

# Analysis of 203 Transistor Patents\*

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## NATURE AND SCOPE OF STUDY

THIS REPORT, THE SECOND OF A SERIES ON TRANSISTORS and related devices,<sup>1</sup> is based on an examination of the 203 original patents (*i.e.*, exclusive of cross references) included in the U. S. Patent Office file for Subclasses 12 through 40 of Class 330. The data were transcribed by the authors in May-June 1960, at which time the entire Class contained over 2,500 original patents.

Class 330 embraces amplifiers of all kinds, while the Subclasses of special interest are restricted to "amplifiers with semiconductor amplifying device (*e.g.*, transistor)". The Class as a whole is thus concerned with such transducer devices as vacuum tubes, controlled gas tubes, saturable reactors (magnetic type), masers, and variable resistance elements, in addition to transistors. The amplifying devices of interest here are constructed of natural semiconductor materials, such as germanium, silicon, or selenium; or of modified insulating materials to which similar electric properties have been imparted. The transistor, which has attracted considerable attention since its invention in 1948, is made of a semiconductor material and has three or more electrodes (for signal input, power supply, and signal output). Because of its economic importance and in accordance with common practice, its name is used here to characterize the varied group that is actually comprised by the 203 patents.

Even as they do not exhaust the field of amplifier technology, the 203 patents do not cover the entire range of semiconductor or transistor technology. Thus, pertinent patents, other than cross references, may also be found in Subclass 253 (manufacture of barrier layer devices) of Class 29 (metalworking); Subclass 200 (coating processes used in making barrier devices) of Class 117 (coating); Subclass 88.5 (nonlinear conductor devices, such as transistor circuits) of Class 307 (electrical transmission); and Subclasses 148.5 (transistor circuit with electric relay or electromagnetic load) and 234-236 (structure of semiconductor devices, including transistors) of Class 317 (electricity). At the time this study was made, these additional subclasses contained about 1,450 original patents.

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\* Interim Report on *Project 3b*, which is concerned with the "Role of Patents in the Evolution of Established Companies".

<sup>1</sup> Edgar Weinberg and Irving H. Siegel, "Development and Implications of the First Transistor Patents", *PTC J. Res. & Ed.*, Vol. 3, No. 4 (Winter 1959), pp. 392-397.

## 202 Patent, Trademark, Copyright Journal of Research, Education

### TIME REQUIRED FOR PATENT PROCESSING

Table 1 presents a frequency distribution, for each year of patent application, of the 203 transistor patents according to the time interval between date of filing and date of grant. From this table, it may be seen that :

1. Applications made in the 4 years 1953-1956 led to 105 patent grants, more than half of the total.
2. Almost two-thirds of the patents (132) were issued 3 to 5 years after the applications were filed.
3. The median interval between filing and issue dates falls in the frequency class of 3.5-4 years.
4. The median interval for patents based on applications made in 1954-1959 is shorter (3-3.5 years) than the median interval for those based on applications made in 1948-1953; but, since some of the applications filed in the later period remain to be approved, the difference between these medians does not yet conclusively indicate a significant reduction in processing time.

### COMPANY PATENTING ACTIVITY

In Table 2, the 203 patents are grouped by company of assignment as well as year of application. The following points stand out:

1. Eight companies account for three-quarters of the patents, while 32 others are named as assignees for fewer than one-fifth.
2. Unassigned patents comprise fewer than 4% of the total number, and assignments to the government comprise only 2%.
3. Bell Telephone Laboratories (B.T.L.), which fostered the invention and early development of the transistor, is named assignee on one-fourth of the patents (51).
4. Radio Corporation of America (R.C.A.), which made its first applications shortly after B.T.L., is assignee of almost as many patents (48).
5. The next two companies, General Electric (G.E.) and North American Phillips (N.A.P.), have the same number of patents (15 each), but they trail far behind B.T.L. and R.C.A. and made their first successful applications several years after the leaders got underway.

### CLAIMS PER PATENT

Table 3 was designed to show whether fewer claims were made or allowed through time as the "space" of transistor technology became more "crowded". This hypothesis does not seem to be strongly supported by the table even though the maximum ratio of claims per patent granted is shown for filings of 1948, the year the transistor was invented, and the minimum ratio is recorded for 1959. The ratios computed for 1957-1959 are, of course, still subject to significant change as additional patents are granted.

Table 4 shows that companies having the largest number of assignments also have the largest ratios of claims per patent. The support for this proposition is still strong if N.A.P. is excluded, despite its 15 patents. This company represents a special case: all of its assigned patents are of foreign origin.

Another striking point in Table 4 is the standing of unassigned patents. For these, the average number of claims (9.3) is comparable to the average for B.T.L. (9.5) and much higher than the ratios shown for most other companies. Apparently, "independent" inventors have striven for broad coverage.

#### SINGLE INVENTORS AND MULTIPLE PATENTS

According to Table 5, single inventors dominate, even though most of the 203 transistor patents were assigned to corporations and were presumably made by employees. Almost four-fifths of these patents carry the name of only one inventor, and less than a handful carry the names of three. B.T.L. shows the same proportion for single inventors, and the ratio is even higher for R.C.A. (nine-tenths). N.A.P. again stands out as an exception, with paired inventors predominant; its United States transistor patents, however, may well differ from its whole portfolio of assigned patents with respect to average number of inventors.

Another analysis of the basic data, not summarized here in tabular form, shows that the 203 patents are the work of 168 inventors. Almost one-fifth of the inventors (38) contributed to more than one patent. Most of the relatively prolific transistor inventors, however, contributed to only 2 patents. The name of William Shockley, co-inventor of the first transistor and a co-winner of the Nobel Prize, leads all the rest, appearing on 14 patents.

As in other fields of invention, foreign-born persons have made important contributions to transistor technology. In addition to Shockley and others who were born abroad but did their work in the United States, we must mention the 27 inventors listed on our patents as residents of other countries—especially the Netherlands, but also England, France, India, and the Union of South Africa.

TABLE 1  
 REQUIRED PROCESSING TIME FOR 203  
 TRANSISTOR PATENTS  
 DISTRIBUTED BY YEAR OF APPLICATION \*

YEAR OF PATENT APPLICATION	NO. OF PATENTS GRANTED BY MAY-JUNE 1960	MONTHS ELAPSED BETWEEN DATE OF FILING AND DATE OF GRANT												
		less than 12	12-17	18-23	24-29	30-35	36-41	42-47	48-53	54-59	60-65	66-71	72-77	78-83
All years.....	203	2	5	3	11	21	47	30	27	27	14	8	3	5
1959.....	1	1												
1958.....	1													
1957.....	11	2			4	3								
1956.....	31	2	1	3	5	11	7	2	3	3	2			
1955.....	26	1			3	6	3	8						
1954.....	32					9	2	7						
1953.....	27				1	6	4	5	4	3	4	3	2	1
1952.....	12					2	4	1	2	2	2	1	2	1
1951.....	17				2	2	2	5	2	2	2	1	1	1
1950.....	12				1	4	4	2	3	2	3	1	1	1
1949.....	12					2	2	1	1	4	1			2
1948.....	15			2	2	3	3			1				
1947.....	1						1							
1941.....	1													
1938.....	1													
1928.....	2						1							
1926.....	1													

\* Compiled from U. S. Patent Office records as of May-June 1960 for Class 330, Subclasses 18-40: "Amplifiers with semiconductor amplifying device (e.g., transistor)." Refers to original patents only (i.e., excludes cross references).

TABLE 2  
ASSIGNMENTS OF 203 TRANSISTOR PATENTS  
DISTRIBUTED BY YEAR OF APPLICATION \*

YEAR OF PATENT APPLICATION	NO. OF PATENTS GRANTED BY MAY-JUNE 1960	B.T.L.*	R.C.A.*	G.E.*	N.A.P.*	M.H.*	MOTOROLA	PHILCO	I.S.E.*	U.S. DEFENSE DEPARTMENT	32 OTHER COMPANIES	UNASSIGNED
All Years.....	203	51	48	15	15	9	6	4	4	4	39	8
1959.....	1										1	
1958.....	1					1					1	
1957.....	11	1	5	1	2	3				1	6	1
1956.....	31	3	8	4	5	3	1	3	1	2	11	1
1955.....	26			1							4	
1954.....	32	1	10	2	6	2	1			1	8	1
1953.....	27	2	8	4	2		4	1			5	1
1952.....	12	5	5	2								
1951.....	17	11	4									
1950.....	12	6	3						2		2	
1949.....	12	6	4	1								1
1948.....	15	13	1								1	
1947.....	1	1										
1941.....	1	1										
1938.....	1	1										
1928.....	2											2
1926.....	1											1

\* See asterisked footnote in Table 1.  
 \* Initials stand for Bell Telephone Laboratories, Radio Corporation of America, General Electric, North American Phillips, Minneapolis-Honeywell, and International Standard Electric.

TABLE 3

CLAIMS ALLOWED IN 203 TRANSISTOR PATENTS  
DISTRIBUTED BY YEAR OF PATENT APPLICATION \*

YEAR OF PATENT APPLICATION	NUMBER OF PATENTS GRANTED BY MAY-JUNE 1960	NUMBER OF CLAIMS	
		Total	Per Patent
All Years .....	203	1,374	6.8
1959 .....	1	3	3.0
1958 .....	1	6	6
1957 .....	11	97	8.8
1956 .....	31	185	6.0
1955 .....	26	133	5.1
1954 .....	32	172	5.4
1953 .....	27	144	5.3
1952 .....	12	76	6.3
1951 .....	17	84	4.9
1950 .....	12	58	4.6
1949 .....	12	89	7.4
1948 .....	15	255	17.0
1947 .....	1	5	5.0
Before 1947 .....	5	67	13.4

\* See asterisked footnote in Table 1.

TABLE 4

CLAIMS ALLOWED IN 203 TRANSISTOR PATENTS  
DISTRIBUTED BY ASSIGNEE \*

ASSIGNEE *	NUMBER OF PATENTS GRANTED BY MAY-JUNE 1960	NUMBER OF CLAIMS	
		Total	Per Patent
Total .....	203	1,374	6.8
B. T. L. ....	51	485	9.5
R. C. A. ....	48	293	6.1
G. E. ....	15	123	8.2
N. A. P. ....	15	71	4.7
M. H. ....	9	70	7.8
Motorola .....	6	21	3.5
Philco .....	4	11	2.8
I. S. E. ....	4	14	3.5
U. S. Defense Department .....	4	19	4.8
32 Other Companies .....	39	193	4.9
Unassigned .....	8	74	9.3

\* See asterisked footnote in Table 1.

\* See footnote \* in Table 2.

TABLE 5

SINGLE AND MULTIPLE INVENTORS ON 203 TRANSISTOR PATENTS  
DISTRIBUTED BY ASSIGNEE \*

ASSIGNEE*	NUMBER OF PATENTS GRANTED BY MAY-JUNE 1960	PATENTS NAMING—		
		1 inventor	2 inventors	3 inventors
Total.....	203	160	39	4
B.T.L.....	51	41	10	
R.C.A.....	48	43	4	1
G.E.....	15	13	2	
N.A.P.....	15	6	8	1
M.H.....	9	8	1	
Motorola.....	6	4	2	
Philco.....	4	3	1	
I.S.E.....	4	1	3	
U. S. Defense Department.....	4	3	1	
32 Other Companies...	39	30	7	2
Unassigned.....	8	8		

\* See asterisked footnote in Table 1.  
• See footnote • in Table 2.