusively for Pioneer Electronic Supply Co. by nationally known communcation engineer J. B. Epperson, Associate Member of Federal Communications Consulting Engineers. Attractive leather case and instructions included. Price, $5.45 net.—**Pioneer Electronic Supply Co., 2115 Prospect Ave., Cleveland 15, Ohio**—TELE-TECH

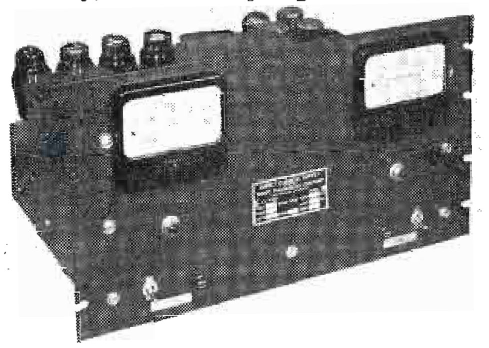
Sound Effects Filter

Model 4200 sound effects filter features low hum pickup through the use of toroid coils. It may be used in circuits having sig-

nal levels as low as -40 dbm without the necessity for taking special precautions against hum pickup. The filter may be used at levels up to plus 20 dbm with negligible intermodulation distortion. All capacitors and inductors are hermetically sealed for lifetime service. Aging effects are said to be negligible. Both low and high frequency cutoff controls cover 100, 250, 500, 1000, 2000, 3000, 4000 and 5000 cycles. Attenuation is approximately 16 db, per octave on both high and low frequency cutoff points. Impedance is 500/600 ohms, in-out. Net price (f.o.b. North Hollywood) is $195.00.—**Hycor Co., Inc., 11423 Vanowen St., North Hollywood, Calif.**—TELE-TECH

Power Supply

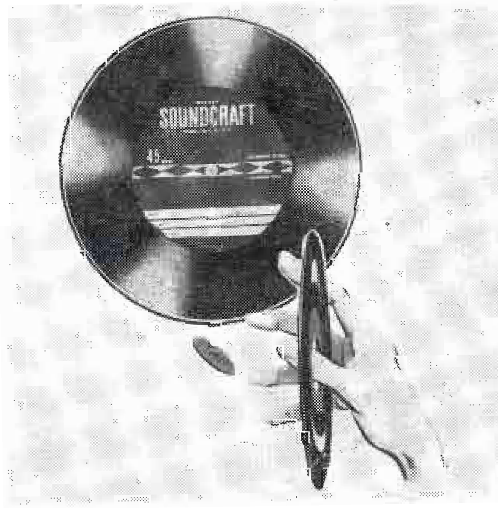
Model No. M-900 regulated dc power supply supplies an output of 300 volts, automatically, electronically regulated to within



0.15% at any current load from 0 to 500 ma. Inherent ripple is below 0.004 RMS v. The unit is also equipped with a time delay relay to withhold the dc output for a period of 40 seconds after initial energization to provide for thermal stabilization and for the protection of circuits powered by the supply, during their warm-up period. A dc bias output of −105 v. is also provided. This voltage is regulated to within 1% at any load from 0 to 5. The entire unit is treated for resistance to extremes of humidity and its preset voltage calibration obviates the necessity for time-consuming adjustments and precludes the possibility of incorrect adjustment in the hands of semi-skilled operators. **—Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.**—TELE-TECH

45 RPM Discs

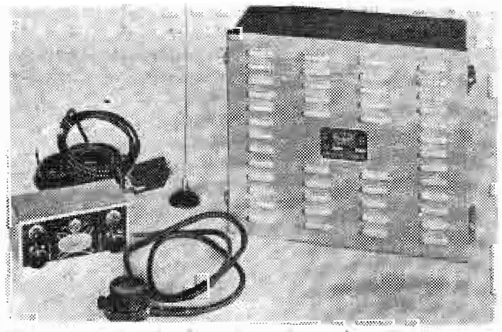
A 45 RPM recording disc has been designed for professional and amateur use. The Soundcraft "45" fits any conventional



recorder spindle and with the perforated center removed is ready for a 45 RPM turntable. The new discs are now in production and initial orders are being filled. List price of the Soundcraft "45" is $1.10.—**Reeves Soundcraft, Inc., 10 East 52 St., New York, N. Y.**—TELE-TECH

Airborne VHF-FM Unit

A two-way VHF-FM communications unit for aircraft, the Model 400, is available for either the 25-50 MC or 152-174 MC band.



Power output for the low band is 12-15 watts, and for the high band 8-10 watts. Self-contained unit consists of a crystal-controlled receiver, transmitter and vibrator power supply, and requires no manual tuning. When operating on 12-v. battery, drain is 4.5 amps standby, 10 amps transmitting; drain for 24-v. battery is 2.5 amps standby, 5 amps transmitting. Spurious radiation is -60 db, modulation deviation is 15 or 7.5 KC, and transmitter frequency stability is 0.01% at 25-50 MC, and 0.005% at 152-174 MC. Compact unit measures 13 x 11 x 5.5 in., and weighs 22 lbs.—**Communications Co., Inc., 300 Greco Ave., Coral Gables, Fla.**—TELE-TECH

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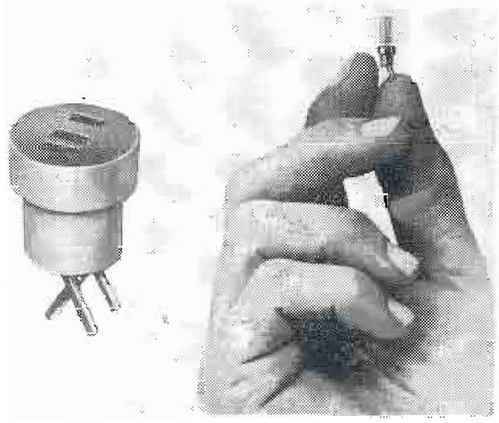
Transistor Sockets

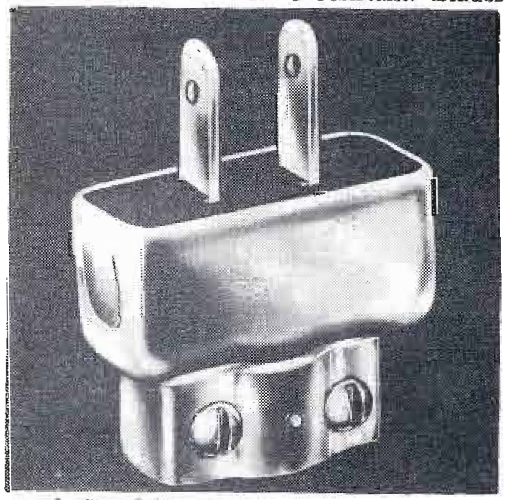
The body of a new transistor socket is precision-molded of Mycalex 410, glass-bonded mica insulation for lasting dimen-



sional stability, low dielectric loss, immunity to high temperature and humidity exposure combined with maximum mechanical strength. The loss factor is only 0.014 at 1 MC and dielectric strength is 400 volts/mil. Contacts can be supplied in brass or beryllium copper. The sockets are readily solderable. The socket bodies will not warp or crack when subjected to high soldering temperatures. They function in ambient temperatures to 700°F.—**Mycalex Tube Socket Corp., 60 Clifton Blvd., Clifton, N. J.**—TELE-TECH

Armored Power Plug

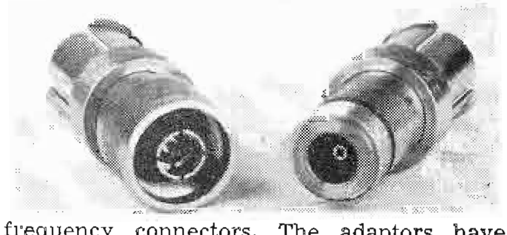
A miniaturized armored plug will withstand high impact and extreme temperatures. It is also moisture resistant. Blades



are designed to capture the wire on all sides to prevent escape from under the screw head. Finger grips are provided on each side of plug. Strain relief guard will withstand 25 lb. pull. All screws are staked, and will always remain fast to the unit.—**Automatic and Precision Manufacturing, 315 East 91 St. New York 28, N. Y.**—TELE-TECH

Coaxial Adaptors

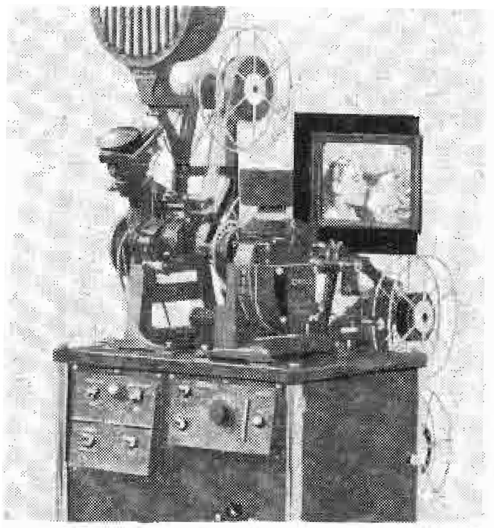
Adaptors are now available to connect type 874 coaxial connectors to either male or female of types N, C, BNC or UHF high-



frequency connectors. The adaptors have excellent electrical characteristics with a low VSWR even at several thousand megacycles. These adaptors not only make it possible to utilize the advantages of the type 874 line when measurements are made on equipment fitted with military-type connectors, but also make it simple to interconnect systems using any of the various connectors. A new adjustable line can be used in measurement work requiring a section of coaxial line of adjustable length but with uniform impedance. The type 874-LK is a 50-ohm line adjustable from 58 to 80 centimeters. It has a VSWR of less than 1.10 at 2000 MC. A shielded component mount has also been added to the GR type 874 line of coaxial elements to facilitate the accurate measurement of resistors, capacitors, and inductors.—**General Radio Company, 275 Massachusetts Ave., Cambridge 39, Mass.**—TELE-TECH

Film Editing Machines

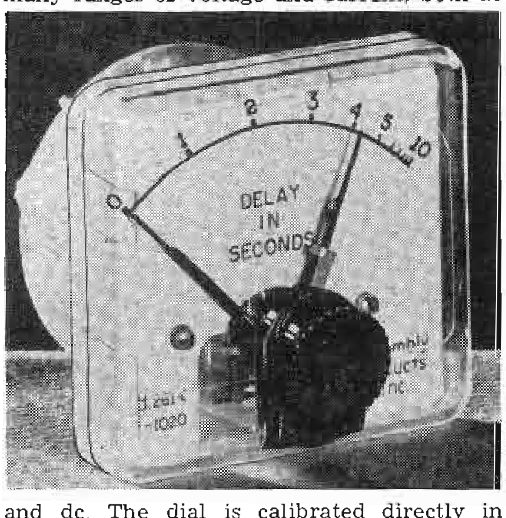
Acmiola Editing Machines for 16mm or 35mm film viewing and sound reproducing are now available to the American market.



The Acmiola design is of a familiar type with film threading standard, straight up and down. This is said to present no problems to film cutters, who have nothing new to learn, permitting Acmiola use with present equipment, without disturbing routine. The machines have reversible variable speed motors for picture head, controlled by foot or hand rheostats. Soundheads have reversible constant speed motors controlled by panel or footswitch, permitting sound and picture heads to be run in synchronization. An unusually sharp, brilliant picture is projected by means of a powerful optical system which throws a picture up to 3 ft. wide if necessary. A unique feature is a 6" x 8½" shadow-box screen on some models which also project larger images if desired. Automatic takeups handling standard exchange type reels, frame and footage counters are provided when specified. All sound machines have a built-in high fidelity power amplifier with sufficient volume for low level tracks. Multiple head models include separate volume control for each soundhead with overall mixing gain control. Sound and picture sprockets are hobbed to SMPTE tolerances while other wearing parts are of high quality steel, ground to fine limits and run in phosphor bronze bearings. The intermittent star wheel is optically divided to mesh with its special strain-relieved alloyed steel cam.—**S.O.S. Cinema Supply Corp., 602 W. 52 St., New York, N. Y.**—TELE-TECH

Time Delay Relay

A new moving coil, permanent magnet-type relay offers adjustable time delays for many ranges of voltage and current, both ac



and dc. The dial is calibrated directly in "Delay in Seconds." The timing is adjusted by hand setting a pointer to the time indicated on the dial. Full scale ranges of less than 10 seconds can be furnished. Timing is relatively unaffected by changes in temperature or barometric pressure. Delay action results from the magnetic drag inherent in sensitive microammeters. There are no condensers, dash pots nor motors. Contacts are self-locking and rated at 5 ma, 100 v. dc for one million operations. Ratings up to 500 ma can be supplied for a reduced number of operations. Contacts are locked by an extra coil in the meter. Relays with non-locking contacts can be supplied for special applications. These relays can be designed to operate on a few μamps or hundreds of amperes. Likewise, they can be supplied for any range of volts from 5 mv up.—**Assembly Products, Inc., Chagrin Falls, Ohio.**—TELE-TECH

CUES for BROADCASTERS

(Continued from page 69)

relay operating contacts of the console microphone switches are shown on the diagram. These contacts can be identified on the console wiring diagram.

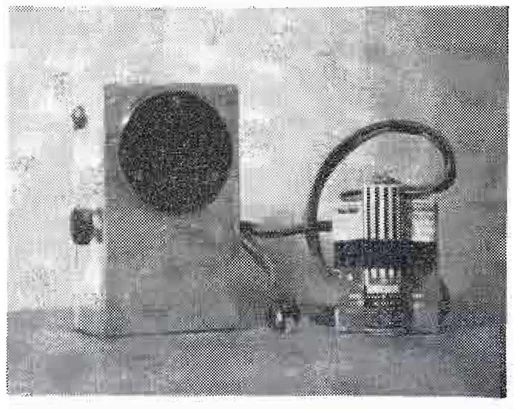
As the console comes from the factory, jumpers are wired between the relay contacts of microphone switches #1 and #2 and switches #3 and #4. Also from each of these jumpers a wire runs to the corresponding speaker relay. This is convenient since the seven wire cable from the switch box terminates at this point. These jumpers must be removed to separate the operation of the microphone switches, and at this point the two wires which come from the switch box may be tied to the console relay circuits without disturbing additional console wiring. The switch jumpers to be removed are shown by dotted lines.

The studio announcer controls his own microphone from Studio "A." This adds complications since the announcer's microphone switch in the studio must also control the speaker-muting and "On the Air" right relays. This problem was met by utilizing an extra set of single pole single throw contacts on the announcer's microphone switch. From these contacts, a line was run to the console and connected as shown in the diagram. With this set-up, the microphone in Studio "A" is operated in the studio by the announcer and when the microphone is switched to Studio "B" it is operated from the control room in the usual manner.

Midget Standby Remote Amplifier

ALVIN H. SMITH, Chief Engineer, KCOM, Sioux City, Iowa

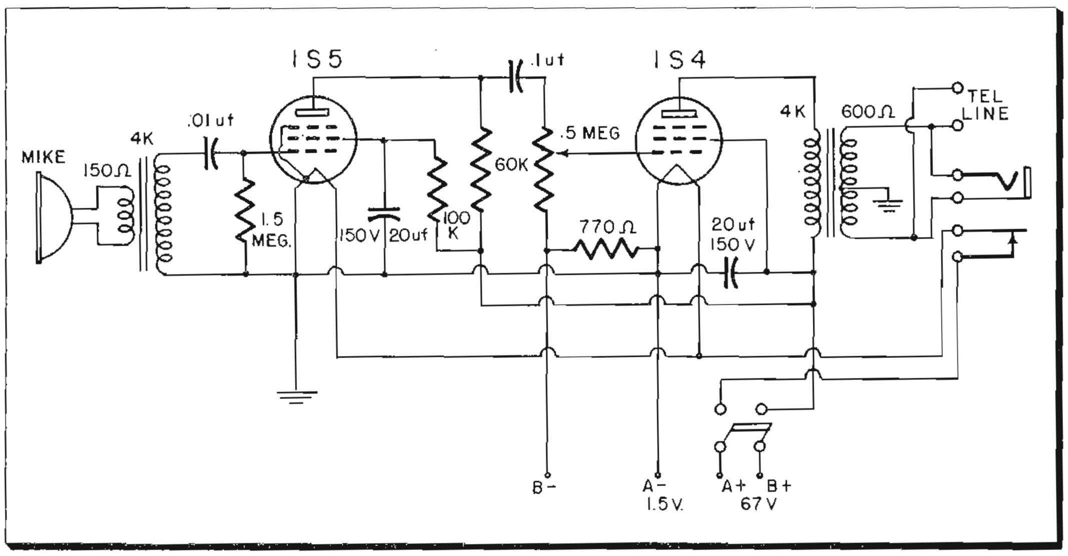
THE unit to be described has proved very satisfactory at KCOM. It is only 7½ in. high, 4½ in. wide and has a depth of 2½ inches. Quality and output compare favorably with a conventional single channel remote amplifier.



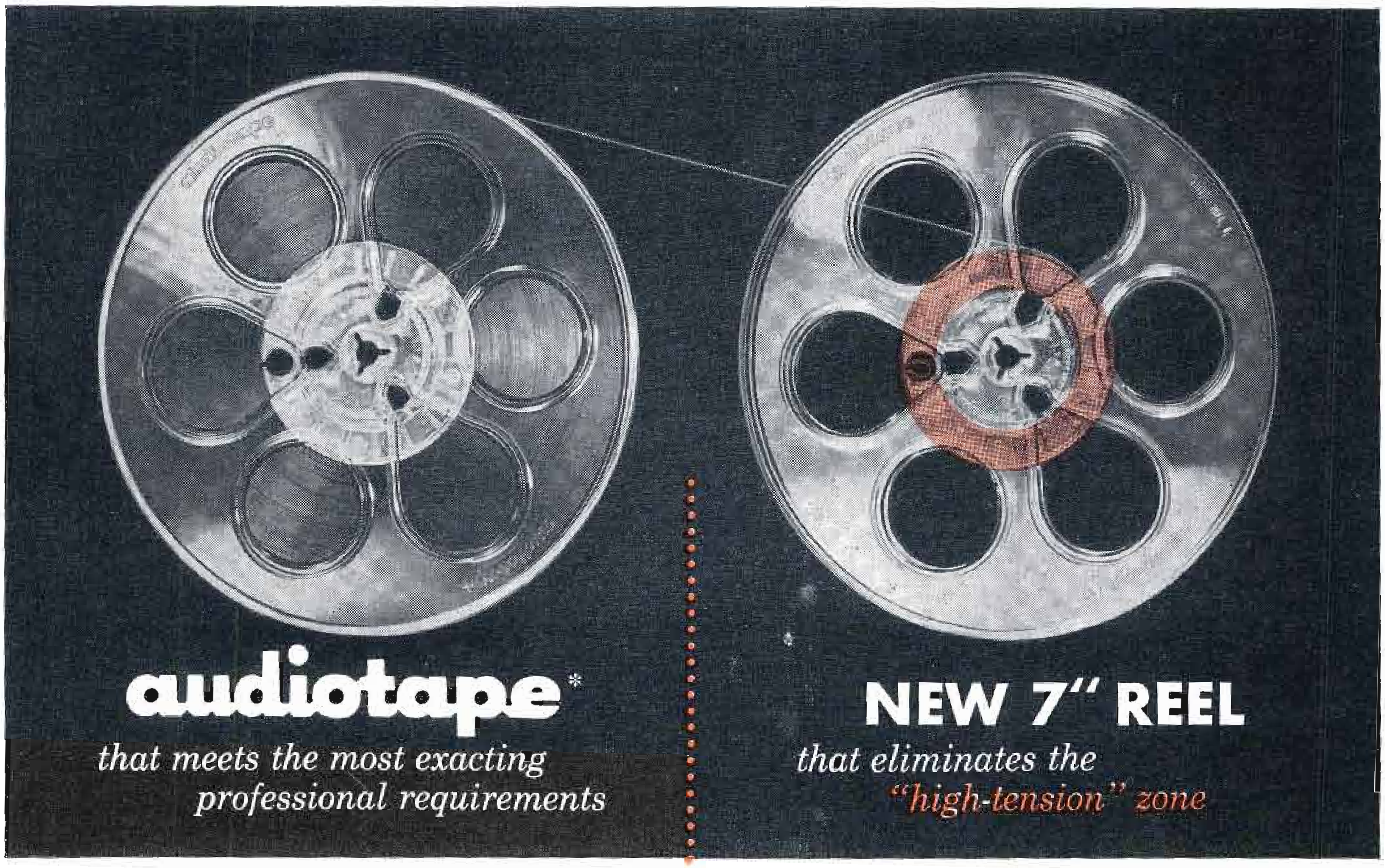
Miniature remote standby amplifier unit

The diagram and photo are in the most part self explanatory. The amplifier is conventional in design. All parts except the microphone are readily obtainable. The microphone and transformers were purchased from war surplus. A small crystal microphone could be used in place of the dynamic microphone and input transformer. Any midget shielded transformers of appropriate impedance can be used in the input and output circuits. A simple headphone jack can be used in place of the one shown. The additional contacts are used as a second switch to conserve batteries. The batteries used are: one XX45 67½ v. Burgess, life—approximately 20 hours; one TE 1½ v. Burgess Hearing Aid Battery, life approximately 5 hours. In order to avoid microphonics both tubes should be shock mounted. The tubes were mounted upright behind the microphone. The transformers were mounted at the bottom of the aluminum case for proper weight distribution.

Simple circuit of the miniature remote standby amplifier shown above with batteries



the RIGHT COMBINATION for maximum performance at minimum cost



NO SPLICES. As always, plastic-base Audiotape in 1200 and 2500 ft reels is guaranteed *splice-free.*

NO FRICTION SQUEAL. Perfected anti-friction process eliminates annoying tape squeal—prevents "tackiness" even under extreme temperature and humidity conditions.

MINIMUM DISTORTION. Audiotape's oxide coating is especially formulated to give *maximum undistorted output.* Comparative tests show its marked superiority in this respect.

MAXIMUM UNIFORMITY. All 7" and 10" reels of plastic-base Audiotape are *guaranteed* to have an output uniformity within ±1/4 db – and a reel-to-reel variation of less than ±1/2 db. And there's an actual output curve in every 5-reel package to prove it!

PRECISION TIMING. Improved reel design with 2¾" hub reduces timing errors by eliminating the tension and speed changes formerly encountered at the beginning and end of the winding cycle. Ratio of OD to hub diameter is the same as the standard NAB 2500 ft reel.

CONSTANT PITCH is another advantage of the new reel design resulting from the more uniform tape speed throughout the winding cycle.

SLOWER ROTATIONAL SPEED, due to larger hub diameter, minimizes vibration and avoids possible damage to tape on fast forward and rewind.

REDUCED HEAD WEAR can also be expected, because the maximum tape tension is materially decreased.

audiotape gives you all these advantages at no extra cost!

* Trade Mark

This new 1200 ft plastic reel with 2¾" diameter hub is now being supplied on all orders for 7" reels unless otherwise specified . . . at no increase in price. Remember – with Audiotape, there's only *one* quality – the finest obtainable! Audiotape is available in all standard size reels from 150 to 5,000 feet.

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Export Dept. 13 East 40th St., New York 16, N.Y., Cables "ARLAB"
audiodiscs audiotape audiofilm audiopoints

Pressure Microphone

(*Continued from page* 59)

acoustic resistance material R_f of sufficient magnitude to make g_m substantially constant with respect to frequency. See Fig. 3.

The diaphragm must be of a material which is low in density, easily fabricated, rugged, and stable with regard to time, temperature, and humidity. A wide choice of materials exists, including metals, plastics and phenolics. Any one of these may be used with success. Aluminum or aluminum alloys are suitable for diaphragms, but are open to objections from the point of ease of fabrication and ruggedness. Such diaphragms are easily deformed by careless handling. In addition they have low values of inherent damping and make the problem of damping the moving system more complex. Phenolics are objectionable because they generally absorb appreciable amounts of moisture and in so doing change shape, which results in a microphone with unstable operating characteristics. The choice is therefore centered on one of the high temperature, non-hygroscopic thermo-plastic materials which had an excellent record in previous microphone designs.

The thickness of the diaphragm is made as small as possible consistent with ruggedness. Trouble with rocking modes of vibration at the higher frequencies will occur if the diaphragm is too thin. The amplitude of the diaphragm motion is very small, however linearity of edge stiffness and stability of position is

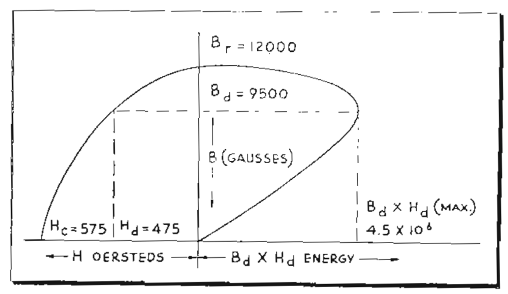


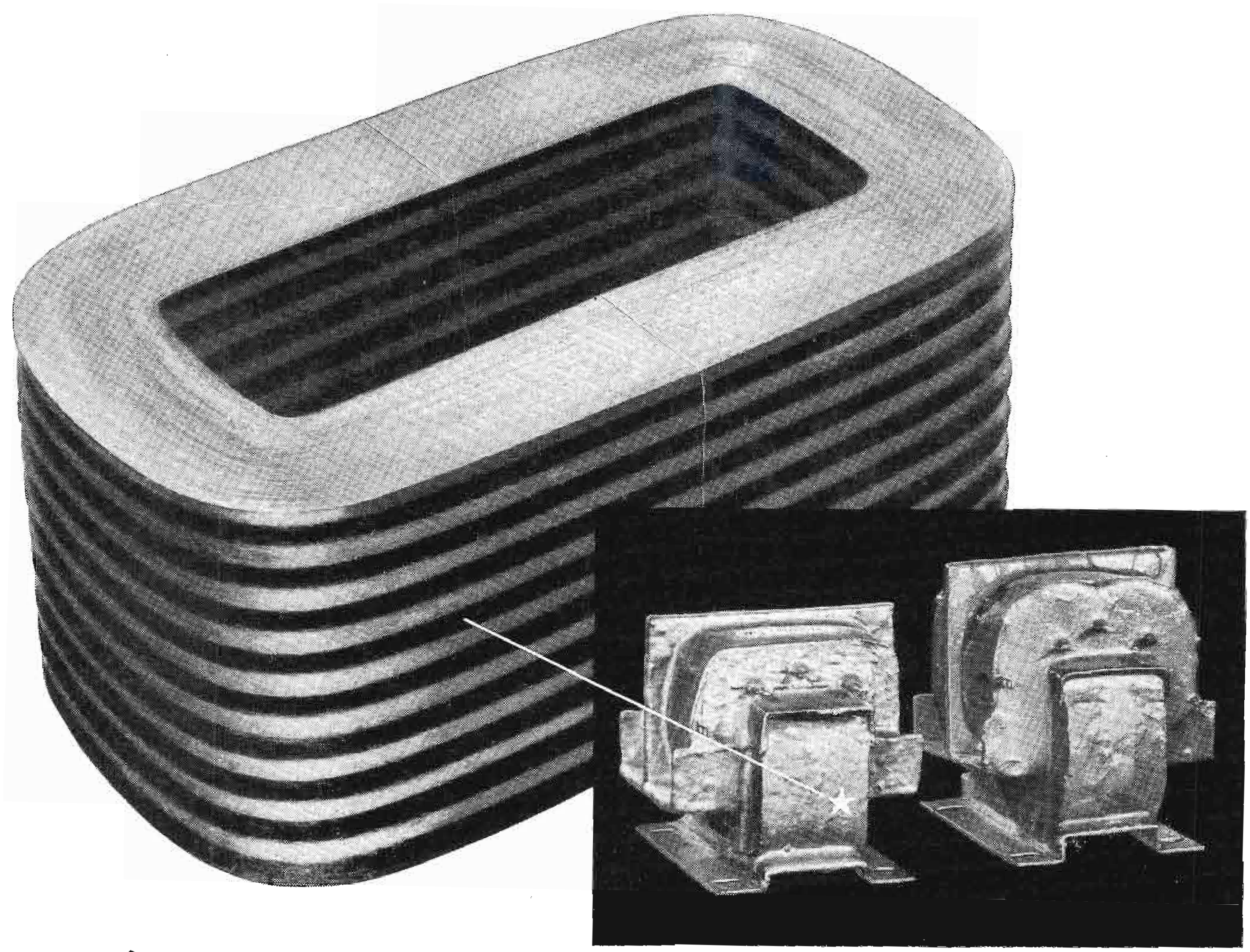
Fig. 5: Magnetization curve for Alnico V

provided either by fluting, or annular corrugations around the diaphragm edge.

The voice coil is securely cemented to the diaphragm. It is a two-layer type for simplicity of manufacture and subsequent assembly. The coil conductor is of aluminum because it exhibits a superior conductivity to mass ratio as compared to copper.

The elementary design of the magnetic circuit and the choice of the magnet material automatically centers on Alnico V. The length of

(*Continued on page* 96)



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Hipersil Cores cut size and weight in *all types* of electrical and electronic transformers. They combine highest permeability with lowest losses in a wide range of sizes (1 through 5 and 12 mils). Two-piece assembly simplifies transformer manufacturing, cuts fabricating costs. Greater flux-carrying capacity, increased mechanical strength help to make them the best core on the market. For specific information on how to apply Hipersil Cores to your product, write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-70632

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the magnet can readily be estimated from the length of the air gap in the microphone, the desired flux density, and the data supplied by the manufacturer of the magnetic material.

$$l_m = (B_g l_g K)/H_d \quad (3)$$

$$A_m = (B_g A_g K_1)/B_d \quad (4)$$

where B_g=flux density in gap
A_g=area of pole face
l_g=length of air gap
l_m=length of magnet
A_m=area of magnet
K=(1.3-1.4) leakage factor
K_1=(3-10) leakage factor
H_d=magnetizing force in oversteds
B_d=flux density gausses (see Fig. 5)

Because of the difficulties encountered in accurately estimating the effect of leakage factors in a complex structure, the final design is evolved from the estimated design by a series of carefully controlled experimental models. The result is a structure which for the volume

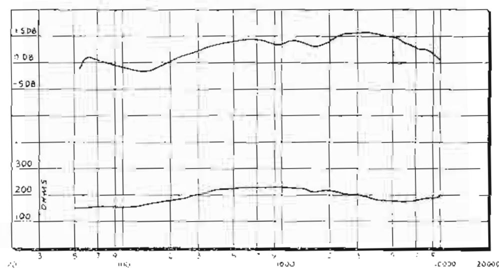

Fig. 6: Typical response and impedance characteristics of the type BK-1A microphone

available for magnet produces a maximum flux density in the gap.

For structures of this general size the maximum efficiency in terms of weight, and air gap magnetic energy, is obtained by placing the magnet material in the center leg. However mechanical considerations of centering and assembly led to the decision to place the magnet material in the form of two semi-annular slugs at the outside of the structure. This was done with a relatively small loss in the efficient use of the magnet material.

Output transformer

It is not feasible to provide voice coil impedances of the order of 150-250 ohms, so an impedance matching transformer must be provided. This transformer must be carefully designed to provide a maximum efficiency consistent with size limitations and at the same time must adequately cover the frequency range over which the microphone is to operate. Every db lost in the transformer can only be recovered at considerable expense in the transducer element.

(*Continued on page* 98)

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Physically the transformer is placed inside the portion of the case which contributes to the acoustic performance of the microphone. The terminal board is not so mounted, and opening the case in order to change impedances in no way affects the performance of the microphone. The gain in mechanical stability and simplicity of the structure is considerable as compared with some of the older designs.

As is desirable, the impedance selective arrangement is not too readily available to operating personnel in order to assure that it

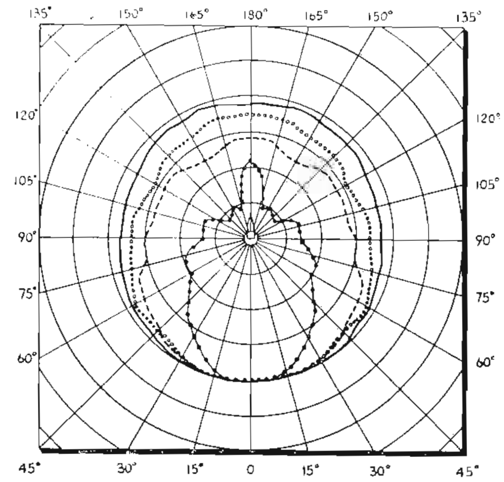

Fig. 7: Typical directional pattern

remains proper for the established system in any given installation. Once set it is rarely changed.

The cable is of high grade and follows the proposed RTMA Standard employing a brown jacket so that the microphone cable may be readily identified among the maze of the wires that commonly cover the floor of the TV studio. This is important since the proximity of the power cables and microphone cable may result in excessive hum pickup.

Typical performance curves of a microphone of the Type BK-1A are shown in Figs. 6 and 7.

The appearance of the microphone is of great importance in television. A satisfactory appearance was attained only through the extensive use of mock-up models and frequent consultations with a qualified functional designer.

The microphone must not present efficient light reflecting surfaces, and as a result it was necessary to develop a finish, which while not light reflecting would still present a pleasing appearance. The result was a low gloss metaluster finish which has come to be called TV Gray. The foregoing approach to the problem of microphone design resulted in the Type BK-1A Microphone shown in Fig. 1.

1. Wente & Thuras, Journal Acous. Soc. Amer., vol. 3 #1, p. 44, 1931.
2. Muller, Black & Dunn, Journal Acous. Soc. Amer., vol. 10 #1, p. 6, 1938.
3. H. F. Olson, Elements of Acoustic Engineering, 1947, pp. 67-85, 226-233.

Radar Display

(Continued from page 57)

frequency filter at the input of the amplifier. It serves to remove any unwanted low frequencies which may have been introduced into the signal as a result of pickup or induction in long coaxial cable lengths. The second clamp is located in the grid circuit of the output 6AG7 whose plate is directly coupled to the CRT cathode. The capacity of the clamp and the input capacity of the output stage have been isolated from the previous stage through the use of an isolation cathode follower.

The amplifier is capable of accepting a nominal one-volt signal input and delivering a 60-volt signal to the CRT. Since electrolytic capacitors could not be used freely in this equipment, plate decoupling and screen bypass capacitors were somewhat of a problem. It was solved by operating a separate feedback amplifier voltage regulator on the video amplifier chassis to supply all screen and plate voltages. The regulator accepts normal +300 v. and delivers +150 v. at an impedance which is sufficiently low to obviate the necessity for individual decoupling of stages.

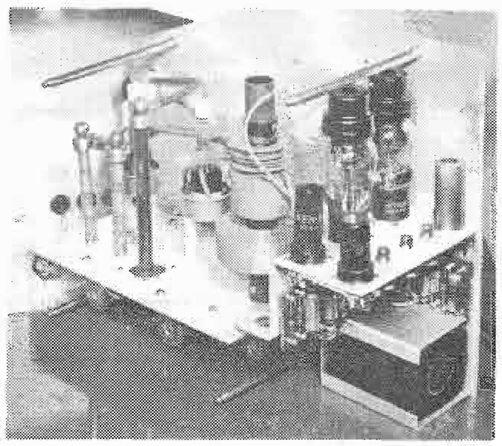

Fig. 6: High-voltage power supply for CRT

HV Power Supply

The anode voltage for the CRT is supplied by the pulse type, voltage doubler, high-voltage power supply shown in Fig. 6. For rather obvious reasons this supply incorporates a feedback regulator circuit. The operation of the circuit may be explained as follows: a negative horizontal drive pulse is fed to a pulse amplifier tube which amplifies and inverts the pulse. This large positive pulse is then used to drive a triode saw generator or discharge tube whose load consists of a charging capacitor and peaking resistor. The shaped sawtooth waveform is then

(Continued on page 102)

New Pressure Microphone

TV style!

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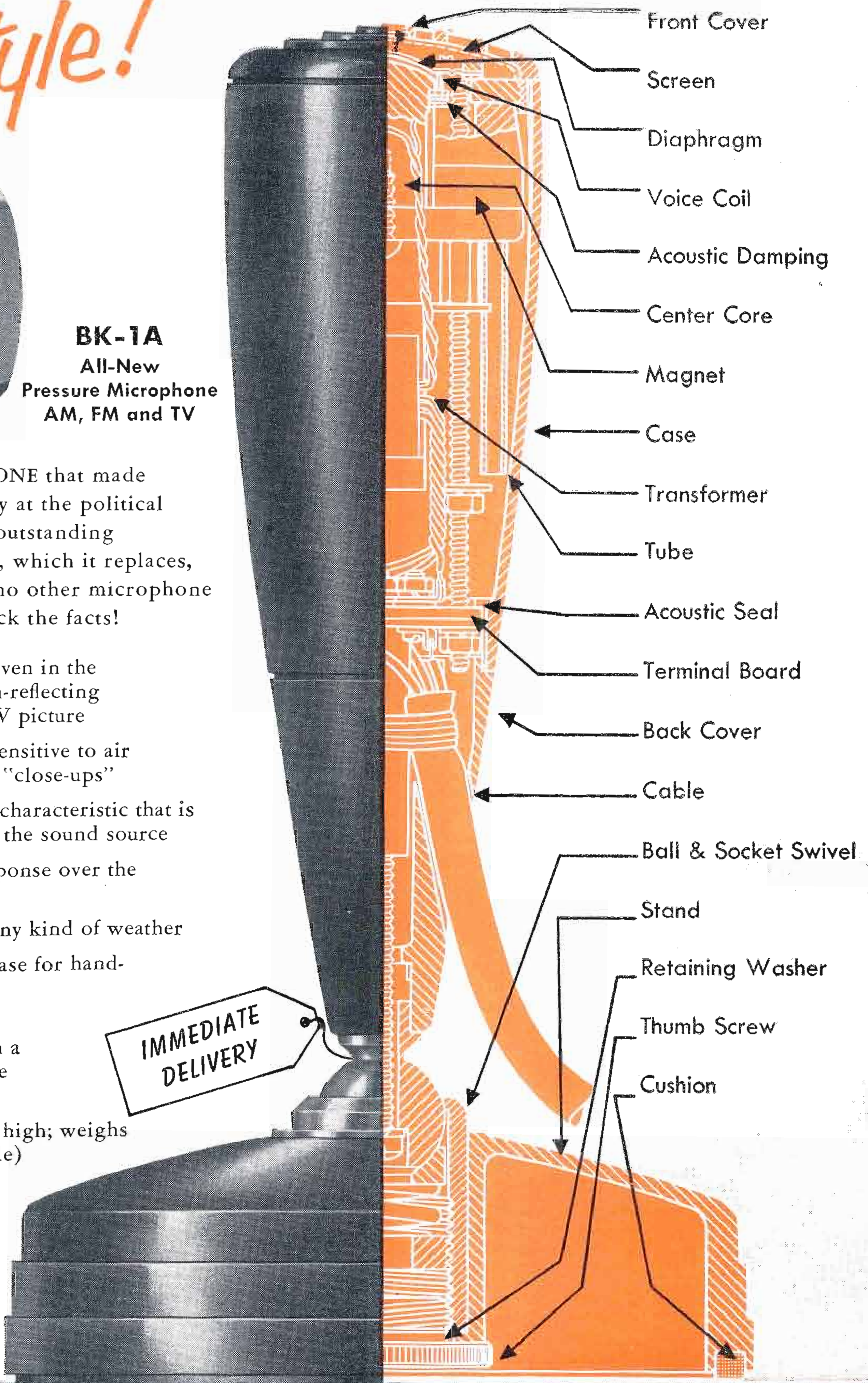
AM, FM and TV



THIS IS THE NEW MICROPHONE that made broadcast and television history at the political conventions. It includes every outstanding characteristic of the RCA 88-A, which it replaces, plus new advantages found in no other microphone in its price range or class. Check the facts!

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- Type BK-1A has a frequency characteristic that is independent of distance from the sound source
- Type BK-1A has uniform response over the essential audio range
- Type BK-1A can be used in any kind of weather
- Type BK-1A detaches from base for hand-announcing (it can also be mounted on floor stands)
- Type BK-1A is equipped with a ball-and-swivel mount—can be turned in any direction
- Type BK-1A is only 8 inches high; weighs just 19 oz. (less base and cable)

For details and delivery information on this new remarkable semi-directional microphone, call your RCA Broadcast Sales Representative

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ENGINEERING PRODUCTS DEPARTMENT **CAMDEN, N.J.**

applied to the grids of two parallelled driver tubes whose plate load is the primary winding of a high-voltage autotransformer. When the plate current of the drivers is cut off at the end of the saw, the high voltage coil executes one complete cycle of oscillation at its own natural frequency. Both half cycles of this oscillation are rectified and added by means of an appropriate capacitor network. By means of a dc amplifier, a portion of the output voltage is amplified and fed back to the screen grids of the driver tubes. The feedback amplifier very substantially reduces the internal impedance of the supply from its normal value of several megohms to somewhere around 200,000 ohms. The output of the supply is 15 kv at approximately 600 μa, and the voltage variation from no load to full load is negligible.

The output voltage of the HV transformer is a function of the current in the coil at the time when the driver tubes are cutoff and the natural resonant frequency of the coil and its associated circuitry.

Since it does not make any particular difference how the final value of coil current is established, it is more efficient to use a waveform of voltage across the coil which allows a lower average current through the drivers. These conditions are met by the peaked sawtooth mentioned earlier, and it is more efficient than a simple rectangular pulse.

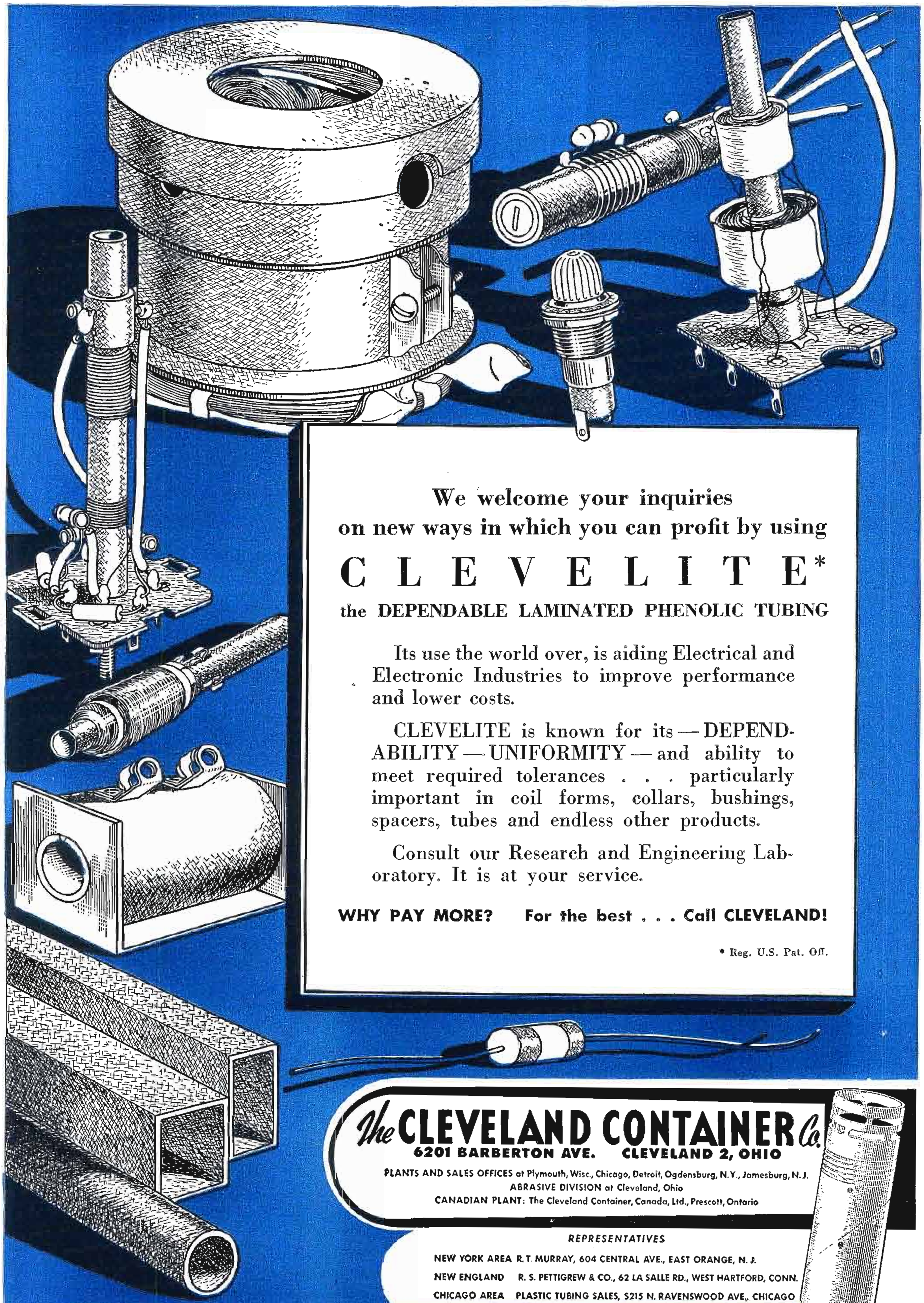
Low-Voltage Power Supply

The low-voltage power supply is a straightforward 300-volt regulated supply which provides 520 ma regulated for load and lien voltage variations. It provides less than 1% change in output voltage with line voltage variation of 105 to 130 v. In addition to providing B+ power, it also includes a source of —150 v. for bias and all of the necessary filament transformers for operation of the display unit.

All components in the power supply were designed to meet the applicable JAN specifications and no electrolytic capacitors were used. In spite of the absence of electrolytics, it has an output ripple of less than 50 mv. The unit is highly compact and contains all necessary fuses.

Western Electronic Show Set for Aug. 19-21, '53

The 1953 Western Electronic Show and Convention will be held Aug. 19-21, 1953 at the San Francisco Municipal Auditorium. At the 1952 meeting in Long Beach, Calif., there were 15,092 registrants and 199 exhibitors.



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Horizontal Deflection

(*Continued from page 72*)

sity of the core, a gap is assumed and the resultant flux density is acquired graphically on the B-H characteristic of the iron used as given by the manufacturer.

Utilizing Figs. 2 and 3 and the following example will help clarify this statement.

In Fig. 2 the following assumptions are made:

lg = 0.020 cm (0.008 in.)
l = 17.13 cm (6.748 in.) (See Fig. 3)
I = 67 ma
N = 600

Inductance Formula

A straight line intersects the ordinate at a point corresponding to B_{dc} = 2,524 gauss, and the abscissa at H = 2.94 oersteds. The rectilinear coordinates give the new values of flux density as 1900 gauss and oersteds as 0.8. These values are then applied to the incremental permeability curves as supplied by the manufacturer, and this figure is inserted in the inductance formula.

$$L = \frac{1.256\ N^2 A \mu_{ac}\ 10^{-8}}{l} \quad (28)$$

$$N = \sqrt{\frac{l L}{1.256 A\ \mu_{ac}\ 10^{-8}}} \quad (29)$$

If incremental permeability curves are not available, the following formula can be used:

$$L = \frac{B_{ac} NA}{10^8\ \hat{I}_p} \quad (30)$$

and

$$N = \left[\frac{10^8\ \hat{I}_p}{B_{ac}\ A}\right] L \quad (31)$$

Or in terms of E_{lb}

$$N = \left[\frac{E_{lb} 10^8}{B_{ac} A}\right] T_{dr} \quad (32)$$

Part Two will appear in the February issue.

TELE-TECH's Washington Editor Mentioned for FCC

Roland C. Davies, Washington News editor for TELE-TECH and editor of Telecommunications Reports, Press Building, Washington, D.C. is currently mentioned by "Broadcasting" Magazine, as one of the likely prospects being talked about for the FCC vacancies which will become available with the new Administration.

"Mr. Davies has a wide experience in following the news of domestic and international communications, and since the war, of mobile radio as well," says the magazine, adding - - - "He is being actively supported by those primarily interested in common carriers, on the theory that FCC should have an expert in that field, notably in view of the imminent departure of Chairman Walker whose experience was in the utility field."

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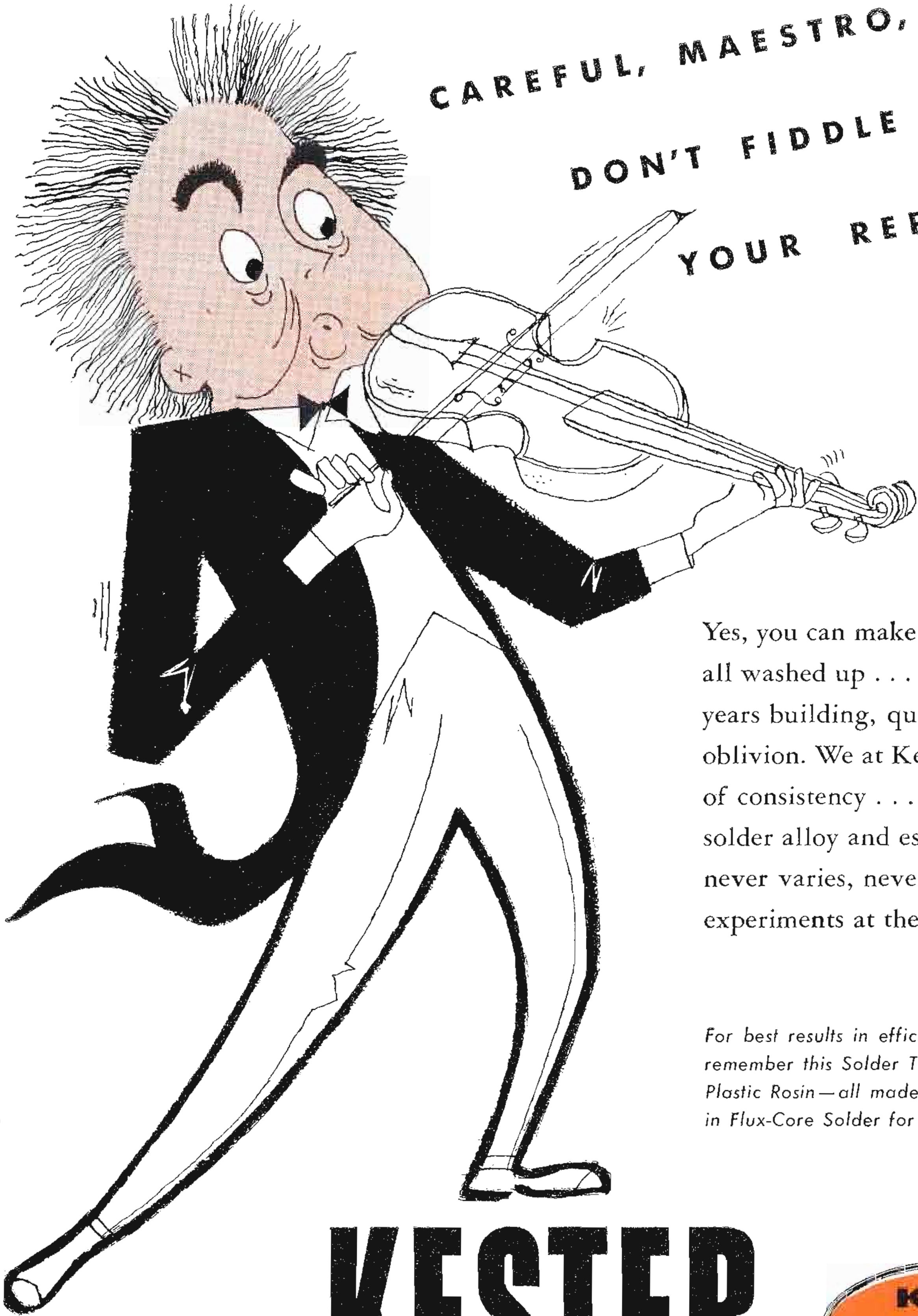

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Printed Plug

(*Continued from page 66*)

circuit wafers, as in the other applications, small copper tubes have been soldered into each wafer terminal. When the wafers are assembled in the steel casing, the small copper tubes project from a recess in the back, and at this point one of the epoxy resins is used to form a hermetic seal between the copper tubes and the metal enclosing shell. We have found the epoxy resins to possess an amazing facility for wetting metals and provide an extremely strong bond. The copper tubes projecting from the molded resin area form the terminals into which the wires may be soldered.

The subminiature design in Fig. 8 is the baby of them all. This 10-conductor male and female assembly is of the order of 0.5 x 0.5 x 0.25 in., including the space required for

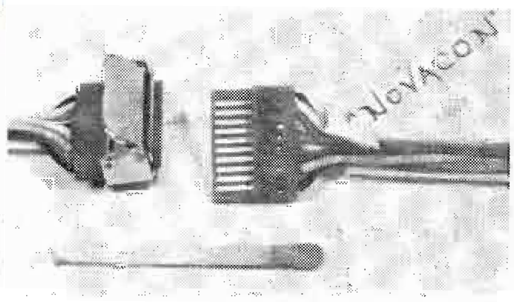

Fig. 8: Closeup of subminiature male and female 10-conductor plug assembly

the quick release clamp. Note that the method of fastening wire to printed circuit is identical with that used in previous designs, but much smaller. Soldering leads in this midget was accomplished by using a fine-line mechanical lead pencil as the carbon heating element. We feel that this method of termination may be employed with insulated conductors as closely spaced as the insulation itself will allow, i.e., insulating surfaces of adjacent conductors in direct contact with each other. A still smaller push-together type has been designed using two decks of 5-conductor width which allows a 10-conductor male and female assembly to be enclosed in a rectangular volume 0.25 in. square and 0.5 in. long.

Tests of Assembly

The basic 10-conductor assembly has been subjected to the following tests:

A. *Insulation Resistance:* Measured under normal room temperature and humidity conditions, insulation resistance between adjacent conductors is found to be anywhere

(*Continued on page 108*)

TERRIFIC!

NEW TV CRANE by *Houston-Fearless*

Extreme versatility, maneuverability and ease of operation are combined in the new Houston-Fearless TV Crane, model TC-1. It provides new convenience and comfort for the cameraman. It allows continuous shooting while raising or lowering camera boom from 9′-6″ (lens height) high to 3′-6″ low, two types of smooth panning, steady rolling-dolly shots or any combination of these actions. High Houston-Fearless quality for complete dependability. This is the perfect answer for top-flight television showmanship.

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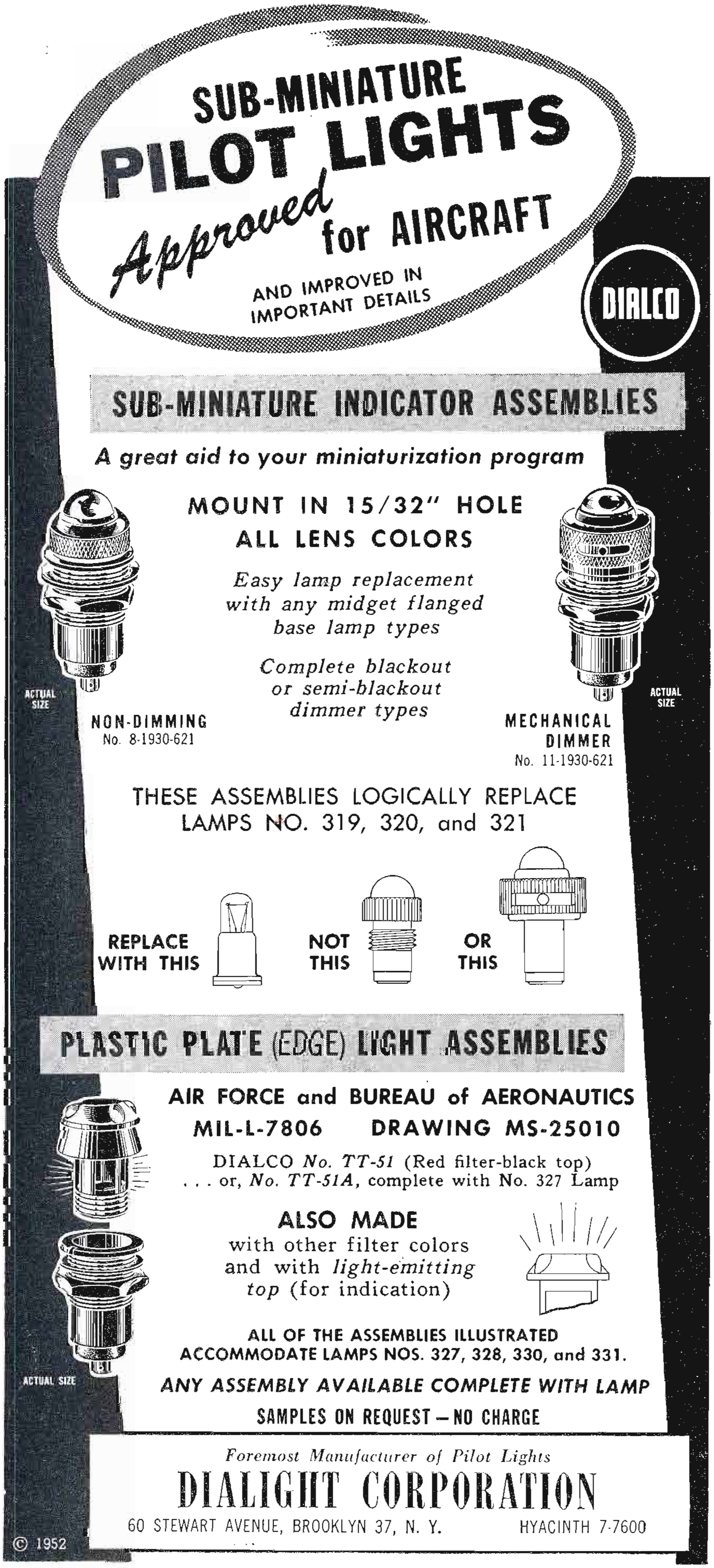

from 300 megohms to several thousand megohms and is purely a function of the base laminate material and its condition. Humidity tests have been run with exposure to cycling conditions of 35 to 95% humidity for 150 hours, and insulation resistance measurements were made within five minutes after withdrawal from the climate chamber. Insulation resistance of 50 megohms or greater was achieved on measurements between adjacent conductor whose near edges were spaced 3/64 in. apart.

B. *Voltage Breakdown:* Adjacent conductors whose near edges were spaced 3/64 in. apart sustained 2000 to 3000 volts without breakdown at sea level altitude. At 80,000 ft. altitude in the order of 700 v. was sustained between adjacent conductors without breakdown. At extreme altitude conditions voltage breakdown becomes a function of the environment and conductor spacing rather than the base laminate material. Breakdown at 80,000 ft. was in the form of corona across the top edges of adjacent conductors and did not mar the base laminate, while at sea level conditions it burned across the base laminate.

C. *Pull Tests:* Pull tests of conductors to show the strength of the termination were conducted and we found in every test that the wire would break outside of the termination. These tests were run with our most common wire, No. 22 stranded with SRIR plastic insulation. Single wires were pulled one at a time and sustained from 17 to 20 lbs. before, in every case, the wire broke outside the termination. The 10-conductor basic element was clamped in the pull testing machine and all 10 conductors pulled at once. The machine consistently registered 175 to 200 lbs. before all conductors broke, outside their terminations.

These pull tests have been sufficient to convince those who witnessed them that this method of forming a termination between conventional wire and printed circuitry is capable of withstanding all tests

---

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Editorial Supplement with this Issue

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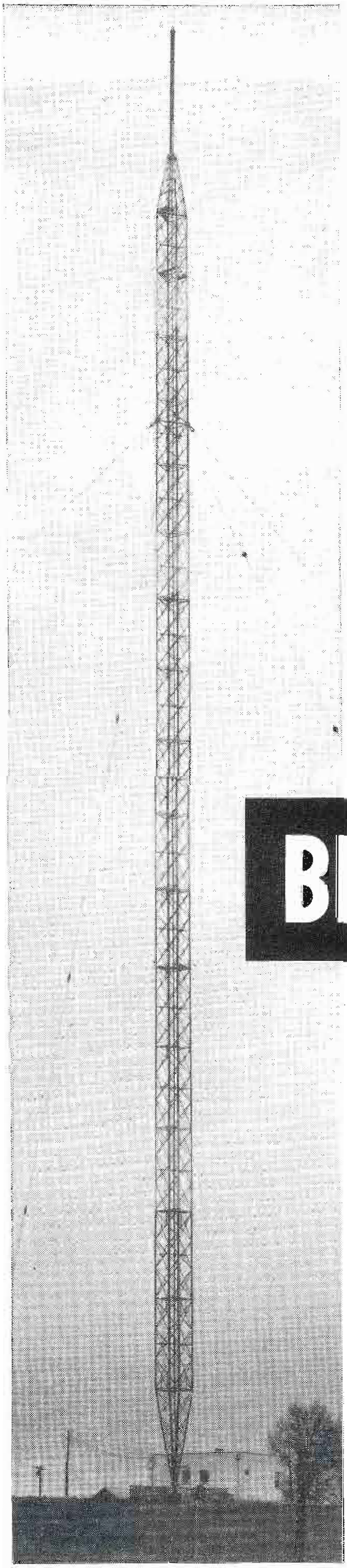

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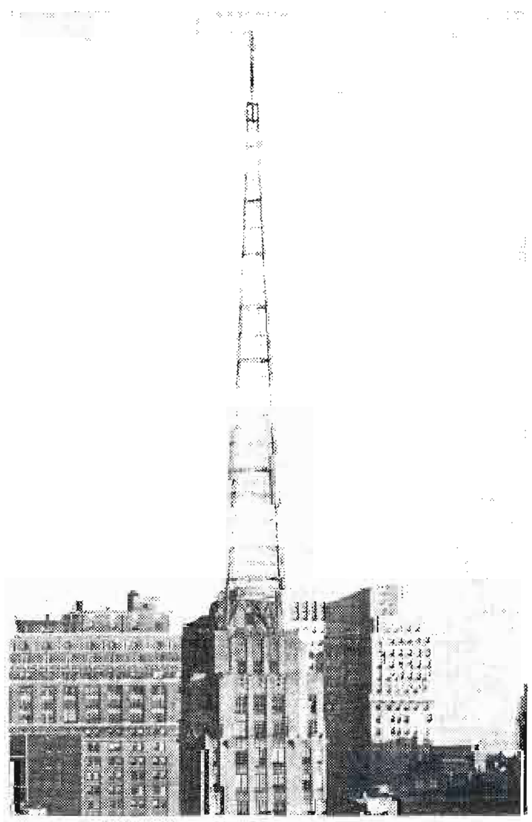
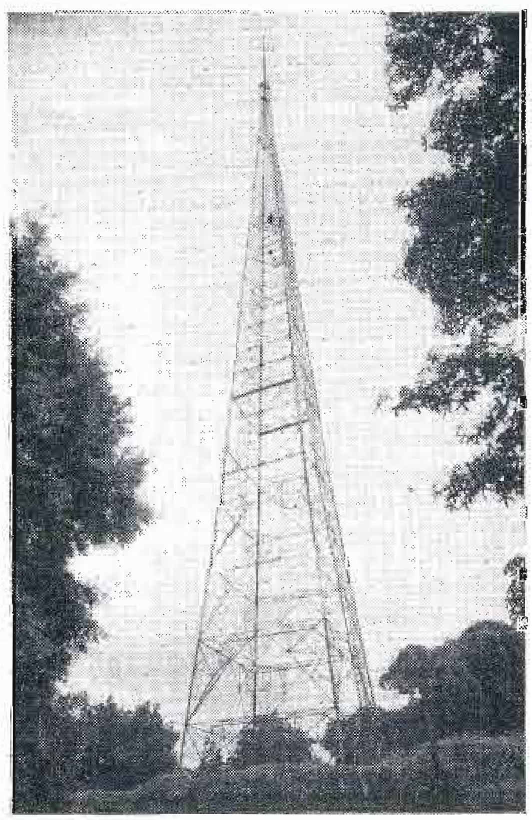




that the wire itself will stand. And since the NOVACON plug features low separation force in some designs and zero separation force in others, the majority of designs should warrant no separate handle, no separate wire clamp, or any protective device for preventing undue strain on the wires.

D. *Push-Together Tests:* As described earlier, the 20-conductor push-together design was subjected to over 3,800 cycles before a single continuity failure developed. Over 12,500 cycles were sustained without physical damage to the printed circuit conductors. It is reasonable to assume that in the "zero-separation-force" designs this kind of test would be extended to several hundred times as many cycles without failure.

E. *Contact Resistance:* With mating conductors $\frac{4}{64}$ in. in width overlapping each other for a distance of ½ in. and plated with a flash silver plate, contact resistance has been observed to be consistently in the order of 0.01 ohm, or less.

Now that we have learned a few of the basic principles upon which a successful design of the printed circuit plug must be founded, we have the sketch books loaded with many, many different versions. Cylindrical shape, U-shape, disc shape forms of the plug and a wide variety of clamps and compression devices have been conceived.

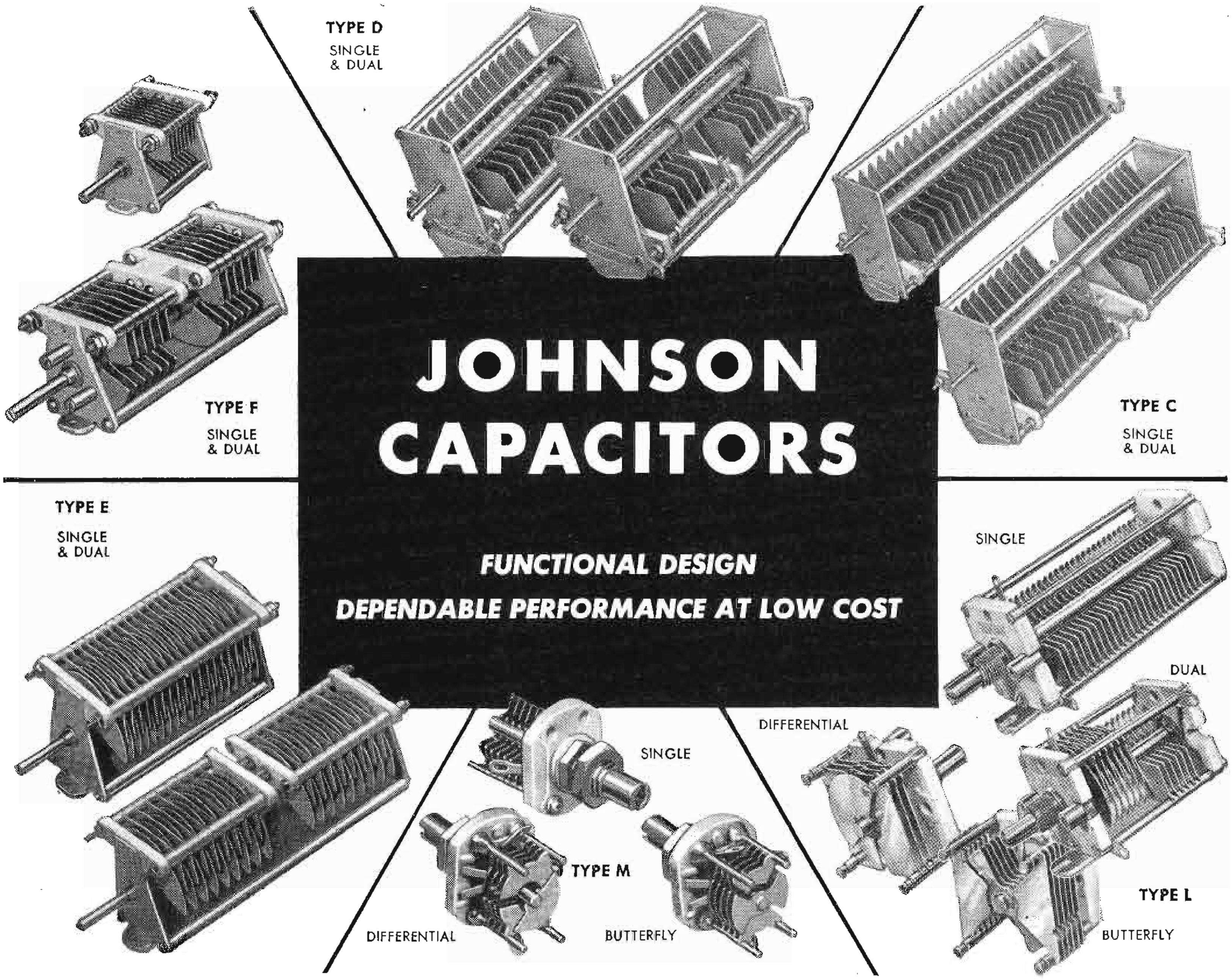
Compression devices in these early designs have been exerting only mild pressures with soft pliable silicone rubber and 0.010 to 0.015 in. beryllium copper spring stock. If greater pressure were required, heavier spring stock and more powerful clamping devices could be built.

If lower contact resistance is desired, plating with copper, nickel, rhodium or even light gold may be used.

Higher voltage breakdown and better humidity performance could be achieved by using better base laminate materials, and improved forms of these are appearing every day. (The silicone-glass and epon-glass materials look especially promising.) Slotting the laminate between conductors may also be used to lengthen the creepage path.

Cylindrical designs hold great promise for complete hermetic sealing of the assembled male and female combination as well as approaching even smaller subminiature designs than previously discussed.

This paper was first presented at the 8th Annual National Electronic Conference, Sept. 29-Oct. 1, 1952, Hotel Sherman, Chicago, Ill.



Engineered to meet virtually every electronic need, JOHNSON Variable Capacitors are sturdy and thoroughly reliable. Their functional design permits high standards of workmanship, yet at low final cost. Production quantities available in a wide range of standard types and sizes.

TYPE L—Full soldered construction and rugged design make JOHNSON Type L high frequency capacitors the perfect choice for any application requiring extreme stability and rigidity. Tie rods are soldered directly to ceramic end frames, plates and metal parts are brass, plated with corrosion-resistant Bright Alloy. Dual, butterfly, and differential types ranging from 11 to 200 mmfds. available with .030" spacing. Type L air variables can be manufactured with .020", .060" and .080" spacing in production quantities on special order. Short, low inductance leads are made possible by dual stator contacts and a silver plated beryllium copper rotor contact which may be brought out at any one of four different angles. Panel space required is 1⅜" square.

TYPE M—Miniatures—The answer to many a design problem, encountered in building compact electronic equipment. Available in three types: single section, differential, and butterfly, JOHNSON Miniature Air Variables are ideal for portable, mobile, and airborne equipment in the VHF frequency range. Manufactured to extremely close tolerances, these miniatures feature: split sleeve bearings, Steatite insulation, beryllium copper rotor contacts, and a 3/16" slotted shaft for knob or screw driver adjustment—all metal parts nickel plated. Stock models range from 1.5 to 19 mmfd., mounting area required: ¾"x⅝".

TYPE E and F—JOHNSON Types E and F variable capacitors are extremely compact, designed for use in medium and low power transmitters. Capacity range from 250 to 500 mmfd. Single and dual section models available for both types in 45 standard sizes. Highest possible capacity/volume ratio, aluminum plates .032" thick, heavy aluminum end frames with ¼" aluminum tie rods. Dense molded Steatite insulators combine minimum loss with strength. Rotor contacts are cadmium plated phosphor bronze. Panel space required: Type E, 2⅝" square; Type F, 2"x2-1/16".

TYPE C and D—For higher voltage applications, Type C and D capacitors are available in 45 standard single and dual models, ranging from 12 to 496 mmfd., 3,500 to 11,000 volts peak. Steatite high frequency insulators, sturdy aluminum end frames, equipped with ¼" cadmium plated shafts. Mounting brackets provided for normal or inverted mounting, panel space required: Type C, 5½" wide x 5⅜" high; Type D, 4¼" wide x 4" high.

The complete line of JOHNSON Air Variables is listed in the new General Products Catalog, No. 973. Write for your free copy today!

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AM Transmitter

(*Continued from page* 51)

amount of water flowing through the phantom resistor, so that by means of two thermometers on the in and outlet water lines, power can be determined.

Mention was made of a centralized metering and control console, which is shown in Fig. 7. The center unit is common to both of the 500-kw transmitters, and to the left of it are controls for transmitter No. 1, and to the right a similar assembly of controls for transmitter No. 2. All the metering for the power amplifier and modulated amplifier is brought to this console, individual meters for the various tubes in the power amplifier being located here. Line current meters measure the incoming 4160 v. and the 230 v. auxiliary supply line. In the central consoles are located all of the power controls which provide individual controls for the auxiliaries and also operation by means of a master switch of the entire transmitter. On the end consoles selsyn indicators are used to show the position of the various tuning components in the power amplifier and modulated amplifier, and these pushbuttons control the tuning motors for these components. On each console, an oscilloscope is used for monitoring various samples of voltage from the power amplifier.

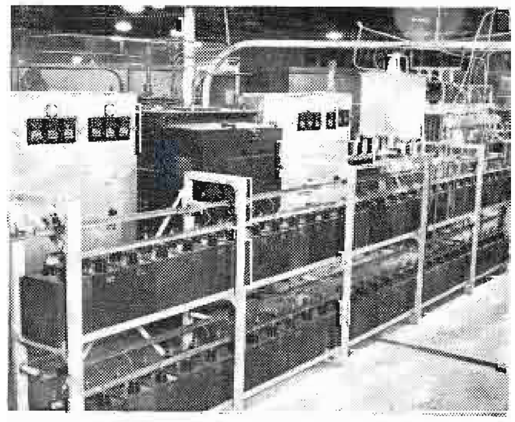


Fig. 10: Filter capacitors for a 500-kw unit

Associated with each 500-kw transmitter is the three-unit assembly of Fig. 8. On the left is the 15-kv rectifier tube assembly. In the center are located three bias rectifiers, and at the right side the audio and r-f driver. The bias rectifier unit in the center contains a three-phase rectifier for peak bias, the single phase rectifier in the top being the supply for the grid bias modulated amplifier. A spare position for tubes is provided on each side in the upper row. The 15-kv rectifier uses the Type GL-870A mercury vapor tube,

(*Continued on page* 115)

and this rectifier has a current capacity of 225 amps, although for 500-kw operation, only about 85 amps are used with full modulation. In the driver we have a separate plate supply rectifier for the driver unit. The audio amplifier consists of two 807's, followed by an 845, followed by four 845's in parallel as a cathode follower for grid bias modulating the ML-5682 in the main transmitter assembly. In the r-f system we have an 807, followed by an 813, which saturates the grids of two ML-357B tubes, providing an output up to 2 kw of r-f drive for the modulated amplifier. The output tank inductor for the two ML-357B tubes has a movable inductively coupled pickup coil which is controlled by motor drive, which is operated from the control console so that after the tuning adjustments are made on this unit, the amount of drive to the modulated amplifier may be controlled fro mthe console without returning to this unit.

The 230-v. distribution system of Fig. 9 provides auxiliary power to the transmitters, one rack for each of the 500-kw units, and the center one from the console without returning cooling system.

The filter capacitors for one 500-kw transmitter, together with a motor-operated grounding switch for protection of personnel is shown in Fig. 10. In the center is a thyrite

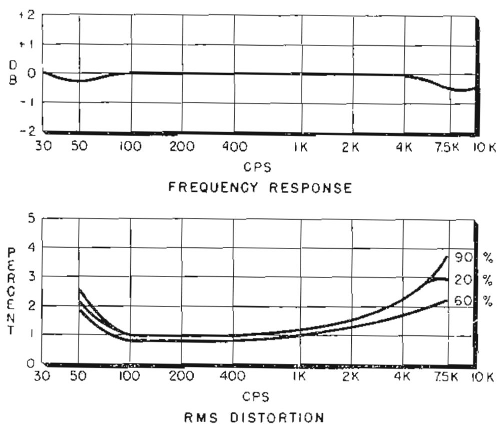


Fig. 11: Frequency and distortion characteristics for one 500-kw unit at full output

protector which is connected in parallel with the filter reactor. The assemblies on each of the capacitors constitute a fuse and shorting device. In case the capacitor should fail, the fuse will remove it from the circuit and short circuit its terminals. Behind the capacitor rack are two assemblies of switchgear. The other cmfwy cmfwy cmfw cmw cf mm mc cubicles all contain 1200-amp, 5000-volt, 3 pole, 150,000-kva interrupting capacity, air circuit breakers. One of these is used for supplying the auxiliary distribution transform-

(*Continued on page* 116)

ers which supply 230 volts for the transmitters. The second is used as the plate circuit breaker in normal operation, and applies power to the plate voltage regulator located between the two switchgear assemblies. From this regulator power is fed to both of the 15-kv rectifiers. In the right-hand switchgear assembly we have two similar breakers used as isolation breakers for the two 500-kw transmitters. All of these are dc-operated from storage battery, both on tripping and closing, and they provide very high speed interruption of the circuit in case of overload.

Table I and the curves in Fig. 11 show the measured performance. These measurements were taken on one of the 500-kw transmitters, operating at full power output of 500 to 550 kw carrier power, and this represents the conditions obtained in operating the transmitter at a large number of frequencies between 540 and 1600 KC. As a matter of fact,

TABLE I

Continental Type 105-B, 1 Megawatt AM Standard Broadcast Transmitter Measured Performance Characteristics

Residual Carrier Noise Level	60 DB below 100% Modulation
Carrier Shift	Zero at any Modulation to 100%
Sustained tone Modulation Capability	100% at any frequency from 30 to 10,000 cps
Final linear power amplifier power gain	33
Final linear power amplifier Efficiency	62%
Overall Transmitter Efficiency	50% at carrier condition 54% at 100% modulation

the operating characteristics were found to be very consistent over the entire operating frequency range. The response curve is reasonably flat because overall feedback is used in the transmitter. The distortion curves are shown at percentages of modulation 20, 60 and 90%.

Largest AIEE Meet Set for Jan. 19-23

The Winter General Meeting of the AIEE at New York's Hotel Statler, Jan. 19-23, will mark the largest meeting in the history of the Institute. Four thousand engineers are scheduled to attend the 89 sessions featuring some 380 papers. UHF, color TV, radio communications, vacuum tubes and coaxial cables are among the subjects to be presented. Fourteen technical papers will be devoted to radio and TV.

Frequency Calibration

(*Continued from page 78*)

fitted with shorting covers. The top cover (Fig. 4, left) is readily removable to admit the sample materials. It was made of beryllium copper so that the bearing surfaces could be machined into a springy yet electrically tight fit. The bottom cover (Fig. 4, right) is attached to the cylinder by screws and has a central spike, 3/16 in. in diamtter, which forms the center conductor of the coaxial line. A hole is tapped into this cover to receive a type N cable plug. A shelf made of low-loss insulating material separatts the upper third of the cylinder from the lower portion.

Toroidal Rings

The coaxial line is designed to receive toroidal rings with inner diameters greater than 3/16 in., and outer diameters less than or equal to 1½ in. A wall thickness of ¼ in. was chosen to improve the high-frequency shielding and to give ample mechanical strength. The shelf acts as a holder for the material to be tested.

A toroidal ring is slipped over the center conductor and rests on the bottom cover of the coaxial line. A number of windings, suited to the conditions of the experiment, are wound on the toroid. The material of the toroid has a low dielectric constant and a high Q at the frequency to be used during the test. One end of the winding is connected to the type N cable plug, and the other end to the coaxial line, thus making the system electrically unbalanced. In this position, the toroid acts as a reference for the measurement by becoming the primary of a transformer, the secondary of which is the metallic portion of the coaxial line.

Test Procedure

A connection is made between the type N cable plug and radio-frequency bridge or a Q-meter. The bridge is first balanced with the secondary of the "transformer" unloaded. The magnetic material to be tested (formed into a toroid and without windings) is then placed on the shelf in the line, and the impedance bridge is rebalanced. The variation in input impedance, as read on the bridge, is the quantity from which the permeability and loss factor of the test ferrite or powdered iron are computed.

[1] G. A. Kelsall, "Permeameter for Alternating Current Measurements at Small Magnetizing Forces," J.P.S.A. and R.S.J., No. 8, Feb. 1924, pp. 329-338.

TELE-TECH's IRE Issue

The annual IRE show issue of (April) TELE-TECH will be published before the opening of the four-day show, March 23-26. This issue is timed for eleventh hour announcements, new products, convention papers, etc.

The March pre-show issue will appear on February 20th, a full month ahead of the show, and will include previews of new products, programs and other pre-show developments.

Coming Events

Jan. 14-16—IRE-AIEE Meeting on High Frequency Measurements, Washington, D. C.

Jan. 19-23—AIEE, Winter General Meeting, Hotel Statler, New York, N. Y.

Jan. 21-23—SPE, 9th Annual Technical Conference, Hotel Statler, Boston, Mass.

Feb. 4-6—IRE-AIEE Western Computer Conference, Hotel Statler, Los Angeles, Calif.

Feb. 5-7—West Coast Audio Fair, sponsored by the AES, Alexandria Hotel, Los Angeles, Calif.

Feb. 5-7—IRE, 1953 Southwestern Conference, Plaza Hotel, San Antonio, Tex.

Feb. 18—ISA, 6th Annual Regional Meeting, Hotel Statler, New York, N. Y.

March 23-26—IRE National Convention, Grand Central Palace & Waldorf-Astoria Hotel, New York, N. Y.

April 12-16—Electrochemical Society, International Meeting, New York, N. Y.

April 18—Cincinnati Section, IRE, Seventh Annual Spring Technical Conference.

April 20-22—MPA, 9th Annual Meeting, Cleveland, Ohio.

April 26-30—SMPTE 73rd Convention, Hotel Statler, Los Angeles, Calif.

April 28-May 1—7th Annual NARTB Broadcast Engineering Conference, Burdette Hall, Philharmonic Auditorium, Los Angeles, Calif.

April 29-May 1—Electronic Components Symposium, Shakespeare Club, Pasadena, Calif.

May 11-13—IRE, National Conference on Airborne Electronics, Dayton Biltmore Hotel, Dayton, Ohio.

May 18-21—Electronic Parts Show, Conrad Hilton Hotel, Chicago, Ill.

Aug. 19-21—Western Electronic Show and Convention, San Francisco Municipal Auditorium, San Francisco, Calif.

Sept. 1-3—International Sight and Sound Exposition, Palmer House, Chicago, Ill.

Sept. 9-12—NEMA, Haddon Hall Hotel, Atlantic City, N. J.

AES: Audio Engineering Society
AIEE: American Institute of Electrical Engineers
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
MPA: Metal Powder Assoc.
NARTB: National Association Radio and Television Broadcasters
SMPTE: Soc. of Motion Picture and TV Engineers
SPE: Society of Plastics Engineers

PERSONAL

Dr. Robert Adler has been appointed associate director of research of the Zenith Radio Corp., Chicago 39, Ill. In 1951, he was elevated to the grade of Fellow by the IRE for his "developments of transmission and detection devices for (FM) signals and of electro-mechanical filter systems."

Harold R. Hunkins has been named chief engineer of the Selenium-Intelin Div., of Federal Telephone and Radio Corp., Clifton, N. J., an I. T. & T. Assoc. He has been with Federal for eight years, formerly serving as product line manager in the Wire and Radio Transmission Div. and later as chief systems engineer.

Leonard S. Cutler, chief engineer of Gertsch Products, Inc., Los Angeles, Calif., has been elevated to the post of vice president in charge of engineering.

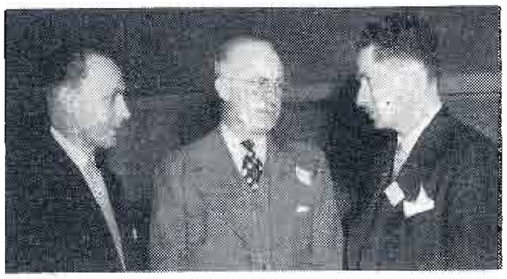
James W. Robertson has been appointed chief engineer of Radio Roanoke, Inc., Roanoke, Va. He will supervise the company's AM, FM and TV facilities in Roanoke.

Albert E. Namey has been promoted to the post of chief engineer of the Test Equipment Design Dept. at the Towson plant of Bendix Radio, Div. of Bendix Aviation Corp., Baltimore 4, Md. He joined the company in 1946 and was formerly supervisor and section chief.

Harry Fisk has been named chief electronics engineer of the Sparks-Withington Co., Jackson, Mich. He will be responsible for all of the company's engineering research as well as engineering supervision of radio television and government projects.

Vehicular Communications

Split-channel radio telephony was a major topic at the third annual meeting of the IRE Professional group on Vehicular Communications, held in Washington, D. C., Dec. 3-5. Progress made by the Joint Technical Advisory



Discussing developments in mobile radio at Vehicular Communications Meeting are l to r M. S. Reutter (RCA), T. B. Jacocks (GE), and F. T. Budelman (Budelman Radio), Chairman of the IRE Group on Vehicular Communications

Committee, established jointly by IRE and RTMA, was reported. Some interesting statistics presented by GE's Dr. W. R. G. Baker stated that some 250,000 mobile units are now authorized, and that two-way radio manufacture is a $34 million/year business.

1% Resistors

(Continued from page 53)

coefficients were taken from the test data and represent T_c for the temperature range of 20 to 70°C.

Conclusions

Temperature coefficients, as well as voltage coefficients of resistors, noise characteristics, frequency char-

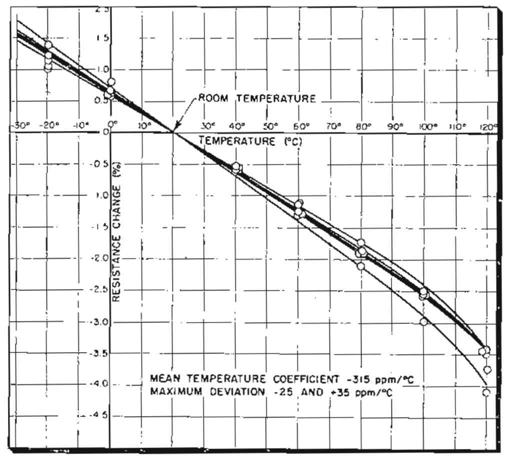


Fig. 6: Temperature-resistance change curves

acteristics, and temperature rise per unit of power, are of interest to the design engineer.

Pyrolytic-carbon resistors have considerably better temperature coefficients than have conventional carbon-composition resistors. How-

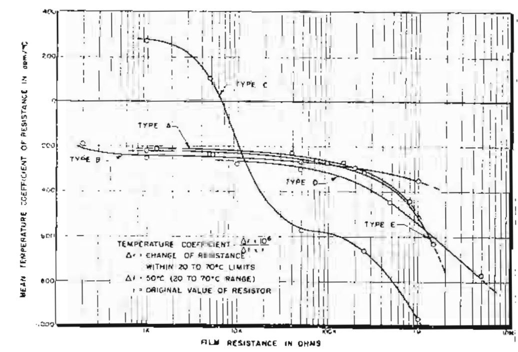


Fig. 7: Film resistance-mean temperature coefficient curves for five resistor types

ever, their coefficients are negative and poorer (by a factor of 10) than are those of wire-wound resistors in general. Hermetically-sealed carbon resistors will probably give lower temperature coefficients, but are considerably more expensive.

Pyrolytic - borocarbon resistors which are under development give promise of temperature coefficients as good as or better than wire-wound resistors and with greatly improved time-stability characteristics.

1. R. O. Grisdale, A. C. Pfister, and W. van Roosbroeck, "Pyrolytic Film Resistors: Carbon and Borocarbon," **Bell System Technical Journal**, 30, pp. 271-314, April 1951.

WHAT ABOUT

Temperature Coefficient

IN *PRECISION WIREWOUND* RESISTORS?

Specify a precision resistor for electronic equipment you are designing, and you frequently become involved in temperature coefficient. At this point, many engineers do not fully understand the temperature coefficient they select from a table.

First of all, the temperature coefficient (T.C.) of a resistor is the variation in resistance (ohmic value) as the temperature changes. It is expressed as a change per degree Centigrade—either Per Cent, Parts/Million, or Ohms/Ohm. It should not be confused with stability—the lack of resistance change at a given temperature after aging, temperature cycling, or overload testing.

SPECIFIED T.C. CAN BE INACCURATE: Temperature coefficient of a precision wire-wound resistor is dependent almost entirely upon the alloy of the wire used. However, it is *not* necessarily the *nominal* value specified by the wire manufacturers for a particular alloy. Wire manufacturers cannot economically control T.C. within the close limits required by many of today's highly precise applications. T.C. of a given alloy and diameter may vary from spool to spool, and even within the same spool.

The variation in T.C. is particularly great in the "E" alloys—commonly called "special low-T.C. wire." For example, Shallcross' laboratory tests have shown T.C. to vary from higher than ±.004%/°C. to lower than ±.001%/°C. for resistors wound with "E" alloys *nominally* ±.002%/°C.

THE ONLY WAY TO T.C. ACCURACY: Shallcross manufactures resistors wound with all commonly used alloys made in the following degrees of T.C. quality:

1. *Resistors wound with a designated alloy and offering no guarantee of T.C. other than the limits established by the wire manufacturer.*

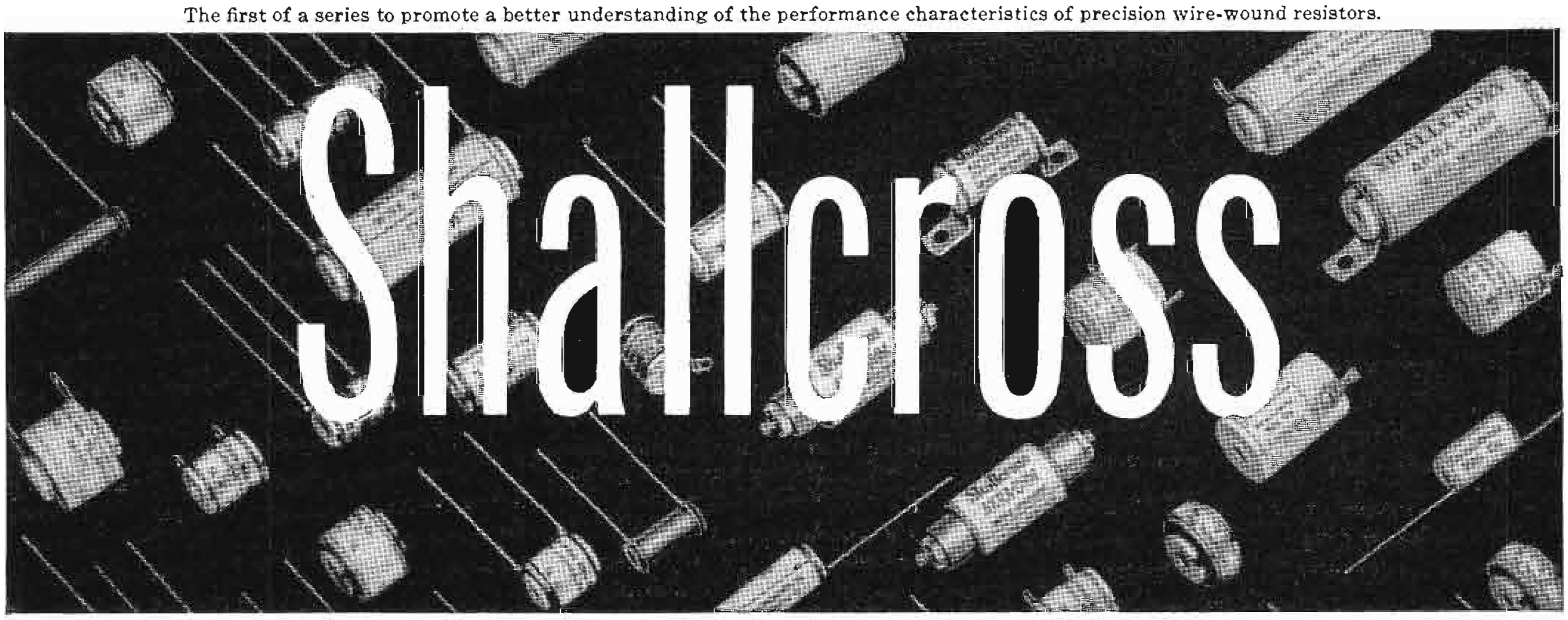
2. *Resistors wound with wire from spools pre-tested and selected for T.C.* Determination and recording of the T.C. of each spool of "E" alloy wire is part of the standard Shallcross inspection procedure. Selection assures only that the yield of resistors within specific T.C. limits will be high. It does *not* assure that *all* resistors wound with tested wire will be within the T.C. limits of selection.

3. *Resistors with a* ***guaranteed*** *T.C. over a given temperature range.* Pre-selected wire is used to wind these resistors, readings are taken at several temperatures, and the T.C. is computed. Only individual resistors within the customer's specified T.C. limits are released. Although time-consuming, this is the *only* known way to guarantee a particular temperature coefficient or, in the case of "E" wire, the much publicized *range* of ±.002%/°C.

Further details on T.C. and other resistor characteristics are available in Shallcross Bulletin R-3C.

SHALLCROSS MANUFACTURING COMPANY • 518 PUSEY AVENUE, COLLINGDALE, PA.

The first of a series to promote a better understanding of the performance characteristics of precision wire-wound resistors.



Junction Transistors

(Continued from page 78)

transition from very low resistivity material of one type to high resistivity material of opposite type, the junction capacitance will vary inversely as the square root of the applied voltage, rather than as indicated above[5].

In Fig. 4c the simple circuit is shown modified to include the effects of widening of the space charge layer with increase of collector potential, as suggested by Early[5].

The space charge layer, X_m in Fig. 3, extends partly into the base region, and partly into the collector. As the collector voltage changes, therefore, the effective base layer

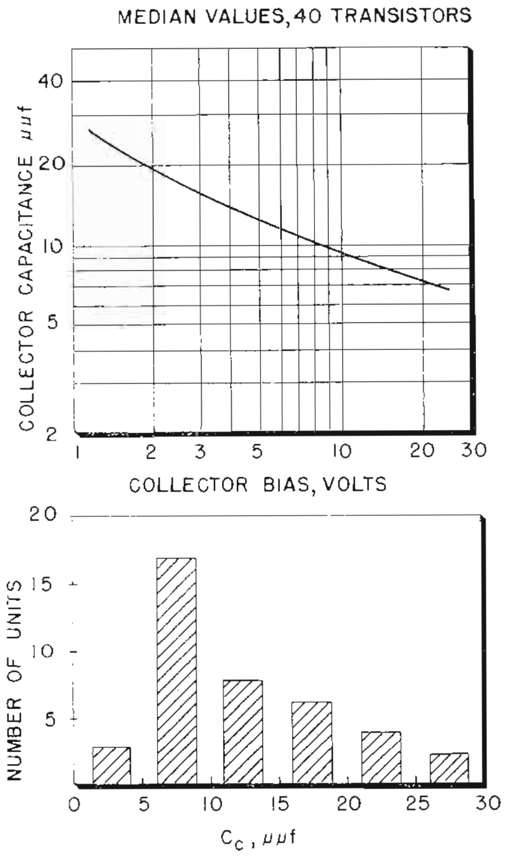


Fig. 9: Collector capacitance measurements

width (in which the minority carriers travel by diffusion) is also changed. The modulation of base layer width gives rise to a collector conductance term, g_c, and to a voltage feedback factor, μ_{ec}, where

$$g_c = \frac{1}{r_c} = \frac{I}{w}\left[2(1-\beta)+(1-\gamma)\right]\frac{\partial w}{\partial V_c}, \qquad (6)$$

and
$$\mu_{ec} = \frac{\partial V_e}{\partial V_c} = +\frac{KT}{qw}\frac{\partial w}{\partial V_c} \qquad (7)$$

The elements of Fig. 4c then become

$$r''_e = r_e - (1-\alpha)\,\mu_{ec}\, r_c \qquad (8)$$

$$r''_c = r_c\,(1 - r_{ec}) \qquad (9)$$

$$r''_b = \mu_{ec}\, r_c = \frac{r_e}{(1-\alpha + (1-\beta)} \qquad (10)$$

$$a'' = \frac{a-\mu_{ec}}{1-\mu_{ec}} \qquad (11)$$

The above relations indicate that the use of thin base layers of high resistivity will result in significant effects because of space charge layer widening. In particular, it will be expected that the measured values of r_c and r_e will be lower than given by the simple theory, that r_b will be higher, and that α will not be significantly changed. An additional point

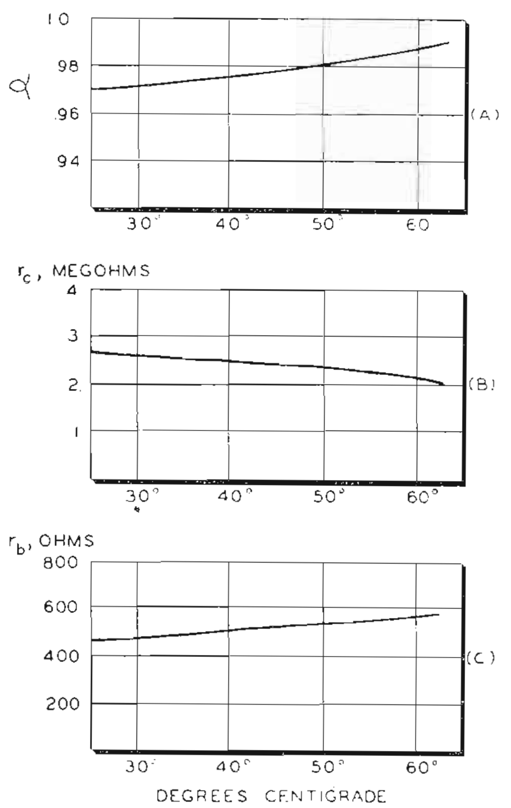


Fig. 10: Effect of temperature on α, r_c, r_b

of interest is that since C_c is not in series with r_b, low frequency measurements of the equivalent circuit parameters will not adequately characterize the performance at high frequency.

The Zener voltage[9,10] of a reverse biased junction is that voltage which produces a maximum field just sufficient to transfer valence electrons into the conduction band. It is of considerable design importance, being the maximum reverse potential which can be applied to the junction without excessive current flow. High Zener potentials may be achieved by making the space charge layer wide, terial for the base or the collector or both, or by a gradual transition from n type to p type material. These measures also reduce the junction capacitance. The Zener field in germanium is considered to be about 2×10^5 volts/cm, so that a junction having a Zener potential of 100 volts would have a space charge layer in the order of 5×10^{-4} cm at this potential.

When no emitter current is passed, and the collector junction is reverse biased, a small current flows from collector to base. This saturation current, I_{co}, may be a few microam-

(*Continued on page* 124)

peres for good transistors, or much larger if the material or the process is defective. In practical transistors the measured saturation current is found to contain a constant and an ohmic component. The constant term (when $V_c > 0.1$v.) should be, at room temperature

$$I_s = 0.24 \times 10^{-6} A \left[\frac{\rho_e}{\sqrt{\tau_e}} + \frac{\rho_b w}{13\tau_b}\right] \quad (12)$$

where the terms inside the bracket represent thermally generated minority carriers which diffuse into the junction. This current may be reduced by the use of low resistivity material of high carrier lifetime. The thermal generation of carriers is an exponential function of temperature, and this component of the saturation current increases at a rate of about 10%/°C in the normal working temperature range.

The ohmic component of I_{co} may result from surface leakage across the space charge region, or possibly from local defects in the germanium material. The ohmic component may

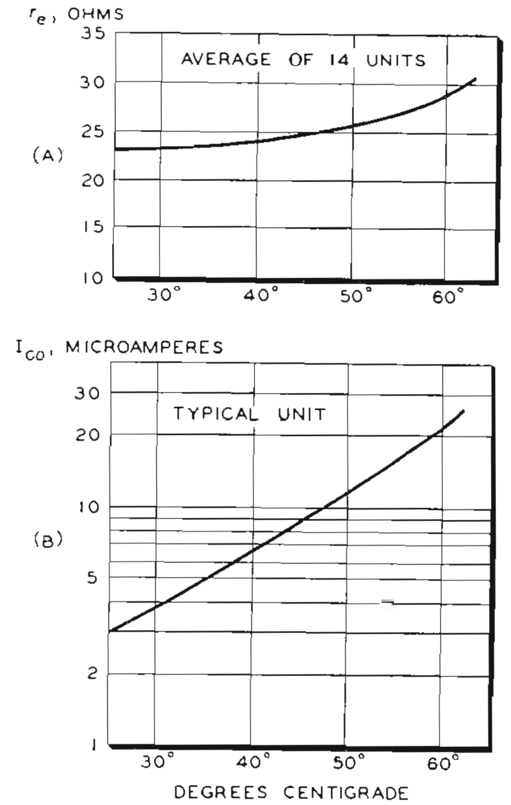


Fig. 11: Effect of temperature on r_e and I_{co}

of course be separated from the true saturation current by measurements at different collector potentials. In presently available transistors, effects of surface recombination and of leakage conductance are not negligible, and current values as low as would be predicted from (12) are not normally observed. The measured temperature coefficient of I_{co} is less than the theoretical value, averaging about 7%/°C for the M1752 transistor.

While other parameters are much less temperature sensitive than the saturation current, the limitations imposed by temperature effects are still significant. As the temperature is raised, r_c decreases, r_b and r_e increase, and α increases slightly. The reduction in r_c is usually the most serious effect, limiting the useful working temperature to about 70°C for germanium junction transistors.

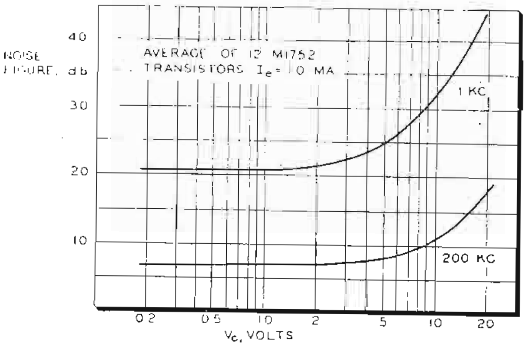


Fig. 12: Noise figure—V_c characteristics

The factors responsible for high-frequency cutoff in junction transistors have been discussed by Wallace and Pietenpol[2], where the importance of the effect of collector capacitance was shown. In some applications, the high-frequency alpha cutoff is the more important factor. The alpha cutoff frequency $f_c(\alpha)$ is defined as the frequency at which the transmission of the device (into a short circuit load) is reduced 3 db from its low frequency value. The cutoff frequency is given by,

$$f_c(\alpha) = D_b/\pi w^2 \qquad (13)$$

where D_b is the diffusion constant for minority carriers in the base, and

w = thickness of base layer.

For a base layer of p type germanium this reduces to

$$f_c(\alpha) \simeq 4.5/w^2 \qquad (14)$$

where f_c is in megacycles and w is in mils.

It is evident that high frequency response in this structure can only be obtained with very thin base layers.

Two other effects of interest in high frequency operation may be mentioned. Where the transistor is used in grounded emitter circuits, the signal is applied to the base, and the current gain at low frequencies is:

$$G.G. = \alpha/(1-\alpha) \qquad (15)$$

As the frequency increases, the reactive component of base current becomes dominant, and the current gain is rapidly reduced. The short circuit transmission cutoff of the grounded emitter connection then is[11]:

$$f^1_c(\alpha) = (1-\alpha)\, f_c(\alpha) \qquad (16)$$

Thus the circuit cutoff may be only a few tens of kilocycles for transistors having alpha values near unity, where the $(1-\alpha)$ term of (16) approaches zero.

The collector junction capacitance is in shunt with r_c, and this combination is in series with r_b. At high frequency, the realizable collector circuit impedance is limited by losses in the C_c, r_b series combination. To achieve satisfactory high frequency narrow band circuits, it is desirable to reduce both C_c and r_b to the minimum practicable values.

Correlation of junction transistor noise with design parameters is at present in an early stage. Some measurements showing the range to be expected for the M1752 development model are given in the next section.

Factors of primary importance in transistor applications are reliability and life. Since the junction transistor consists of three leads connected to a single piece of semiconductor material, with nothing to wear out, the design problems of the device are those of mechanical durability of the structure and chemical stability of the germanium surface and the lead connections. Although considerable progress has been made in these regards, it is evident that improve-

(*Continued on page 126*)

ments can and will be made. Measurements over a period of time on a group of development model junction transistors are given in a later section.

The M1752 development model n-p-n transistor is shown in the center of Fig. 1. This transistor is designed for low power applications at low and moderate frequencies. Several hundred of these M1752 transistors have been made to provide units for study and to assay design and fabrication techniques. The units were all tested at a nominal operating point of $V_c = 4.5$ v., $I_e = 1.0$ ma, and were required to pass the tentative test limits shown in Table II. Sample measurements were made of collector capacitance, frequency response, noise, and dependence of parameters on temperature.

The distribution of measured values of the parameters indicated in Table II is shown in Figs. 5, 6, and 7 where the ordinate is in each case the per cent of the group lying between the limits indicated. In Fig. 5a which shows the α values for 547 transistors, it is evident that the distribution is not well centered in the 0.95 to 1.0 range, although the median value ($\alpha = .973$) is near the center. Fig. 5b shows the distribution of measured values of collector resistance. Here the five groups are chosen from a logarithmic plot, as the range

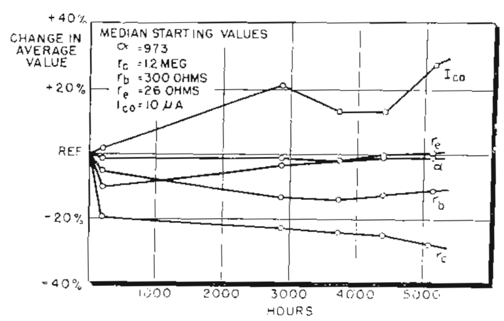


Fig. 13: Early life data, n-p-n transistors

of collector resistances is very large. It may be noted that here, as for the α plot, the application of the lower limit has resulted in appreciable shrinkage. This means that for these parameters the material, process, and test limits were not in good balance, and that these should be studied in order to permit improved yields.

Fig. 6a gives measured values of r_e at an emitter current of 1 ma. A significant fraction, slightly more than 30% of the values, are below 20 ohms, where the simple theory would require 25.9 ohms plus the body resistance of the emitter. This shift in the direction of lower emitter resistance is in accord with Early's theory, outlined in the previous section.

Fig. 6b shows r_b to follow a rather smoothly graded distribution, centered in the 500 ohm region. The r_b measured here includes the r_b, indicated in Fig. 4, and the values are thus higher than the r_b which would be computed from the base layer dimensions and resistivity.

Fig. 7 shows the results of saturation current measurement, in which the groups are selected on an approximately logarithmic basis. The rather wide range of values indicates a considerable spread in material, process, or both. It may be noted, however, that at the cost of an additional 5% shrinkage, the upper limit of I_{co} could have been made 10 μa. While it is certain that further improvement can be obtained, saturation currents of this order are tolerable in many applications.

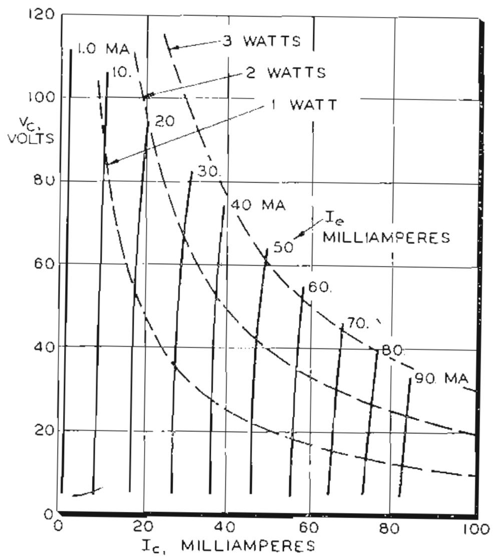


Fig. 14: Static characteristics of power transistor shown at right side of Fig. 1

The median values for the 547 transistors used in the above tests were:

$\alpha = 0.973$, $r_c = 2.7$ megohms,

$r_e = 24$ ohms, $r_b = 480$ ohms,

$I_{co} = 3.3$ μa.

The measurements were made at low frequency, after an aging period of 24 hours at a power dissipation of 25mw. Information obtained in life tests of a smaller group of M1752 transistors suggests that a longer aging period should be used. These tests are discussed in a later section.

Fig. 8 shows the distribution of alpha cutoff, measured on a sample of 40 transistors. The rather wide range of cutoff frequency is in reasonable agreement with predictions based on measured values of w, and could be reduced by selection of material.

Measurements of collector junction capacitance, C_c, of 40 transistors are shown in Fig. 9. Fig. 9a gives the median capacitance vs collector bias

(*Continued on page* 128)

potential. The slope of this curve is slightly steeper than the value of 1/3 which would be expected for a junction having a linear concentration gradient. Fig. 9b gives the distribution of measured capacitance values at a collector potential of 10 volts. Variation of capacitance from unit to unit is due to variation of junction area and differences in concentration gradient at the junction. The transistors used in these capacitance measurements were selected to cover the full range of material properties used in fabrication of the M1752, hence give wider dispersion of capacitance values than would be obtained from more uniform material. Measurements of area, capacitance, and Zener voltage of individual transistors show qualitative agreement with theory, hence if the area and the Zener voltage are measured, the capacitance may be estimated.

The results of parameter measurement of fourteen M1752 transistors over a limited temperature range are given in Figs. 10 and 11. The saturation current varies much more widely than the other parameters. The reduction in slope of the curve of Fig. 11b at low temperature is considered to be the result of ohmic leakage across the junction.

Fig. 12 summarizes noise measurements for 12 junction transistors in the low and carrier frequency range. It is evident that for quiet operation the collector bias should be low. Though not shown in Fig. 12, there is some evidence that the optimum noise figure will be obtained at low emitter currents, in the order of 0.1 ma, when the collector bias is in the order of 1 volt.

At frequencies below 50 KC, the noise spectrum appears to be of the form[12] $P(f) \doteq K/f^{1.2}$. As the frequency is increased above 50 KC, some units continue to follow the above relation, while others show several db less improvement than would be expected.

The construction of the junction transistor by welded or soldered connections to crystalline germanium should allow an almost indefinitely long life for the device.

Although not enough information is at present available to make accurate life estimates of junction transistors, some early results are indicated in Fig. 13. Thirty-five development model M1752 units were placed on life test. Two of these units were accidentally destroyed in subsequent testing operations, but none has failed on the life rack, after slightly more than 5,000 hours operation. The changes of average value of α, r_c and saturation current shown in Fig. 13 are in the direction of poorer performance, while the reduction of average r_b is an apparent improvement, which may be largely due to the reduction of r_c as indicated in (10).

The M1752 transistor is designed for low power applications at low and moderate frequencies, and has a nominal power dissipation rating of only 50 mw. It is of interest to consider some of the possibilities and limitations of the same basic n-p-n structure, when designed for applications which require the transistor to dissipate appreciable power. In this respect the junction transistor has a fundamental advantage over the point contact transistor in that the heat source is not concentrated in the vicinity of a small collector point but is distributed over the area of the collector junction.

It will become evident early in an anlysis of the heat dissipation problems of germanium transistors that heat dissipation by radiation cannot play the important part which it does in low and medium power vacuum tubes. The available temperature differences between the transistor and its environment are low, since the maximum temperature of the semiconductor must be held to perhaps 70°C. This in turn means that the power radiated per square cm of area will be very low indeed.

When we turn to conduction cooling, the outlook is more promising. Germanium, fortunately, has a thermal conductivity of about 0.125 in the temperature range of interest, which is about the same as the thermal conductivity of brass. If all the power dissipated in the transistor were assumed to appear as heat at the collector junction and to be conducted to a heat sink at one end of the transistor, the temperature rise at the junction would be

$$\Delta T = .24Wl/\sigma A = 1.92\, Wl/A \qquad (19)$$

where σ = Thermal conductivity of germanium
= 0.125 cal/°C at 55°C
A = Area of germanium bar
W = Power dissipated in watts
l = Length of germanium between junction and heat sink.

In a practical case it will not be possible to hold the heat sink at ambient temperature, and some allowance must be made for the thermal impedances external to the transistor. Since the total temperature rise must be kept small, extreme measures are in order to reduce thermal impedance wherever possible.

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United Nations

(*Continued from page 74*)

one half by a limiter used in this way.

The distance between offices and meeting halls and between offices and studios are, in some cases, very much greater in the new building than they were at Lake Success, and the need was felt quite early for some system to enable staff in offices to listen to the proceedings of meetings or programs in studios. There have been many attempts in Europe to produce automatic switching systems in which a number of different "sources" could be connected over rotary line switches to any of a large number of destinations. After many failures, the following general rules have, I believe, been accepted:

A. The level of program to be switched should not be less than —30 db in circuits, the impedance of which lies between 300 ohms and 5,000 ohms.

B. For the type of rotating contact in which the wipers pass simultaneously over both sides of the contacts over which they are sweeping, and the contacts are of phosphor bronze, at least two independent sets of such contacts should be used for each connection in parallel.

C. Switches in which the contacts are of silver have been satisfactory in some atmospheric conditions, and some silver alloy contacts have been found satisfactory under all ordinary atmospheric conditions in Europe. The number of failures, however, has been such that double contacts are probably still desirable as a safety measure.

D. Steps should be taken to keep the program wiring away from possibility of interference from the dc switching circuits, and no part of the circuit carrying program should be too close to the magnetic field of solenoids which drive the rotary switches.

The program distribution system adopted operates off 24 volts dc and any of 22 different programs may be selected by any of the out-stations; with a little rewiring this number can be increased to 44. Circuits to the individual stations are four wires, two for carrying program and two for carrying the dialing impulses.

Sound System

A special sound system has been designed for the Plenary Hall. This hall has a total volume of just over one and a half million cu. ft. and holds about 3,500 people. The architecture of the hall has, I think, been determined by aesthetic considerations; at any rate, it is by no means an ideal from an acoustic point of view. Provision of an adequate sound system has been made still more difficult by the fact that, in order to

(*Continued on page 132*)

achieve realism it was decided that the loudspeakers had to be mounted in the wall behind the rostrum and chairman's table as shown in Fig. 3.

After a great deal of discussion, the following main requirements were formulated:

on the rostrum should be small so as not to mask speakers from cameras in the booths.

B. The system, like the hall, would be designed primarily for speech but a music circuit condition would be provided.

C. It was considered desirable that it should be possible to raise the sound level at the back of the hall to as near 70 phons as possible.

It seemed likely at the beginning that the big problem would be to avoid direct pickup from the loudspeakers into the microphones, but this has not in fact as yet proved troublesome. The main difficulties have arisen because the seats, balconies and other reflecting surfaces all focus back approximately on the rostrum and chairman's table where the microphones are situated, and because fairly late in the design a large dome has been added focusing on the floor near the middle of the delegates area.

Four Channels

The sound system provided for the hall has four channels as follows:

1. A main channel in which two large high-frequency horns, each having two rows of four cells, and a double theatre type low-frequency unit mounted just below them, are fed through a dividing network having a crossover frequency at about 500 CPS.
2. A second main channel feeding two more similar high-frequency units through a similar network, to cover the galleries for the press and public at the back of the hall.
3. A third relatively low power channel feeding a single loudspeaker mounted in the base of the rostrum through a network which cuts off fairly sharply (12 db per octave) below the 1,000 CPS.
4. A straight relatively low-powered channel feeding a number of ceiling loudspeakers underneath the balconies at the extreme sides of the hall.

An additional network cutting off below 1,000 CPS, 6 db per octave, is inserted, in the main channel referred to in "1" above and may be removed from circuit for the "music" condition.

The design originally called for very small condenser microphones to be used on the rostrum and chairman's table. Experiments are now in progress to see how much improvement is possible by taking advantage of the directional properties of cardioid microphones. With the hall empty it appears that a sound level at the back of the hall of about 62 db may be achieved, but it is confidently expected that this figure will be improved somewhat when the hall is in use.

The television installation has to meet rather unusual requirements. Normally, in a public service, the problem is to supply pictures from studios in continuous or at any rate frequent use or to pick up programs from more distant points with mobile equipment. Our requirement is to take pictures from any of seven or eight conference rooms as a rule once a week, but sometimes every day. It was, therefore, necessary to concentrate all of the camera control equipment in the operating center, and permanently to install cables to the more important meeting halls so that only the cameras had to be moved from hall to hall as the service demanded.

Kinescope Recording

A 16mm video recording and rapid processor equipment has been installed. It is a "single" system in which video and sound are both recorded on the same film, and it is possible to record simultaneously several language versions for association with the one picture by recording the additional languages simultaneously on a standard tape recorder and using markers to synchronize the beginning and ending of the program. An electronic timing circuit replaces mechanical shutters, and blanks the cathode-ray tube of the monitor during the time the film is being pulled down. Film exposure is started by a pulse generated by the camera on completion of pull-down of the film. Exposure is maintained for a complete TV picture (two interlaced fields) and half a field is then dropped for the blanking period during which the film is pulled down. This effects conversion from 30 pictures to 24 pictures per second. A Gamma control panel (inverse power low amplifier) provides adjustment of gray scale. Sound is recorded on film by variable density system.

The rapid processor is a device which automatically develops, rinses, fixes, washes, dries and waxes exposed film from the video recorder in 40 seconds; high pressure, high temperature sprays are used to make sure that the solution permeates the emulsion during this short period.

Performance and Criticisms

It is too early to report with any confidence on the performance of the equipment. It can safely be said, however, that low-level switching of

(*Continued on page* 134)

microphones, about which a great many doubts were expressed in the early stages of the design work, is working well and the very large economies in amplifier equipment which have resulted from it have been fully justified.

We have done sufficient TV shows from conference rooms to know that our television production staff are quite satisfied with the arrangements provided for them. To date, the distribution system for programs into offices has not been put into operation and whether programs can be transmitted over the contacts of rotary switches without noise and interruption has yet to be proved.

Some difficulties have been experienced as follows:

A. The optimum sound level in the conference rooms and council chambers varies with the number of people in the meeting hall. The system is liable to "howl" when the hall is empty. If the sound reinforcement is set so that it is always stable regardless of how many people are in the hall, it may be noticed that a number of people at the back are using headphones to hear when they are not interested in the simultaneous interpretation. This may necessitate providing a microphone whereby the operator can measure the sound level at the back of the hall and adjust to a predetermined figure regardless of the number of people in the hall.

B. A great deal of trouble has been experienced already as a result of the extreme inflexibility of the duct arrangements. Some equipment could not be installed because of the cost of getting at the main ducts.

C. There has been some indication already that the relative levels in language and floor channels would be improved if limiters were available to provide AVC in all the language controls.

D. The arrangement of equipment in the studios so that magnetic and disc reproducers are within reach of an operator sitting at the console is not altogether successful. The console itself is very long and it is difficult to get all of the equipment within reach.

E. Many of the arrangements made to provide the maximum possible output from the present operational staff has not been introduced with the result that some of the equipment and control facilities are not distributed in the best possible way.

F. It is much too early to form an opinion about the performance of the sound system in the General Assembly, but as far as preliminary tests show, disadvantages inherent in a domed auditorium and one in which the walls are roughly circular and shaped to focus towards a small area towards the center of the hall will most certainly be apparent. It seems unlikely that these will interfere with the use of the hall for the General Assembly meetings, for which it was primarily designed.

Junction Transistors

(*Continued from page* 129)

The right hand transistor illustrated in Fig. 1 is a development model designed for power dissipation in the order of three watts. Representative static characteristics are shown in Fig. 14. This model is intended to be mounted in direct contact with a metal chassis or other thermal sink. Class A power output of one watt may be obtained at a collector potential of 60 to 80 volts, at an efficiency of 33%. The distortion at this power level is in the order of 8%, and the power gain is 26 db. It is noted that some compensation of input and output distortion is obtained by making the generator impedance low.

While junction transistors have not as yet been produced in large numbers, results obtained in the measurement of several hundred development model n-p-n transistors indicate that such production is practicable. The foundation of design theory is on relatively firm ground, in that performance of devices may be predicted to a reasonable accuracy when the characteristics of the starting material are known.

Early results of life tests indicate a long useful life, but data are available for only five thousand hours operation.

As diverse applications arise, it will be possible to design for special performance qualities, as higher power, extreme miniaturization, higher voltage, lower capacitance, or higher frequency.

The writer gratefully acknowledges the suggestions and comment of J. A. Morton and W. J. Pietenpol. He is indebted to R. L. Johnston and Mrs. D. L. Boardman for most of the data presented.

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Microwave Relay

(*Continued from page 63*)

reduced to its sensitivity-test value at which the signal-to-noise ratio is about 3 db. If the i-f should vary beyond the range of control of the AFC circuit due to a large frequency shift or the loss of transmitted carrier, the sweep oscillator drives the local oscillator frequency back and forth at a 2-CPS rate until an i-f is available within the range of the AFC circuit. After this occurs, enough output is taken from the last i-f amplifier to cut off the sweep circuit and the AFC circuit remains in control until the signal is again interrupted.

Microwave Squelch: During a carrier failure, the i-f strip will put out noise (at limiter level) instead of signal. With such failure, noise would be passed along the system and occupy some portion of the allowable system deviation, competing with any other FM subcarriers that may have been inserted along the way. Also, each subcarrier receiver would pick up this noise in a proportion which falls within its own bandpass, and all telemeters, loudspeakers and other indicators might then be noise actuated and cause various errors. It is therefore important to squelch out the i-f strip output, at some point preceding the next klystron transmitter, whenever the signal-to-noise ratio is too low. For this purpose, a differential amplifier is arranged to sample the noise output in a portion of the spectrum where subcarrier signals are ordinarily absent, and also to sample the combined subcarrier spectrum which is carried through the system. The differential circuit provides an accurate "go or no-go" control depending upon whether the subcarriers or the noise predominates; if noise predominates, modulation is removed from the outgoing microwave transmitter. At any subsequent station the microwave carrier quiets the i-f strip so that further noise is not generated and squelch action will not take place.

Fig. 15 illustrates the application of the squelch chassis. Several repeater stations may be grouped together and considered a section, in which case the station at each end of the section will contain a pair of squelch chassis, one for the westbound signal and one for the eastbound signal as shown in the figure. In the following paragraphs on "sensing," it will be observed that a 60-cycle test tone passes thru the i-f strip; to preserve this voltage for the next video amplifier during a squelch, the noise output of an i-f strip will switch the next video input wire not to ground, but to a source of 60-cycle voltage.

Sensing for switchover: One of the most important contributions of the Motorola system to MR reliability is the automatic switchover circuit, which causes a standby full-duplicate system to be connected in place of the main circuits whenever any failure occurs which could seriously impair communications. In order to obtain triggers for causing the switchover, there are a variety of checkpoints each of which will obtain a sensing voltage null in case of a serious failure of the main communication equipment; such sensors are strategically located so as to monitor all of the i-f, video, and microwave circuits, with a total of three sensing voltages. A serious rupture of the klystron transmitter oscillation is monitored by a built-in power meter which consists of a directional coupler and a crystal detector built integrally with the waveguide rotary switch. This detector feeds a small and sensitive relay, called a "sensitrol" by the manufacturer, which is rugged and reliable in order to not cause more switchovers than are necessary. The microwave receiver mixer and local oscillator are similarly monitored by a sensitrol operated by the dc output of the mixer crystal.

It is important that the sensing circuit be sensitive only to the apparatus at a particular station and not to the incoming signal. In order to sense failure of the i-f and video circuits, a test tone must be injected at the extreme input and monitored to the extreme output, with such monitoring being independent of the incoming signal. For this purpose, a 60 cycle tone is injected into the first i-f or video input circuit and is sensed at the video output. At a repeater station this injection is made at the local oscillator repeller so that the 60 cycle tone must pass through the mixer crystal, the i-f strip, and the video amplifier, after which it is filtered out of the combined-channel modulation and led to the sensor. At a terminal station, where no i-f strip precedes the video amplifier, a special 60-cycle connection is made to the input of the video amplifier.

Switchover Circuit: Sensing circuits have been described which provide a loss of voltage or the closing of a contact to indicate than an important component has failed, yet without these circuits being sensitive to loss of signal from a remote station. These sensing voltage

(*Continued on page* 138)

nulls are fed to a "switchover unit" which contains relays for converting the sensing information to a complete switchover, and which unit also contains manually operated switches for testing either the main or standby equipment individually or for causing an intentional switch to either main or standby unit. Such a unit is installed with the main equipment for causing a switchover to standby, and a similar unit without the switchover accessories is installed in the standby equipment as part of the circuit for manual switching.

An entire MR station is switched to standby when any one component fails, regardless of whether the failure is in the east or west side of the station and regardless of whether the failure is in any of the r-f units or is in the power supply which is shared in common by both the east and west sides of a station. However, the subcarrier and other modulation equipment are separate equipment from the MR proper, and therefore are not included in this particular automatic switchover arrangement. In fact, it is an obvious intent of the microwave relay to appear exactly like a piece of coaxial cable relative to the output of the subcarrier frames.

It is the detailed objective of the switchover circuit to translate any failure which it receives from a sensor into a ground potential for a specific wire which is otherwise not grounded. This wire is a connection of each of the four sensitrols, which devices represent transmitter and local oscillator crystal sensing from east and west main equipment. The one sensing terminal for i-f and video chassis is also connected to this wire, but obtains its ground from its own sensing relay rather than from the action of the sensitrols which produce such ground from the failure sensing of the crystal voltages. Both the eastbound and the westbound video and i-f sensing wires connect to the same terminal because a closed contact from either one is to actuate the switchover mechanism.

It is useful to have several successive samples of the sensing current so that momentary failures, if self clearing, will not cause a switchover. Therefore, the sensitrol deflection coil is given successive opportunities to hold off the failure position by means of a timer which rotates a set of sampling cams. One cam energizes a microswitch for a short interval once in each five seconds, thereby energizing the sensitrol reset coils which push the sensitrol armature off the magnetic contact to permit a recheck of the presence of a failure; without such reset mechanism, a failure for a short period of time would have the same effect as a 45 second failure. At the same time that the first cam resets the sensitrol, a second cam, for a slightly longer period of time, short circuits the sensitrol wire to ground, thereby maintaining a record of the starting time of the original failure signal.

Thus, any sensed failure has 45 seconds in which to clear itself, after which time the standby r-f unit will be turned on and will start a 60-second warmup. If the failure persists through the total of 105 seconds, the automatic switchover circuit will connect the antenna to the standby r-f unit by means of the rotary waveguide switch. Because the system switches over only after a failure, and never from the absence of an incoming signal, there is no necessity for remote control of the main-standby switching function; that is, all such switching is either automatic and due to a failure, or else it is accomplished manually at the station by a maintenance technician.

Alarm transmitters: Each time a switchover occurs, it is important to alarm the nearest maintenance headquarters, so that a repair can be effected promptly and the equipment restored to its main units. For this reason, audio alarm tones are installed in the standby unit, these tones always modulating the standby transmitter klystron until the serviceman causes a switch back to the main unit. There are other uses for alarms. The law requires the operator to know when his tower lights fail and to repair them promptly as the outage would otherwise constitute a hazard to aviation. One type

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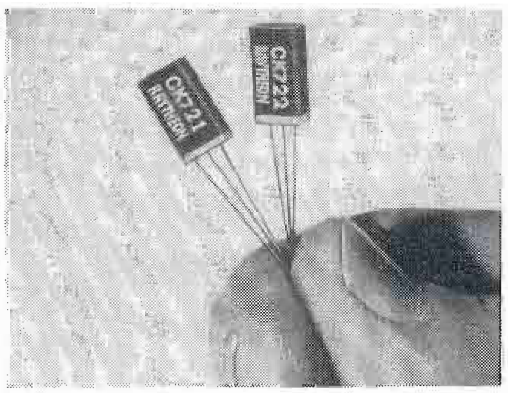
Raytheon Commercial Transistors

Raytheon Mfg. Co., Newton, Mass., culminates four years of semi-conductor research by announcing commercial availability of two germanium junction



transistors, Types CK721 and CK722. Although a portion of initial output will be channeled to top priority defense applications, distributor pipelines are now being filled with the PNP units.

of alarm is therefore installed to monitor tower light failure and to emit a steady modulation onto the mr. until the failure is repaired. Another alarm indicates switchover from the commercial 60-cycle power line to the standby engine generator, and still others are available for burglar alarming.

Fig. 16 illustrates the basic alarm transmitter which is utilized at various audio frequencies which are coded to indicate the cause of the alarm. The video amplifiers are equipped with a receptacle into which one such alarm may be plugged, this one ordinarily signalling a radio switchover by modulating the standby klystron transmitter. When the alarm is plugged into this video chassis, the output wire shown in the schematic circuit is fed to the repeller modulating capacitor in parallel with the customary subcarrier modulation, so that the alarm output frequency modulates the klystron in the same manner, and to nearly the same depth, as one subcarrier channel. R1 and C2 are chosen to obtain any desired audio frequency, each tone corresponding to a different station in one section. Additional coding in the form of a dot-dash code is available at each station to distinguish between r-f switchover, tower light failure, and the other alarms.

In addition, coding is available for the 60-cycle power alarm. B+ for this separate chassis is supplied by the subcarrier multiplex assembly. 60-CPS voltage is supplied from the auxiliary engine; when the engine operates, the alarm chassis is energized and places the tone coded audio signal on the microwave modulation wiring. The cam actuated microswitch is optional for dot-dash coding or flashing to warn that a fuel supply is being exhausted.

Alarm Detection: The simplest alarm detector used is that shown schematically in Fig. 17. The input circuit is resonant at a particular alarm tone frequency which tone is then amplified, rectified, and amplified again to close a relay, which lights a red lamp on the control panel, and which closes another pair of contacts available for any desired auxiliary indication. The input line to this and other types of alarm detector is common with the various subcarrier receiver inputs, the one line merely feeding every tuned-circuit input filter in parallel with all the others.

Where there are several stations, each with several types of alarm, the station is identified by the frequency of the alarm tone and the nature of the alarm is indicated by a dot-dash code. The headquarter station in which these alarms are to be detected is then equipped with a "Master Alarm Detector" having an input circuit of 10 paralleled selective filters. Each channel is sampled in succession for a six-second interval by means of a 10-position stepping switch. There is also a two-stage tone amplifier, a tone rectifier, and a relay control circuit. The alarm tone frequencies are spaced at 1 KC intervals starting with 5.5 KC.

Regulated Power Supply: Fig. 18 is the schematic circuit of one of the regulated power supplies, this particular one being selected for illustration because of the voltage regulator tube problem associated with low-voltage power supplies. Since the output is only 105 v. dc, the customary connection of the VR tube in the cathode circuit of the difference amplifier would obtain insufficient voltage to operate the VR tube. The VR location shown is highly successful. The constant-current nature of the VR tube causes the ac drop across itself to be nearly constant at some dc level instead of containing a large ac component. The ac component is passed on to the error voltage developing resistor R14 with very little loss even though the dc component is appreciably reduced at that point. The combination puts practically full output voltage hum into the grid of the difference amplifier so that the series regulator action produces a very small hum output. Since it is desired to compensate for hum, variable load, and also variable input voltage, the difference amplifier also obtains an input sample from R11 with the values of R11 and R12 so adjusted that the entire regulator circuit has a stable dc output in spite of changes of load or input voltage. The dry rectifiers illustrated have proven to be essentially failure-proof while operated at low dissipation per unit area. All other power supplies in the equipment have similar schematic arrangements, including 300 v. for klystron anodes, 400 v. for the klystron repellers, and 250 v. for video amplifiers and all accessory circuits.

Tower Lighting Equipment: The lighting control may contain a photocell or clock for illumination after sundown. Lamp failure monitoring is accomplished by an automatic sensing device which measures current drawn, light emitted, or temperature of the lamp's glass bulb. An automatic coded alarm notifies headquarters of the nature and location of failures.

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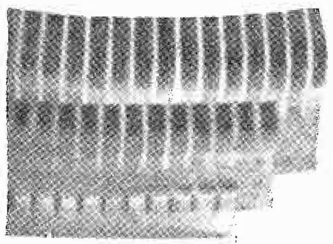

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Silver-plated, spring alloy, pre-formed finger stock especially suited for electrical "weather-stripping" for TVI-proofing cabinet access doors, etc. Also ideal for making coaxially constructed tube connections and many other uses. Available in 17/32", 31/32", and 1 7/8" widths.

• Write for new Eimac Catalogue Summary showing Eimac tubes and other accessories.

* Eimac

Eitel-McCullough, Inc.
San Bruno, California

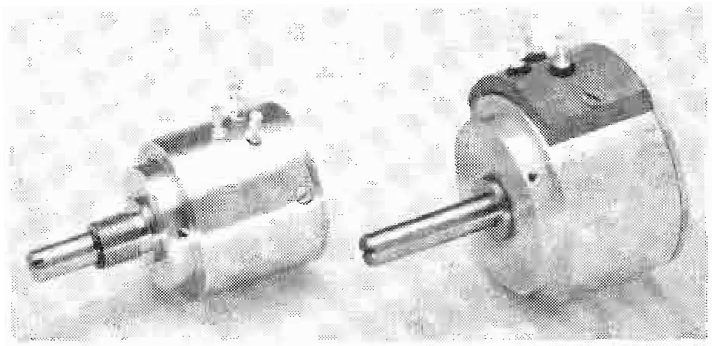
CORNELL'S

PRECISION POTENTIOMETERS

Cornell Precision Potentiometers perform mathematical computations in electrical computing systems of all types. They are available in non-linear and linear types and in ganged combinations of either or both, with windings to meet your requirements and specifications.

Custom design, both mechanical and electrical, is a featured CORNELL service.

Taps and special winding angles anywhere up to 360° continuous rotation or limited by stops as required.

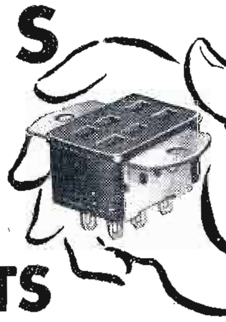


Type RAS-2 1-1/4" in dia. Can be ganged if required — Type DS-6, 1-5/8" in dia. Ganged up to 21 units

If you want ACCURACY in your control systems, ask for CORNELL Precision Potentiometers.

Cornell Electronics Corporation
40-33 Main Avenue • Douglaston, N. Y.

INSURE *Proven Quality* with JONES PLUGS AND SOCKETS



P-306-CCT Plug, Cable Clamp in Cap.

Jones Series 300 illustrated. Small Plugs & Sockets for 1001 Uses. Cap or panel mounting.

S-306-AB Socket with Angle Brackets.

- Knife-switch socket contacts phosphor bronze, cadmium plated.
- Bar type Plug contacts brass, cadmium plated, with cross section of 5/32" by 3/64".
- Insulation molded bakelite.
- All Plugs and Sockets polarized.
- Metal Caps, with formed fibre linings.
- Made in two to 33 contacts.
- For 45 volts, 5 amperes. Efficient at much higher ratings where circuit characteristics permit.

Ask for Jones Catalog No. 18 showing complete line of Electrical Connecting Devices, Plugs, Sockets, Terminal Strips. Write or wire today.

Jones
HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORP.

Designed for Better Coils....

PRECISION COIL BOBBINS

Designed and manufactured under strict quality standards, PRECISION COIL BOBBINS provide superior insulation, moisture resistance and heat dissipation. Exacting tolerance control affords maximum winding space. Spiral winding and heat treating under compression results in greater strength and lighter weight.

Cores are furnished in an infinite variety of sizes and shapes—in kraft, fish paper, acetate or combinations. Flanges cut to specification—plain or fitted with leads, slots or holes—plain or embossed.

Send specifications for sample. Request Arbor List of over 1500 sizes.

PRECISION
PRECISION PAPER TUBE CO.
2057 W. Charleston St., Chicago 47, Ill.
Plant No. 2: 79 Chapel St., Hartford, Conn.
Also mfrs. of Precision Paper Tubes

Fig. 19 is a simplified schematic circuit which combines several small chassis. This diagram is typical of most Motorola installations, although some will have clock control instead of photocell, some will have no standby engine with alternate flashing operation, and a visually monitored station would not need the thermostat sensors nor the coded alarm connections. Only one each of the beacon lamp and the sidelamp are illustrated, all others having the thermostat sensor in parallel with those illustrated so that failure of any one lamp will initiate an alarm via a thermostat sensor. Two separate thermostat circuits are used in order that a separate code may distinguish between beacon lamp failure and sidelamp failure in accordance with FCC regulations. The 45-minute time delay in the alarm circuit prevents false alarms during the initial lamp bulb warm-up each evening; after 45 minutes all lamps will have reached equilibrium heat in even the coldest weather.

In recognition of the combined efforts of many men, the author acknowledges the contributions of the following: H. Magnuski, Dr. W. Firestone, W. Fitch, L. Fisher, R. Hoffman, F. Mills, W. Byrne, J. Cohn, N. O'Connor, R. Roberts, N. Weinhouse, R. Wells, H. Ross, W. Steen, and staff.

TELE-TECH

Advertisers — January, 1953

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

BULLETINS

Metals

J. M. Ney Co., 71 Elm Street, Hartford, Conn., announces the availability of their revised edition bulletin R-12 on the subject of precious metals for sliding contacts, brushes, wipers, slip rings, commutator segments, resistance wire, and non-corrosive wear-resistant parts.

DC Solenoids

The Cannon Electric Catalog Dept., 420 West Avenue 33, Los Angeles 31, California, has just issued a new and revised Third Edition covering the company's line of dc solenoids. The bulletin is coded DCS3-1952.

Relays

A complete line of telephone-type relays, including hermetically sealed (in metal and glass containers) sub-miniature, plug-in types, etc., is described in a new, color-illustrated brochure released by Automatic Electric Co., 1033 W. Van Buren St., Chicago 7, Ill.

Pocket Reference Book

Handy technical reference material on RCA kinescopes, receiving and transmitting tubes, electronic components, test equipment, radio and industrial batteries, and miniature lamps are included in the RCA Pocket Reference Book, published by RCA Victor Division of Radio Corporation of America, Camden, New Jersey.

Electrical Embedment Resin

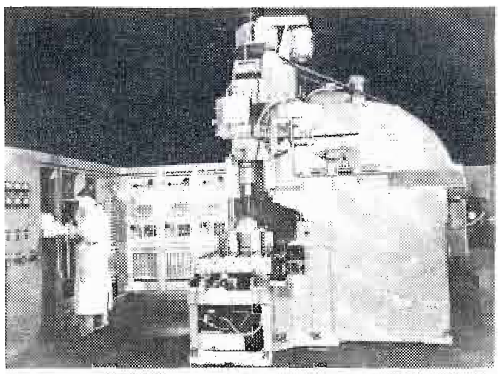
The embedding of electrical components in "Scotchcast" brand electrical insulating resins is described in an 8-page, illustrated booklet available on request from Minnesota Mining and Manufacturing Co., 900 Fauquire St., St. Paul, Minn.

Printed Circuits

Printed circuits, their function, fabrication and application are comprehensively outlined and described in a new 8-page brochure prepared by Photocircuits Corporation, Glen Cove, N. Y. Information on methods of application, materials, electrical characteristics with tables of values, components such as capacitors, resistors, tube sockets and switches are included.

Computer Conference Shows Input-Output Device

The Second Annual Computer Conference and Exhibition, jointly sponsored by the IRE, AIEE and Association for Computing Machinery, was held in New York City's Park Sheraton Hotel, Dec. 10 through 12. Recent developments in printers, data converters, magnetic tape, punched cards, and other input-output equipment were described. During the first day a record attendance of 800 viewed the 13 equipment displays. The 27 technical papers on the program are listed on page 92 of the Oct. 1952 issue of TELE-TECH.



Computer-operated milling machine points way to automatic factory control. Device described at 1952 Computer Conference feeds instructions by punched tape. Servo guides cutting tool. New system in use by Air Force cuts production time of one cam from about 30 hours to 4 min.

ELECTRONIC INDUSTRIES

TELE-TECH

A Caldwell-Clements Publication

FEBRUARY, 1953

SECTION ONE:

FRONT COVER: A PREVIEW OF THE MANY ANTENNA TYPES that will be appearing on house roof-tops in 1953. Shown (l to r) are stacked V, stacked dipoles and reflectors, corner reflector, stacked fan dipoles, fan dipole or bow tie, Yagi, helical, parabolic reflector, sheet reflector, rhombic and slotted line type antennas. (See page 38, Tele-Tech, Dec. 1951.) As of Jan. 1 the number of TV stations authorized totaled 283. Of the 175 post-freeze grants included in this figure, 127 are for UHF operation. Post-freeze VHF and UHF grants made during 1952 will bring TV service to 112 additional cities—making a total of 177 cities in 43 states, the District of Columbia, Puerto Rico and Hawaii now having or slated to have TV stations. (See also Timetable of New TV Stations Coming on the Air, page 93, this issue)

DEPARTMENTS

SECTION TWO:

TELE-TECH, Vol. 12, No. 2, February, 1953. 75 cents a copy. Acceptance under Section 34.64 Postal Laws and Regulations authorized at Bristol, Conn., February 8, 1952 with additional entry at New York, N. Y. Annual Subscription Rates: United States and Possessions: $7.00; Canada: $8.00; All Other Countries $10.00. Please give title, position and company connection when subscribing.

Published monthly by

CALDWELL-CLEMENTS, Inc.

Publication Office, Bristol, Conn. Editorial/Business Offices, 480 Lexington Ave., New York 17, N. Y., Tel. Plaza 9-7880

Publishers also of TELEVISION RETAILING

MALLORY TYPE XT TANTALUM ELECTROLYTIC CAPACITORS

MFD	SIZE D	SIZE H	C	OHMS	200°C MAX. Type No.	DCV	µA	150°C MAX. Type No.	DCV	µA	125°C MAX. Type No.	DCV	µA	85°C MAX. Type No.	DCV	µA
120	7/8	1/2	1	2.5	XT120-12	12	80	XT120-14	14	90	XT120-15	15	100	XT120-18	18	125
240	1 1/8	9/16	1	2.5	XT240-12	12	80	XT240-14	14	90	XT240-15	15	100	XT240-18	18	125
75	7/8	1/2	1	2.5	XT 75-20	20	80	XT 7[illegible]	23	90	XT 75-25	25	100	XT 75-30	30	125
150	1 1/8	9/16	1	2.5	XT150-20	20	80	[illegible]	[illegible]	90	XT150-2[illegible]	25	[illegible]	XT150-30	30	125
40	7/8	1/2	1	2.5	XT 40-38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100	XT 40-60	60	125
80	1 1/8	9/16	1	2.5	XT 80-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	XT 80-60	60	125
25	7/8	1/2	1	2.5	XT 2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 25-100	100	125
50	1 1/8	9/16	1	2.5	XT [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0-100	100	125
12	7/8	27/32	2	5.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]12-180	180	125
25	1 1/8	15/16	2	5.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]25-180	180	125
8	7/8	1 3/16	3	7.5	X[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	XT 8-270	270	125
16	1 1/8	1 5/16	3	7.5	XT[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	XT 16-270	270	125
6	7/8	1 17/32	4	10.	XT 6[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	XT 6-360	360	125
12	1 1/8	1 21/32	4	10.	XT 12-2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	XT 12-360	360	125
5	7/8	1 29/32	5	12.5	XT 5-300	[illegible]	[illegible]	XT [illegible]	[illegible]	[illegible]	[illegible]	400	100	XT 5-450	450	125
10	1 1/8	2 1/32	5	12.5	XT 10-300	300	80	XT 10-37[illegible]	[illegible]	[illegible]	[illegible]	400	100	XT 10-450	450	125
4	7/8	2 1/4	6	15.	XT 4-360	360	80	XT 4-450	450	[illegible]	XT 4-480	480	100	XT 4-540	540	125
8	1 1/8	2 3/8	6	15.	XT 8-360	360	80	XT 8-450	450	90	XT 8-480	480	100	XT 8-540	540	125
3.5	7/8	2 19/32	7	17.5	XT 3.5-420	420	80	XT 3.5-525	525	90	XT 3.5-560	560	100	XT 3.5-630	630	125
7.	1 1/8	2 3/4	7	17.5	XT 7-420	420	80	XT 7-525	525	90	XT 7-560	560	100	XT 7-630	630	125

Case Sizes from 5/8" x 7/8"

The Mallory Tantalum Capacitor shown is but one of the complete range of sizes and ratings indicated in the table. Note the following advantages:

- Compactness
- Continuous performance over a temperature range of –60° C. to +200° C.
- High resistance to shock and vibration
- Proof against thermal shock from –60° C. to +200° C. without damage
- Double sealing for absolute protection under all operating conditions.

Originally developed for the Armed Forces subminiaturization program, Mallory Tantalum Capacitors are now available in quantity. If you are redesigning your equipment, don't hesitate to call on us for help in any problem involving the application of capacitors, the development of special types or the simplification of related circuits.

For Complete Information...

The above table is part of our new Technical Bulletin 4-3. Write for your copy today. It is complete with sizes, mounting arrangements, surge voltages and performance curves.

Expect more... Get more from **MALLORY** (P.R. MALLORY & CO. Inc.)

Parts distributors in all major cities stock Mallory standard components for your convenience

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P. R. MALLORY & CO., INC., INDIANAPOLIS 6, INDIANA

Facts and Figures Round-up February, 1953

ELECTRONIC INDUSTRIES TOTALS

Broadcast Stations in U. S.

	AM	FM	TV
Stations Air	2377	612	120 VHF 5 UHF
Under Construction (CPs)	139	36	46 VHF 119 UHF 10 Educational
Applications Pending	232	8	463 VHF 294 UHF

FM Station Changes

FCC Chairman Walker at year-end reported 722 FM stations on the air, including 98 educational outlets. During the first 10 months of 1952, he said, 28 FM stations went off the air and 24 new ones went on the air. He added that 18 FM stations were under construction and 11 applications for construction permits were pending.

Amateur Licenses

Licensed ham stations at end of '52	117,069
Licensed ham stations at end of World War II .... (Increase 67%)	70,000
Licenses in new Novice class, authorized July 17, 1951	12,730
Licenses in new Technician class, authorized July 17, 1951	3,601

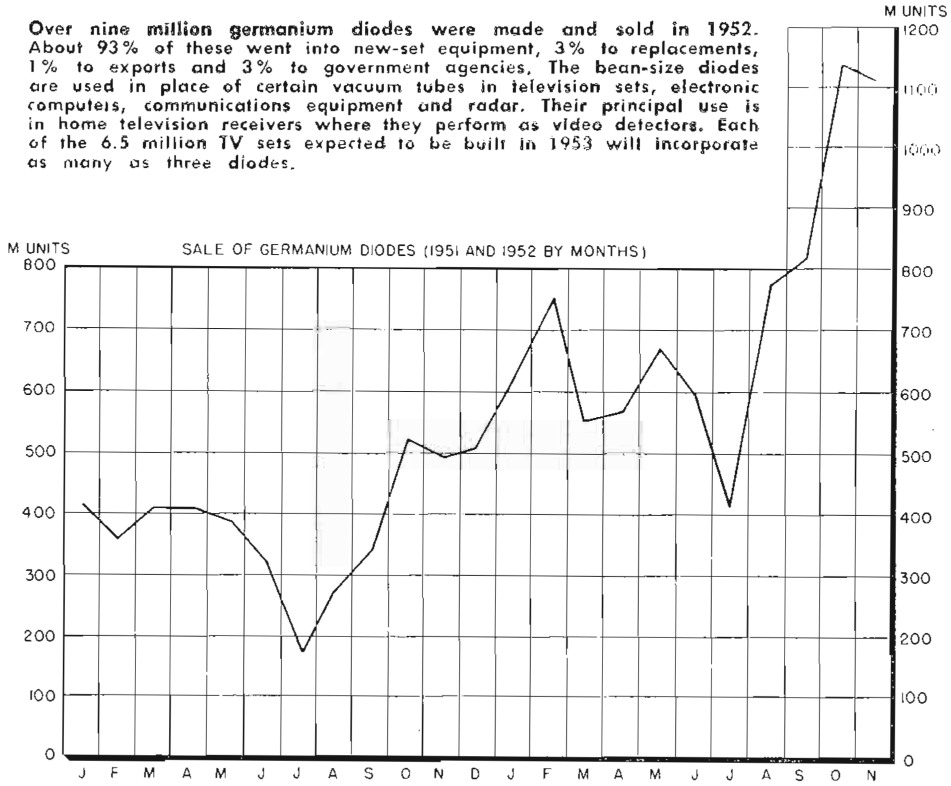
(Figures supplied by FCC Commissioner George E. Sterling.)

TV Abroad, 2,400,000 Sets

The U. S. State Department reports that TV stations are now operating in 21 countries on four continents, with two additional nations to begin TV service shortly, and three others in 1953. By the close of the present year, 28 may have TV.

TV sets in use abroad rose from 1,680,000 in October 1951 to 2,400,000 at close of '52. The latter figure does not include an estimated 77,000 sets in use in Russia. The report estimates the regular TV viewing audience outside the Iron Curtain and USA at 24,450,000 persons.

Over nine million germanium diodes were made and sold in 1952. About 93% of these went into new-set equipment, 3% to replacements, 1% to exports and 3% to government agencies. The bean-size diodes are used in place of certain vacuum tubes in television sets, electronic computers, communications equipment and radar. Their principal use is in home television receivers where they perform as video detectors. Each of the 6.5 million TV sets expected to be built in 1953 will incorporate as many as three diodes.



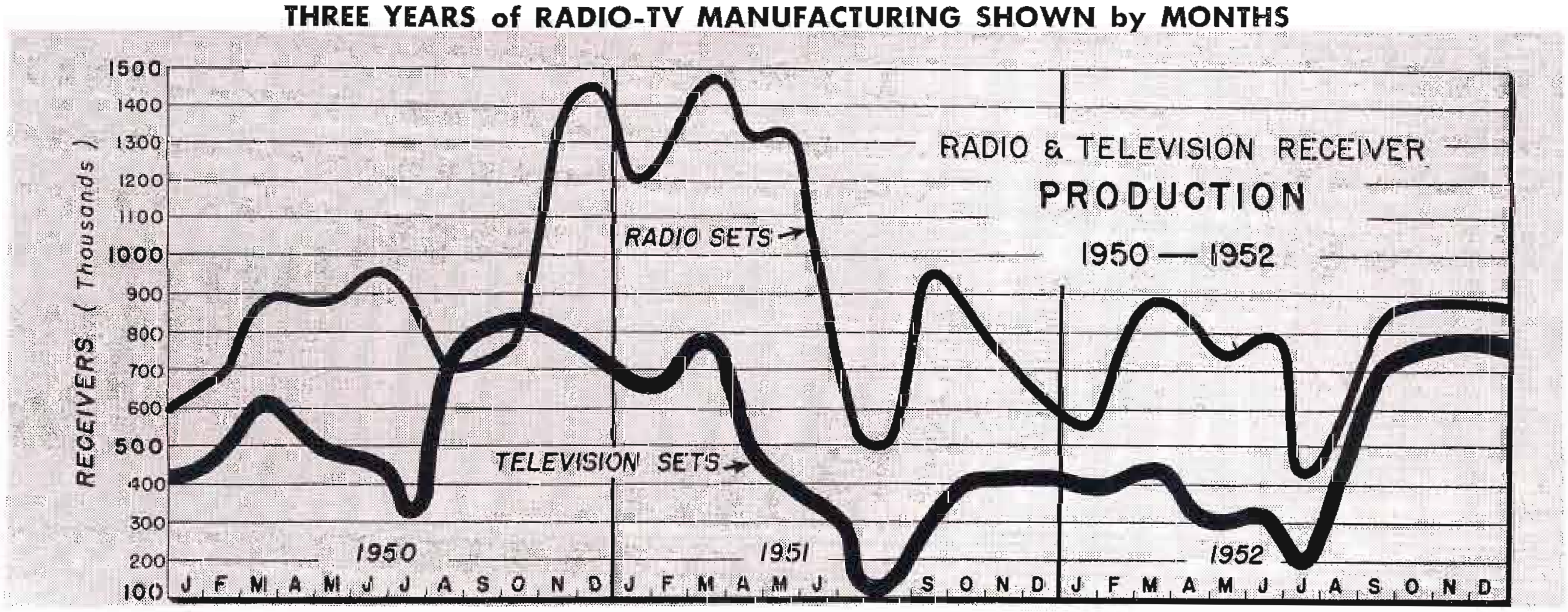
TV and Radio Receiver Production by Months, 1952

	Television	Home Radios	Portables	Auto	Clock	Rotal Radio
January	404,933	288,723	68,433	195,147	80,152	632,455
February	409,337	312,705	72,866	267,779	106,103	759,453
March (5 weeks)	510,561	357,689	99,720	343,314	175,169	975,892
April	322,878	286,164	110,529	275,250	176,003	847,946
May	309,375	288,927	128,351	215,478	115,588	748,344
June (5 weeks)	361,152	297,669	205,186	246,909	124,489	874,253
July	198,921	203,868	81,353	95,220	61,295	441,736
August	397,769	235,728	105,006	94,315	108,753	543,802
September (5 weeks)	755,665	324,786	126,666	230,706	183,496	865,654
October	724,117	314,459	113,552	163,494	180,841	772,346
November	780,486	389,853	153,503	195,200	185,639	924,195
December	760,000	370,000	153,500	185,000	180,000	888,500
1952, year	5,935,194	3,670,571	1,418,665	2,507,812	1,677,528	9,274,576
1951, year	5,562,000					12,895,000
1950, year	7,520,000					14,630,000

1952 FM Production - Home sets with FM facilities totaled 33,200 units in November and 32,000 units (estimated in December, bringing the 12-month 1952 total to 387,249 FM sets.

In addition, 7,603 television sets with FM circuits were produced in November and 6500 (estimated) in December, bringing the 12-month 1952 total to 93,781 TV sets with standard (100-mc band) FM output.

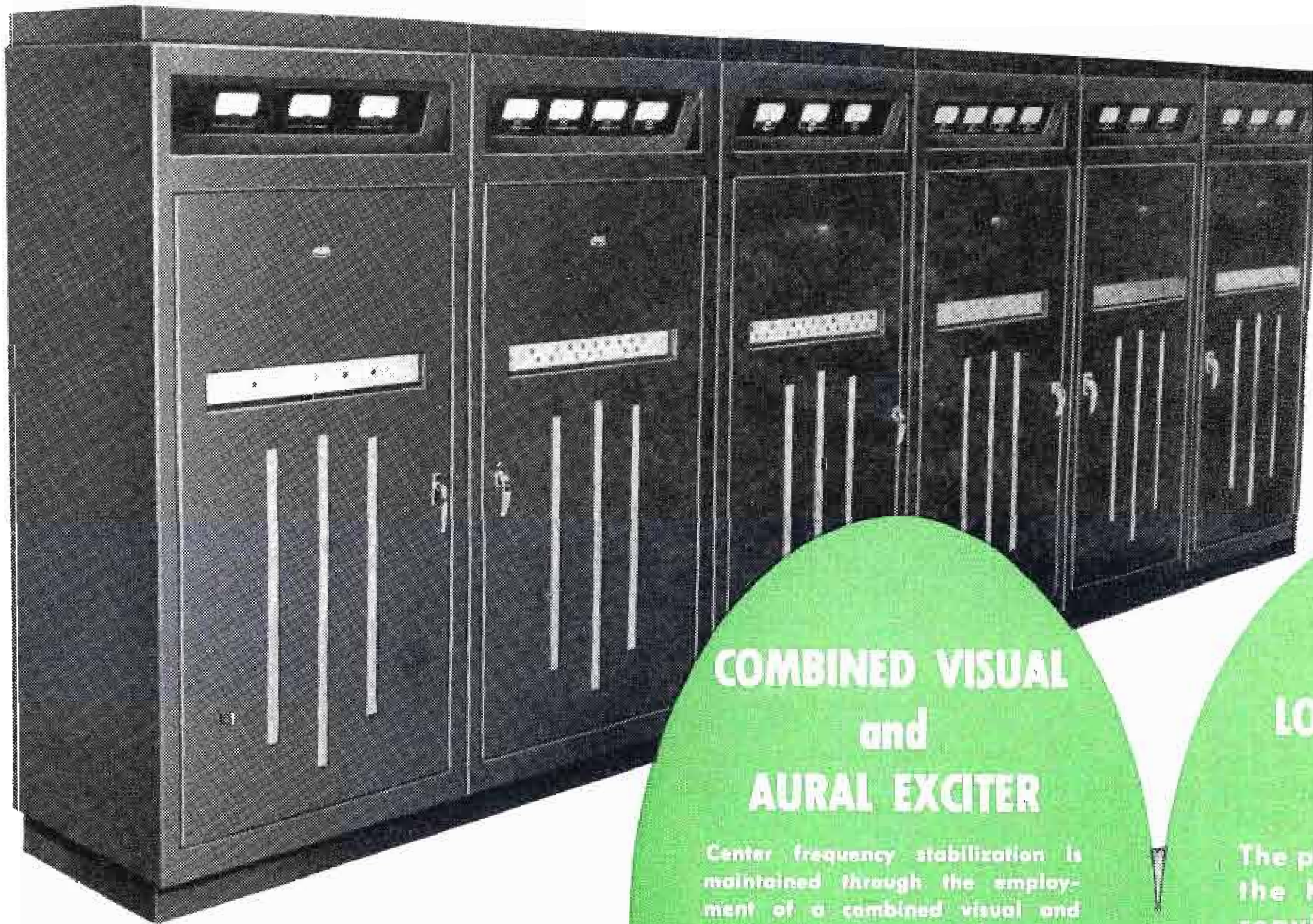
THREE YEARS of RADIO-TV MANUFACTURING SHOWN by MONTHS



See also Caldwell-Clements Statistics in World Almanac, Encyclopaedia Britannica, National Conference Board Economic Almanac, and "Information Please" Almanac

designed with YOU in mind...

the new DuMont 5kw

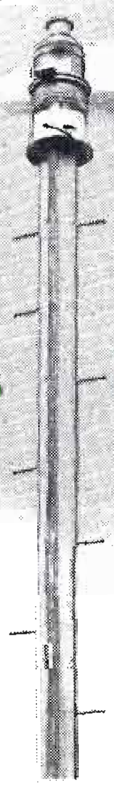


COMBINED VISUAL and AURAL EXCITER

Center frequency stabilization is maintained through the employment of a combined visual and aural exciter. One crystal controls the center frequency of both the aural and visual transmitters. The 4.5 megacycle difference frequency is thus maintained to positive accuracy. This Du Mont development results in clean, simple circuitry that means easier maintenance, trouble-free operation.

LOW DRIVING POWER

The phenomenal gain of the Klystron amplifier requires only nominal driving power. The driver unit is a simple, low-maintenance unit employing few tubes. Utmost dependability and performance are realized with this design.



and... The Du Mont CUSTOMER-FITTED UHF ANTENNA

The perfect UHF antenna custom-fitted to your needs by Du Mont's staff of leading propagation experts assures the success of your installation. The new Du Mont antenna is a rugged, simple, reliable design. Power gain 14 to 25, beam width 2.1° to 4.2°, vertical nulls filled in and beam tilted to meet terrain requirements. VSWR less than 1.1 to 1. Will handle up to 50 KW power.