

# GRAPHIC PRESENTATION SIMPLIFIED

by R.R. Lutz

*A guide to the use of  
graphic methods  
in business*



MODERN INDUSTRY BOOKS

**A MODERN INDUSTRY BOOK**

# GRAPHIC PRESENTATION SIMPLIFIED

By **R. R. LUTZ**

A MODERN INDUSTRY BOOK

A practical guide to the use of modern graphic methods in business, this new book shows you how to present facts in their most simple visual form . . . how to make all kinds of graphic charts . . . how to use them . . . how to analyze a problem, select the equipment and execute the graph or graphs best suited to the problem.

Detailed information is given on:

Curve charts • Bar charts • Circle charts • Sector charts • Statistical map charts • Dot maps • Pin and tack maps • Flow maps • the use of color.

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In addition, the book offers a training program for beginners who must depend on their own efforts without skilled supervision, with clear instructions in layout and plotting, and examples for practice.

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BY R. R. LUTZ



FUNK & WAGNALLS COMPANY • NEW YORK

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## ACKNOWLEDGMENTS

THE AUTHOR wishes to express his deep appreciation for the help received in the preparation of this volume from fellow workers with whom he has been associated in the course of nearly twenty years' experience in graphic design and presentation. He wishes also to thank the business firms and associations which have made available for inclusion in the book many of the graphic examples used as illustrations in the discussions of methods and principles. He is especially indebted to Mr. Willard C. Brinton for his helpful advice and counsel during the planning stage of the volume. Grateful thanks are due Mrs. Mabel Howell for her painstaking aid in the preparation of the charts and other illustrations for publication.



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GRAPHIC PRESENTATION SIMPLIFIED





## AN EXPANDING ART

**T**HE major development and utilization of graphic presentation as a medium for translating statistics into condensed visual form have taken place during the present century. Statistical charts were employed previously to a limited extent by specialists in various branches of science, but were little used in the world of commerce and industry. Much of the progress achieved in the last fifty years must be credited to the pioneers who visualized the potentialities of a wider employment of graphic presentation in these fields. Worthy of special mention is the work of Willard C. Brinton, whose *Graphic Methods for Presenting Facts* was published in 1914. In the following decade there appeared a number of excellent treatises on this subject, among them Karsten's *Charts: How to Make and Use Them*, and Riggleman's *Graphic Methods for Presenting Business Statistics*. Brinton's encyclopedic *Graphic Presentation*, containing practically every known chart design, was one of the outstanding contributions in the decade 1930-40. *Time Series Charts, A Manual of*

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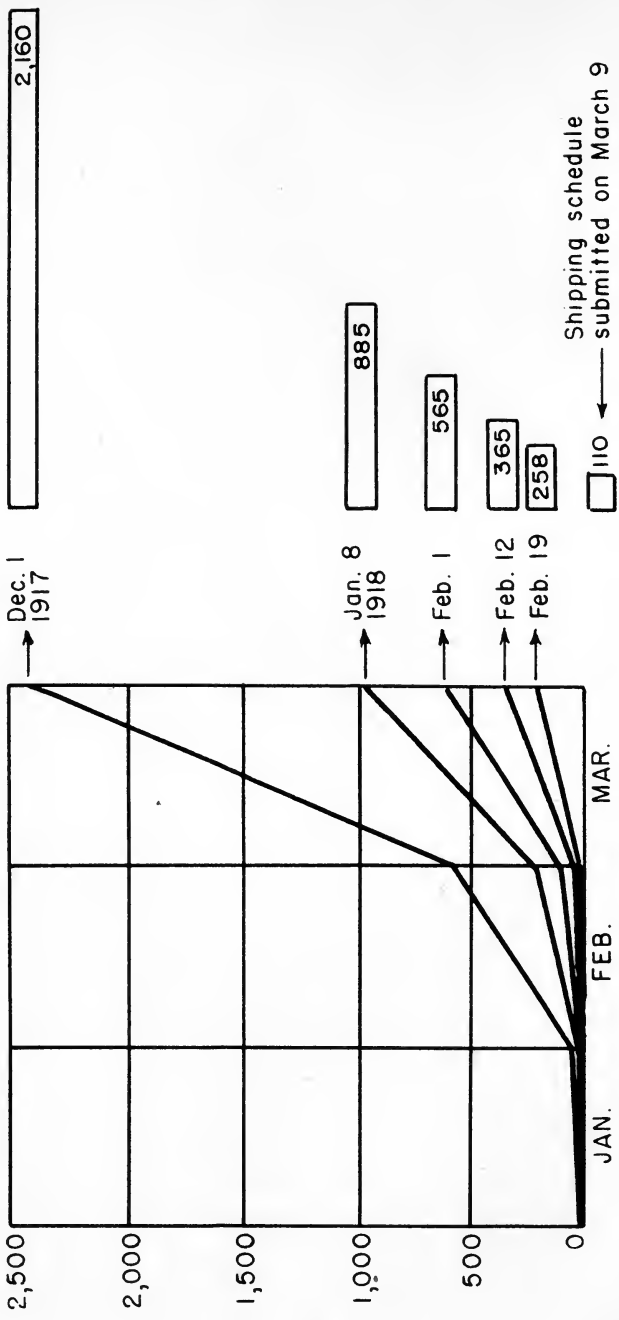


CHART 1. REDUCTION IN SCHEDULES OF PRODUCTION, COMBAT PLANES:  
 DECEMBER, 1917, THROUGH FEBRUARY, 1918.

*Design and Construction*, prepared by the Committee on Standards for Graphic Presentation under the procedure of the American Standards Association, published in 1938, marked an important advance in the standardization of nomenclature and methods of presentation.

## GRAPHIC PRESENTATION IN TWO WORLD WARS

A comparison of the use of graphic methods by Army agencies during the last war with the extent they were employed to record and summarize military statistics in World War I gives some indication of the advances realized in this field during the last twenty-five years.

For some time during World War I, the production of statistical charts was centered chiefly in the Statistics Branch of the General Staff. As a member of that agency, the writer had many opportunities to observe the methods employed in the various services for presenting statistical data. Of figures there was no end, but few attempts were made to reduce them to graphic form. Only a limited number of the higher officers were familiar with this type of presentation.

In the General Staff the value of compact graphic summaries of the principal statistical facts of the war soon gained recognition. Early in 1918, the Statistics Branch established a system of weekly reports for circulation in the General Staff. These reports consisted of statistical charts accompanied by text discussion and summaries. This service was supplemented by large display charts for presentation in weekly conferences attended by the Secretary of War, the Chief of Staff, and a selected group of officers representing the various services.

Copies of two charts shown in these conferences appear on pages 2 and 4. Both have a certain historical interest. Chart 1 played a prominent part in the crisis which finally resulted in the removal of combat plane and engine procurement from the Signal Corps to another procurement agency. The curve chart shows the successive reductions in the schedules of production from December, 1917, through February, 1918. The bars at the right indicate the effect of these reductions, after allowing for transportation to Europe and other delays, on the projected supply of fighting planes available at the French front by the following July.

Chart 2 pictures the shipping situation resulting from the submarine campaign against the British Merchant Marine from the beginning of

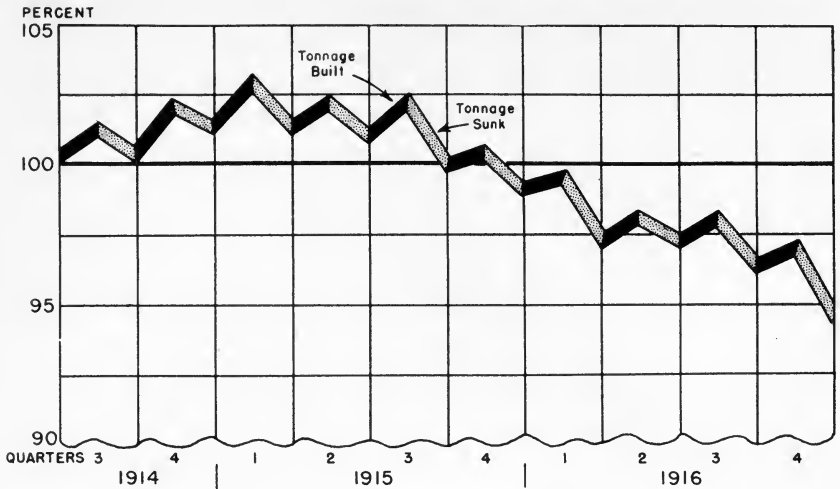


CHART 2. BALANCE OF CONSTRUCTION AND SINKINGS, BRITISH MERCHANT MARINE: 1914 TO 1916.

the war in 1914 to the end of 1916. The 100 percent line represents the total tonnage at the outbreak of war. The black portions of the curve indicate the new tonnage built, the shaded portions the tonnage sunk. The end of the curve in each quarter shows the net balance to that date.

The subjects discussed in these conferences were limited to questions of major importance in the conduct of the war. Few of the officers attending them were accustomed to the use of charts as a medium for the presentation of statistical data. Some of them found rather puzzling the conversion of the tabular forms with which they were familiar to graphic arrangements of curves, bars, and columns. At the end of the first conference one of the officers, a lieutenant general, confessed that he had been able to understand only the bar charts and added the comment that the other types, particularly the curve designs, were too technical.

Experience quickly demonstrated the need for extreme simplicity in design and the organization of complicated presentations into independent units limited to single aspects of the subject-matter. Every effort was directed toward making each chart so clear that its meaning and significance could be grasped in the shortest possible time. Details which did not bear directly on the purpose of the chart were rigorously excluded. Verbal definitions and explanations

were reduced to a minimum by clear labeling of each element in the design.

Within a few months after the declaration of war in 1941, facilities for the production of statistical charts were installed by every major procurement agency of the Army. Several months earlier, Colonel, later General, Leonard P. Ayres, who directed the work of the General Staff Statistics Branch in World War I, was called to active service to head the central statistical organization. The adoption of graphic methods in the various services was furthered by the active support of many officers from civil occupations, where their advantages were generally recognized.

Early in the war, arrangements were made by General Ayres for monthly meetings with the House and Senate Military Committees for the presentation of current information concerning the procurement of supplies and military equipment. For this purpose large display charts in color were employed. The sessions were short, lasting usually from one to two hours. Only through the facility for condensation afforded by charts was it possible to cover in so short a time the required range of subjects and volume of data. Many knotty questions arising in the course of the discussions were quickly cleared up by charts which compressed on a few square yards of cardboard the pertinent facts from tables covering scores of pages.

## CHARTS VERSUS TABLES

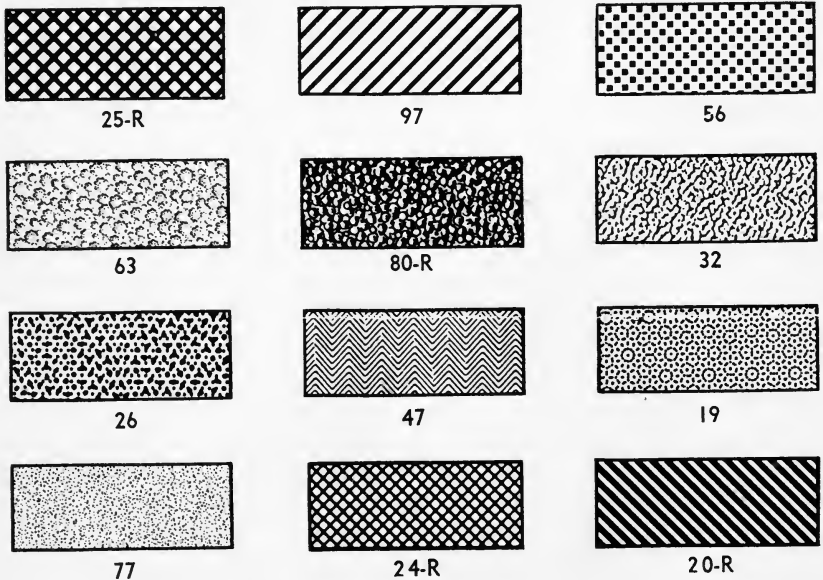
Charts are the shorthand of statistics. In a period in which every kind of factual information tends more and more to expression in statistical terms, they have become one of the most effective means for converting masses of data to a form that facilitates rapid comprehension and interpretation. Statistical information presented graphically has the great advantage over tables that it is more easily understood and remembered than the same data in tabular form. This applies particularly to inter-related factors, which in the chart form part of an integrated whole, while in the table they appear in unconnected detail. The coordination of significant relationships made apparent by the graphic method is of special value to executives whose duties leave them little time for analysis of data presented in tables.

Charts serve better than any other method of presentation where data must be presented to a number of persons at the same time. Statistical tables cannot be used effectively in a conference, board meeting, or

hearing. The employment of display charts for such purposes has kept pace with the increasing use of the conference method for discussion and study of economic and legislative problems.

### IMPROVEMENTS IN EQUIPMENT

Shortening of the training period has been made possible by innovations in equipment which have reduced the need for long practice and a high degree of manual skill. The introduction of two inventions, mechanical lettering guides and a new type of adhesive screen for the application of shading and color, has greatly simplified the drafting techniques employed in the production of statistical charts. Lettering of titles, scales, labels, and stubs usually takes from one half to two thirds of the time required to complete a chart. Before lettering guides came into common use, the proportion of time for this part of the work, done by hand, was much greater, while the results were inferior in uniformity and appearance to those obtainable with the guides. Free-hand lettering is seldom seen now except for ornamental lettering or on very large charts where the size of the lettering exceeds the capacity



*The Para-Tone Company*

FIGURE 1. SAMPLES OF ADHESIVE SCREENS.



of the guides. Relatively few statistical draftsmen can do good freehand lettering. In an extensive check of drafting rooms in Washington the average was less than 25 percent.

The use of adhesive screens for shading and color has cut down materially the time, labor, and skill required for filling in surfaces on statistical charts. Hatching by hand or with a section liner was a tiresome and time-consuming job, and the product often lacked uniformity in lining and spacing. In addition the patterns of shading that could be done by hand were limited in number and variety. A few samples of the many designs now available are shown in Figure 1. They are backed with a special adhesive which permits removal and replacement, if corrections or substitutions are necessary, without defacing the surface of the chart. They can be applied in about one tenth the time that would be needed to duplicate them by hand.

Formerly, where color was employed, poster paints or water-colors were painted on the chart with a brush. The process was extremely slow as compared with the speed attainable with adhesive colors, and the results were less finished and attractive. The saving in time is around 60 to 75 percent.

## REDUCTION IN LENGTH OF TRAINING

Today practically all large enterprises maintain graphic records of their internal operations. That the use of these methods has not spread to the same extent among the smaller business firms is partly due to the common assumption that the preparation of statistical charts requires the services of highly skilled draftsmen. The experience gained during the last war in the training of drafting apprentices does not bear out this assumption. On account of the heavy demands of the military agencies and the shortage of draftsmen, it became necessary to recruit drafting personnel from every possible source. In Washington alone a large number of clerks, typists, and other clerical employees were enlisted for apprenticeship courses in drafting. Within a surprisingly short time most of them were able to turn out work of acceptable quality.

Many of these recruits were women, with a sprinkling of young men who failed to pass the physical tests for the draft. Practically all accepted willingly the opportunity to learn statistical drafting. With some the higher rate of pay was the chief incentive. Others welcomed the release from monotonous clerical duties offered by the new occupation. A creative activity that gives play to imagination, ingenuity, and the

exercise of manual skill has attractions lacking in the average clerical job.

An experiment conducted by a Federal agency in 1947, involving the use of partly trained drafting personnel, showed some interesting results. The project was the establishment of a system of control charts in each of thirty-three regions throughout the country. Many difficulties were encountered. In some localities the services of trained draftsmen were unobtainable. In several instances it became necessary to send skilled personnel from Washington to get the projects started. The experience was enlightening, particularly where, due to the shortage of draftsmen, it became necessary, in order to meet the emergency, to develop a drafting force recruited from office employees engaged in other occupations. On the whole, these makeshift methods were successful. Within the time limit set, a matter of two months, each of the regions was able to show the status of its operations in a series of fairly presentable charts.

## TRAINING METHODS

Apprentice training during World War II was carried on chiefly in large drafting rooms under the direction of experienced supervisors and chief draftsmen. Beginners were first taught the use of a few drafting instruments. Following this, they were assigned simple tasks under close supervision on current jobs in process. Through the instruction they received from the chief draftsman and their observation of the work performed by other members of the drafting staff, they gradually acquired a working knowledge of the use of scales, plotting methods, application of shading and color, and lettering with mechanical guides. The time required for development of average speed in lining, plotting, and lettering generally ranged from one to three months.

The conditions were those which usually exist where the volume of work is large enough to warrant specialization. The selection of designs usually was made by a member of the statistical staff in consultation with the supervisor. Details of the design and lay-out were sketched by the chief draftsman, who also wrote the instructions concerning the dimensions and spacing of the chart, what scales to use, the weight of the lines, the curve patterns, the color and shading, and the size and distribution of the lettering. The draftsman had only to carry out these instructions. Any question or doubt arising in the course of the work was quickly resolved by consultation with the chief draftsman.

This method, which closely resembles those employed by industry in training beginners for specialized mechanical operations, has the advantage that it develops a fair degree of productive capacity in the shortest possible time. Its weakness, from the standpoint of the embryo draftsman, is that it gives him little opportunity to acquire the general background he will need if later he finds himself in a position where he must take the responsibility for the entire process, involving not only the manual execution of the chart, but the selection of the design and combination of the graphic elements to bring out clearly the purpose of the chart.

The facilities afforded by ample equipment and skilled supervision found in the drafting installations of governmental agencies and large corporations are generally lacking in small commercial and industrial enterprises. Apprentice training of the type described in the preceding paragraphs is out of the question. The beginner can make a start by taking a short course in drafting. The long study and practice required for mechanical or architectural drafting is unnecessary. However, the average teacher of drafting knows little or nothing of graphic presentation. At the end of the course, the student will have acquired some proficiency in the use of drafting instruments, probably sufficient to enable him to carry on under conditions where the major part of the thinking and planning is done by others, but entirely inadequate if he is faced with the problems of selecting and adapting graphic designs to the requirements of complicated statistical presentations.

The method of training suggested in later chapters of this volume was planned for those who must depend on their own efforts, without the aid of skilled supervision and instruction. It comprises a careful reading of Chapters II to XVI, in which are described the various graphic types commonly employed in statistical charts, the uses for which each is adapted, their limitations, and their relation to the many forms in which the results of statistical tabulation, research, and analysis are embodied. Included are detailed instructions in methods of lay-out and plotting, with examples-for practice on small charts with the tools immediately at hand, followed by suggestions and rules for planning and drafting charts of greater size and more complicated designs, involving the use of additional types of equipment. The principle is that of learning by doing. It will insure at least the acquisition of what so many draftsmen lack, a thorough understanding of the *why* as well as the *how* of each step of the process.



## CURVE CHARTS

**T**HE curve chart, sometimes referred to as a "line" chart, is one of the oldest forms of graphic presentation. It is most frequently used in presenting time series, in which the data correspond to successive time periods.

The curve design is generally employed in charts showing projection of trends, or where exact plotting for close reading is required. It is not well suited for charts of short time series nor where the purpose of the chart is to show comparisons of size or amount rather than the movement and direction of change.

### DESIGNATION OF CHART COMPONENTS

Chart 3 shows the terms generally employed for designating the various curve-chart components. Many of the terms apply also to other graphic types. These designations, with slight modifications, follow the terminology approved by the American Standards Association.

A variation of minor importance is "stub," sometimes used to desig-

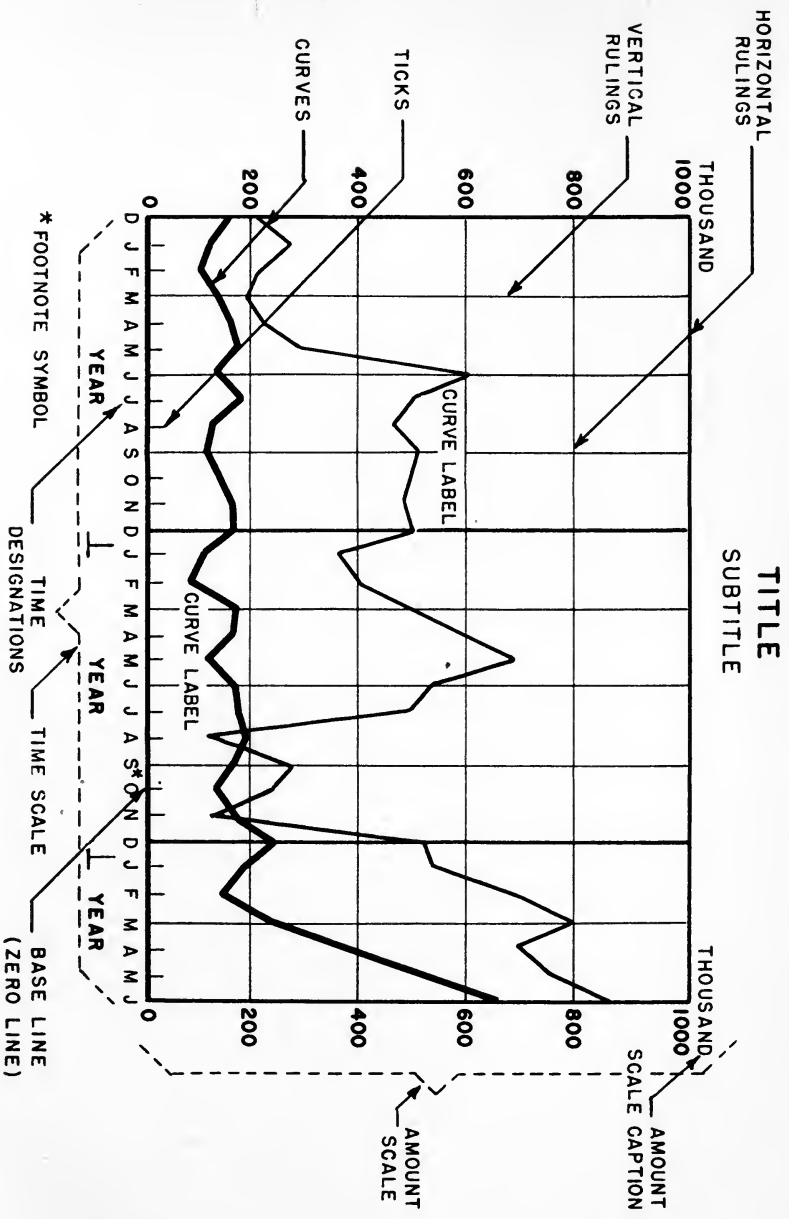


CHART 3. DESIGNATION OF CHART COMPONENTS.

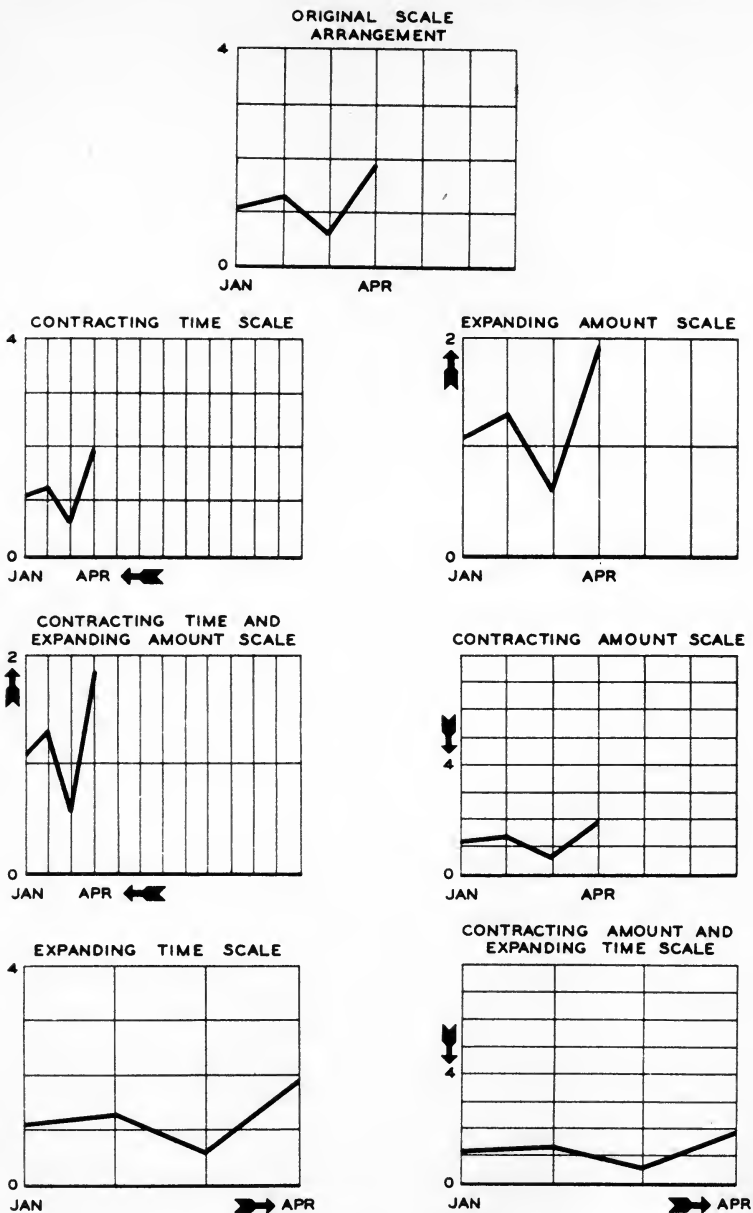


CHART 4. EFFECTS OF SCALE ALTERATIONS. FROM *Time Series Charts, A Manual of Design and Construction*.

nate the abbreviated scale rulings in time and amount scales, called in this example "ticks." "Stub" is confusing, for the reason that it applies also to the list of items in bar charts. Another term not shown is "grid," signifying the total plotting area, bounded by the side, top, and bottom lines of the chart.

## **TITLES**

The title should be brief, but without sacrifice of clarity or omission of essential details. As to position, above or below the grid, the practice varies. In charts appearing in periodicals it is often placed below the drawing. Titles of display charts are generally lettered above the grid. If economy of space is important, as in miniature charts, the titles, if not too long and not accompanied by subtitles, may be lettered within the grid. If the chart is surrounded by a border, the title is centered between the vertical border lines, not over the space occupied by the chart.

## **ABBREVIATIONS FOR TIME SCALES**

Time scales are in units of years, months, weeks, or days. Frequently in charts of yearly data there will not be room to letter the full figures, in which case two digits with an apostrophe may be substituted, as '39, '40. If there is enough space, three-letter abbreviations should be used for monthly time units. If this results in crowding, single-letter abbreviations may be employed. Time-scale abbreviations are not followed by a period. Time units in weeks should be lettered in figures, with the month lettered horizontally below. The clearest form is 1-7, 8-14, and so on. Time units in days of the week should be designated by three-letter abbreviations.

## **PROPORTIONS OF WIDTH AND HEIGHT**

The impression created by a curve chart depends to a great extent on the shape of the grid and the distribution of time and amount scales. Overexpansion or contraction of one of the scales throws the graphic picture out of balance and makes interpretation difficult. Chart 4 illustrates the effects of different scale alterations.

While no fixed rules for the proportions of grid dimensions can be laid down, a convenient standard is the method known as "root-two," a ratio of 1 (short side) to 1.414 (long side). These proportions approxi-

mate those of standard sizes of paper and illustration board. The table of root-two dimensions on page 15 will save time and calculation of grid measurements. If for any reason either dimension is predetermined to fit a given space, the other dimension can be found immediately by reference to the table.

These proportions are suggested as a general guide. Modifications will often be necessary if the shape of the chart has to be accommodated to space requirements of other material, as, for example, column widths in periodicals, reports, and other printed matter.

## SCALE NUMBERS

Amount scales should be in even numbers or in multiples of five or ten. No definite rule can be laid down concerning the number of amount-scale rulings, but ordinarily they should not exceed five.

## POSITION AND LABELING OF SCALES

The position of the amount scale is to the left of the grid, close to and exactly opposite the scale rulings. In wide charts covering a large number of plottings the scale may be repeated at the right of the grid.

The amount-scale unit, if rounded, should be lettered under the title. It should specify not only the size of the unit, but what it represents, as "Millions of dollars," "Thousands of men," etc. If this is done, the caption over the scale can be shortened to a single word, "Millions" or "Thousands," a considerable advantage in drafting, as space for scale captions is usually limited.

Scale labels should not be lettered vertically at the left or right of the scale column. All lettering should be easily read without turning the chart sidewise.

If monthly series extend over a year, the end of each year should be indicated by a heavier vertical rule or by the symbol 1 between December and January. Both methods are shown in Chart 3.

## SCALE RULINGS

The number of scale rulings for time and amount scales depends on the nature and distribution of the data and the shape and dimensions of the grid. The extremes in practice range from too little to too much. Chart 5 shows an example of too much. The multiplicity of rules clut-



TABLE I

ROOT-TWO DIMENSIONS

<i>Short Side</i>	<i>Long Side</i>	<i>Short Side</i>	<i>Long Side</i>	<i>Short Side</i>	<i>Long Side</i>	<i>Short Side</i>	<i>Long Side</i>	<i>Short Side</i>	<i>Long Side</i>	<i>Short Side</i>	<i>Long Side</i>
1.0	1.4	4.5	6.4	8.0	11.3	11.5	16.3	15.0	21.2	18.5	26.1
1.1	1.6	4.6	6.5	8.1	11.5	11.6	16.4	15.1	21.4	18.6	26.3
1.2	1.7	4.7	6.7	8.2	11.6	11.7	16.5	15.2	21.5	18.7	26.5
1.3	1.8	4.8	6.8	8.3	11.7	11.8	16.7	15.3	21.6	18.8	26.6
1.4	2.0	4.9	6.9	8.4	11.9	11.9	16.8	15.4	21.8	18.9	26.7
1.5	2.1	5.0	7.1	8.5	12.0	12.0	17.0	15.5	21.9	19.0	26.9
1.6	2.3	5.1	7.2	8.6	12.2	12.1	17.1	15.6	22.0	19.1	27.0
1.7	2.4	5.2	7.4	8.7	12.3	12.2	17.3	15.7	22.2	19.2	27.1
1.8	2.6	5.3	7.5	8.8	12.4	12.3	17.4	15.8	22.4	19.3	27.3
1.9	2.7	5.4	7.6	8.9	12.6	12.4	17.5	15.9	22.5	19.4	27.5
2.0	2.8	5.5	7.8	9.0	12.7	12.5	17.7	16.0	22.6	19.5	27.6
2.1	3.0	5.6	7.9	9.1	12.9	12.6	17.8	16.1	22.7	19.6	27.7
2.2	3.1	5.7	8.1	9.2	13.0	12.7	17.9	16.2	22.9	19.7	27.9
2.3	3.2	5.8	8.2	9.3	13.2	12.8	18.1	16.3	23.0	19.8	28.0
2.4	3.4	5.9	8.3	9.4	13.3	12.9	18.2	16.4	23.2	19.9	28.1
2.5	3.5	6.0	8.5	9.5	13.4	13.0	18.4	16.5	23.3	20.0	28.3
2.6	3.7	6.1	8.6	9.6	13.5	13.1	18.5	16.6	23.5	20.1	28.4
2.7	3.8	6.2	8.8	9.7	13.7	13.2	18.7	16.7	23.6	20.2	28.5
2.8	4.0	6.3	8.9	9.8	13.9	13.3	18.8	16.8	23.7	20.3	28.6
2.9	4.1	6.4	9.1	9.9	14.0	13.4	18.9	16.9	23.9	20.4	28.8
3.0	4.2	6.5	9.2	10.0	14.1	13.5	19.1	17.0	24.0	20.5	29.0
3.1	4.4	6.6	9.3	10.1	14.3	13.6	19.2	17.1	24.1	20.6	29.1
3.2	4.5	6.7	9.5	10.2	14.4	13.7	19.4	17.2	24.3	20.7	29.3
3.3	4.7	6.8	9.6	10.3	14.6	13.8	19.6	17.3	24.5	20.8	29.5
3.4	4.8	6.9	9.8	10.4	14.7	13.9	19.8	17.4	24.6	20.9	29.6
3.5	4.9	7.0	9.9	10.5	14.8	14.0	19.9	17.5	24.7	21.0	29.7
3.6	5.1	7.1	10.0	10.6	15.0	14.1	20.0	17.6	24.9	21.1	29.9
3.7	5.2	7.2	10.2	10.7	15.1	14.2	20.1	17.7	25.0	21.2	30.0
3.8	5.4	7.3	10.3	10.8	15.3	14.3	20.2	17.8	25.2	21.3	30.1
3.9	5.5	7.4	10.5	10.9	15.4	14.4	20.4	17.9	25.3	21.4	30.2
4.0	5.7	7.5	10.6	11.0	15.6	14.5	20.5	18.0	25.5	21.5	30.4
4.1	5.8	7.6	10.8	11.1	15.7	14.6	20.6	18.1	25.6	21.6	30.5
4.2	5.9	7.7	10.9	11.2	15.8	14.7	20.7	18.2	25.7	21.7	30.6
4.3	6.1	7.8	11.0	11.3	16.0	14.8	20.9	18.3	25.9	21.8	30.8
4.4	6.2	7.9	11.2	11.4	16.1	14.9	21.0	18.4	26.0	21.9	31.0



ters up the chart unnecessarily and obstructs rather than facilitates reading the curve.

Chart 6 shows the same curve on a grid in which the vertical and horizontal rulings are replaced by ticks. Those who favor this method hold that all ruling extending through the field of the grid detracts from the graphic effect of the curve. Against this view is the objection that the curves appear suspended in the air, separated from the scales so far that only a rough approximation of the amount value of any given plotting point can be made. The same difficulty is encountered in identifying a point in the curve with the corresponding time unit below it.

A compromise which has the sanction of generally accepted practice is shown in Chart 7. The ruling for the time scale is inserted at quarterly periods, with the intervening months indicated by ticks. The amount scale is ruled at intervals of twenty, with ticks representing units of five. The grid field is fairly clear, and the identification of any point in the curve with the corresponding amount or date presents little difficulty.

**CURVE PATTERNS**

Chart 8 shows some of the types of curve patterns that are in common use. The simpler designs are more economical from the point of view of the time consumed in the drafting and are generally the most effective, particularly in charts where the curves are close together. If the number of curves does not exceed three, marked contrast in the

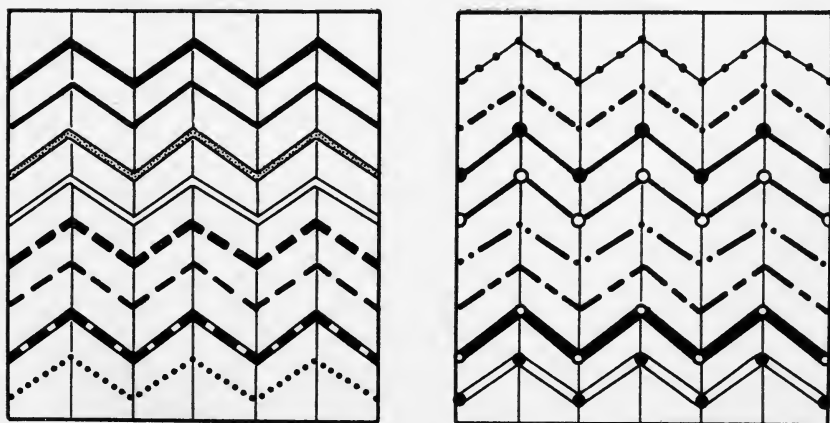


CHART 8. CURVE PATTERNS.

patterns selected is unnecessary. The usual practice is to employ a solid curve for the most important item, a dash curve for the next in order of importance, and dots for the third. Although somewhat less striking, different weights of solid curves may be used. On large display charts the curves may be fashioned of narrow strips of color. The strips are cut from the adhesive color sheets and pasted on the illustration board to form the line of the curve. Irregular curves should be lighter than smooth ones.

Usually one of the curves in multicurve charts is of special significance. This should be plotted in a pattern that will stand out clearly from the others. For this purpose the line-and-dot and the ball-and-line types are very effective.

### OMISSION OF ZERO BASE

An important rule in the drafting of curve charts is that the amount scale should begin at zero. In comparisons of size the omission of the zero base, unless clearly indicated, is likely to give a misleading impression of the relative values and trend. The first chart on the opposite page shows the data plotted on a grid covering the full amount scale. In the second the amount scale under the lowest point of the curve is omitted. The third represents the generally approved method for indicating the omission of the zero base. Another form commonly used consists merely of a wavy line similar to the one at the bottom of the plotting field in the third chart. A light straight line with wavy sections at each end is sometimes used for this purpose. Whatever the device, it should clearly remind the observer that the full scale is not shown.

Whether to include the full scale or omit part of it depends on the nature of the data. Fluctuations in the curve may occur within a limited range only. Changes in prices of bonds are an example. Against the par value of \$100, the price variation within a normal year may amount to only a few dollars. These small changes are important to investors, but if the whole scale from zero to 100 is included, they will be scarcely visible in the curve.

### 100 PERCENT BASE IN INDEX-NUMBER CHARTS

Exceptions to the zero-base rule are admissible in index-number curve charts, where the relation of the curves is to 100 rather than zero. The usual practice is to omit the zero base in such charts without the

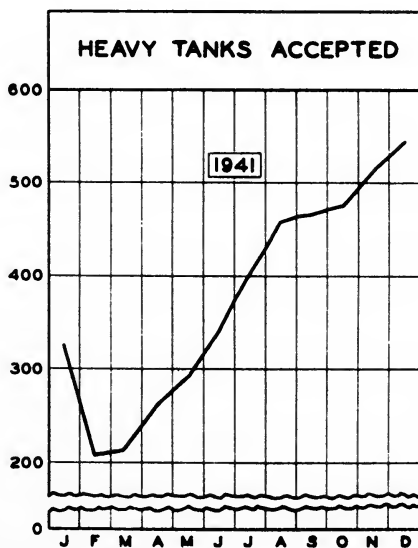
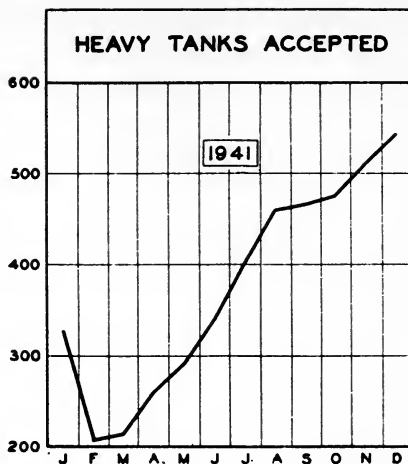
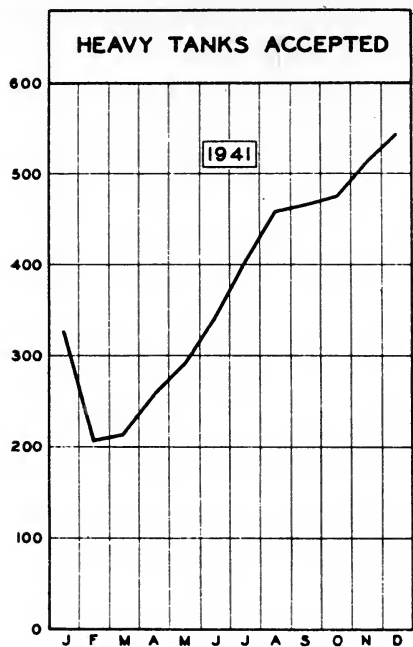
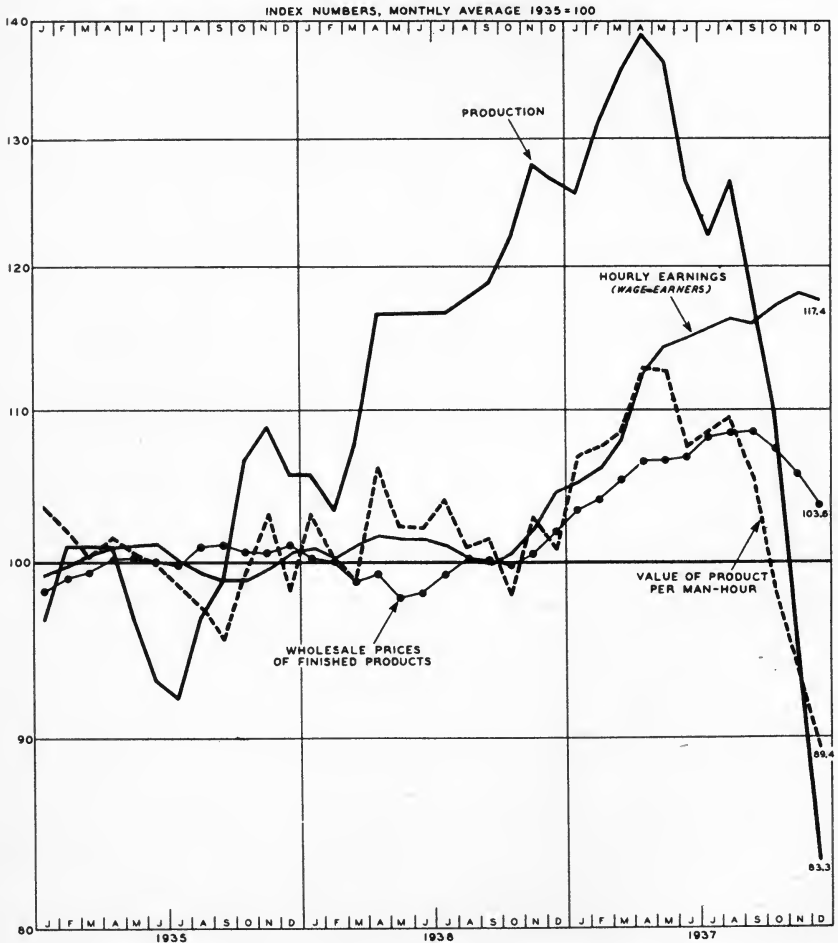


CHART 9. OMISSION OF ZERO BASE. FROM *Manual of Statistics*, WAR DEPARTMENT, SOS.

reminder of a break in the scale. Instead, the 100 percent line is made heavier than the other horizontal lines, as illustrated in Chart 10, to indicate that the curves are to be interpreted with relation to this base.

A further reason for omitting the lower part of the amount scale in this chart was to gain space for the curve plotting. Had the full scale

### WAGES, PRICES, AND PRODUCTION MANUFACTURING INDUSTRY, 1935, 1936, 1937



National Industrial Conference Board

CHART 10.

been included, the curves would have been brought too close together for easy reading and comparison. The number of curves that can be shown effectively in a single chart, if they are very irregular or cross each other, is generally limited to three or at most four. But if the scale outside the plotting field is omitted, thereby increasing the separation between the curves, a fairly clear presentation of a larger number is possible.

BREAK IN TIME SCALE

Sometimes monthly time series start from a date several years subsequent to the period with which they are compared. In such cases lack of space may make it advisable to omit part of the intervening time units. In Chart 11 index numbers of retail prices for fruits and vegetables and for all foods during the last two war years are compared with the monthly average in 1939. To have included all the monthly data

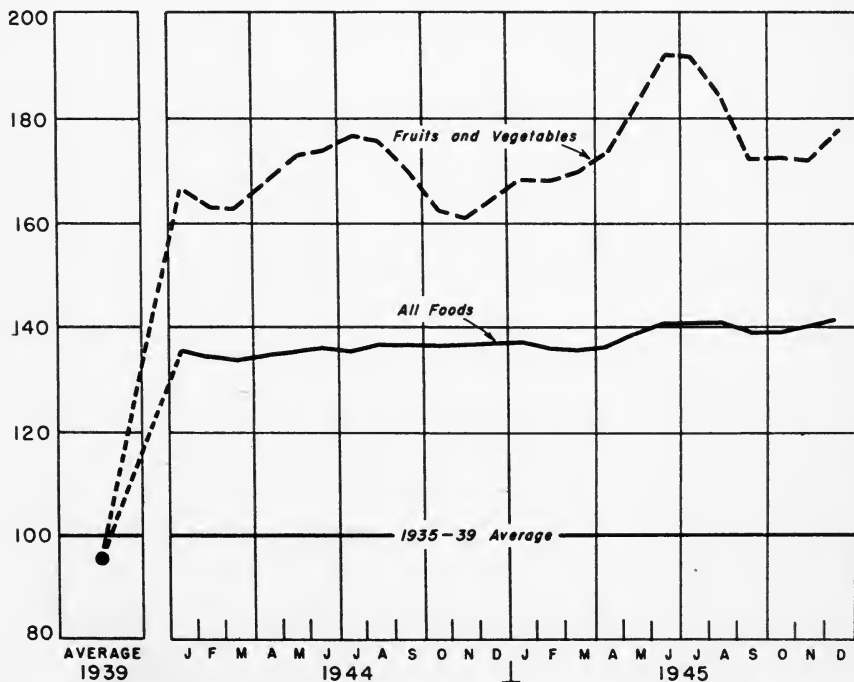


CHART 11. RETAIL COST OF FOOD: 1939, 1944, AND 1945.

for the intervening four years would have made the chart too crowded. The monthly average in 1939 is connected with the plotting for the first month in 1944 by dash lines crossing the break in the time scale.

If there is a gap in a series for the reason that the data are not available, a break in the curve is necessary. The usual practice is to fill in the break with a light dotted line labeled "Data not available," or it may be footnoted, in which case the footnote symbol should be placed closely above or below the dotted line.

### FITTING CURVES TO GAIN SPACE

When it is necessary to present a large number of series on one chart the curves may be "fitted" by the method illustrated in Chart 12. This method is feasible where the curves represent index-number series in which the base for all of them is the same. This is indicated in the example by the figure 100 at the first plotting point of each series. The spaces between the horizontal rulings are equal to ten points of the index.

This chart was reduced from an original printed on a standard 8½-by-11-inch sheet. Twelve series were fitted within this space. If drafted separately, each with its individual amount scale, they would have required many times the space, without the advantage of close comparison secured by this method.

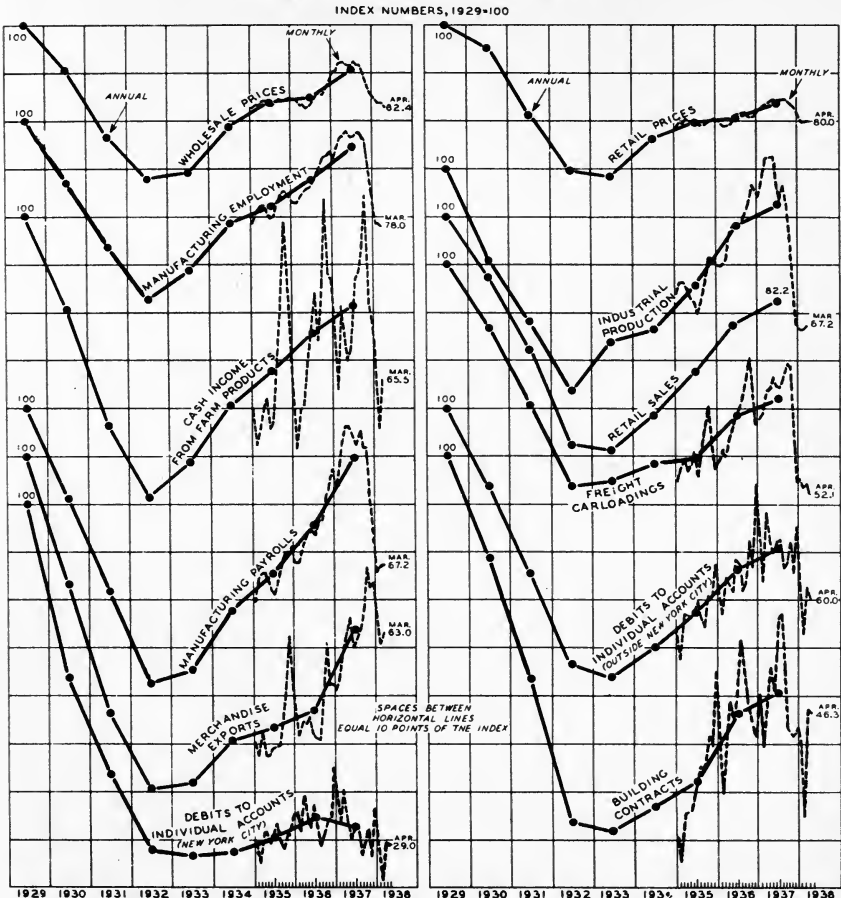
Another feature of interest in this chart is the combination of yearly and monthly plotting. For the first six years the ball-and-line pattern is used for the yearly averages. This is continued through the following years, but with the addition of monthly data plotted in light dash curves. In this manner the monthly record is kept up to date until the end of the year, when the twelve-month average is added.

Lettering the last figure at the end of the curve aids in showing the exact current status, which often is the point of chief interest to the observer. It is of special advantage to those who customarily think in terms of figures or who do not readily interpret charted statistical data. In nearly all curve charts that picture extensive economic series it is advisable to label the high, the low, and the end points of the curve.

Lettering of titles following the course of each curve is imposed in this chart by the close fitting. If there is sufficient space, titles should



# DEPRESSION, RECOVERY, DEPRESSION UNITED STATES, 1929 - 1938



National Industrial Conference Board

CHART 12.

be lettered horizontally. If title and curve are widely separated, a connecting arrow should be drawn between them.

## OMISSION OF TIME-SCALE RULING ABOVE CURVES

In single-curve charts the time-scale ruling above the curve is often omitted. The employment of this method in charts containing a number

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of curves of approximately equal significance, as illustrated in Chart 13 is sometimes criticized on the ground that the lack of ruling in the upper part of the chart tends to emphasize the importance of the highest curve.

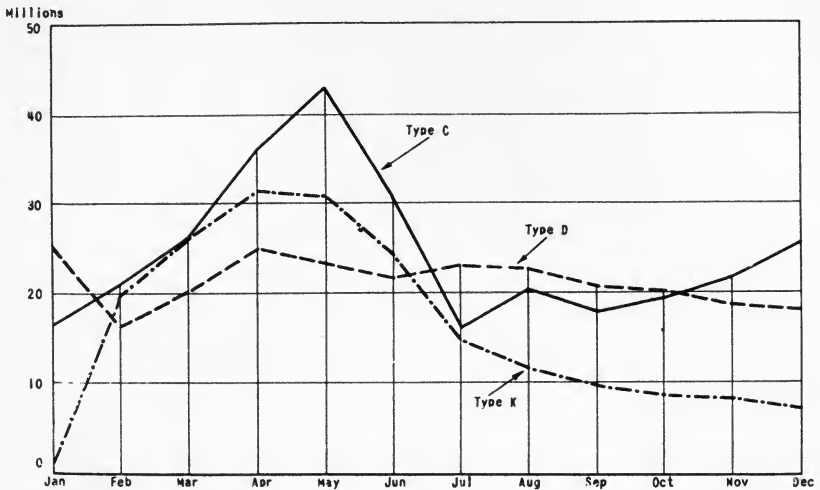


CHART 13. STOCKS OF C, D, AND K EMERGENCY RATIONS: 1943 (MILLIONS OF RATIONS). FROM *Statistical Handbook*, QUARTERMASTER CORPS.

## PLOTTING POINTS

The data may be plotted on the vertical time-scale lines or centered in the spaces between them. Plotting to the line is generally preferred. The observer tends to read a curve where it crosses a line. Also, in plot-to-space charts ruled at wide intervals it is difficult to identify the plotting with the corresponding time unit at points where the angle of the curve does not change.

Plot-to-space should be used if the series contains differing time units (such as end of the month and middle of the month) or if the data are reported at irregular intervals.

Chart 14 shows both methods. The plot-to-space chart is ruled in quarterly subdivisions. The plot-to-line chart, having only eleven spaces, cannot be subdivided in this manner, as one of the quarters will be narrower than the other three. Plot-to-space must be used if quarterly or semiannual subdivisions are to be shown.

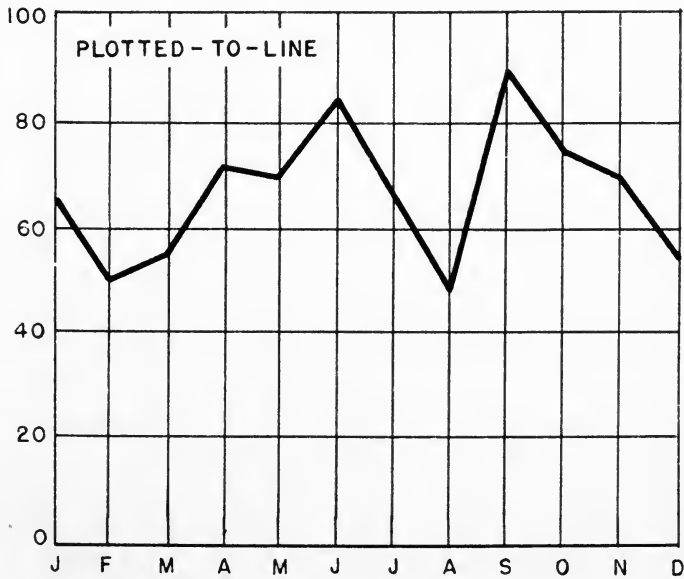
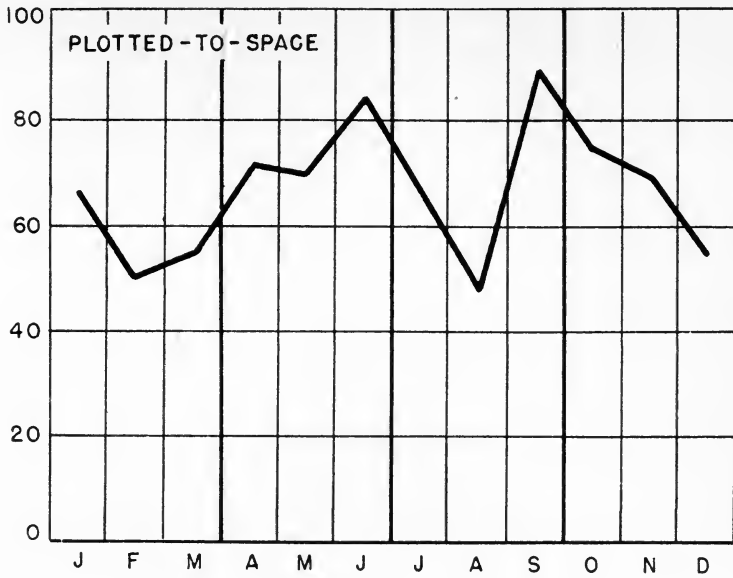
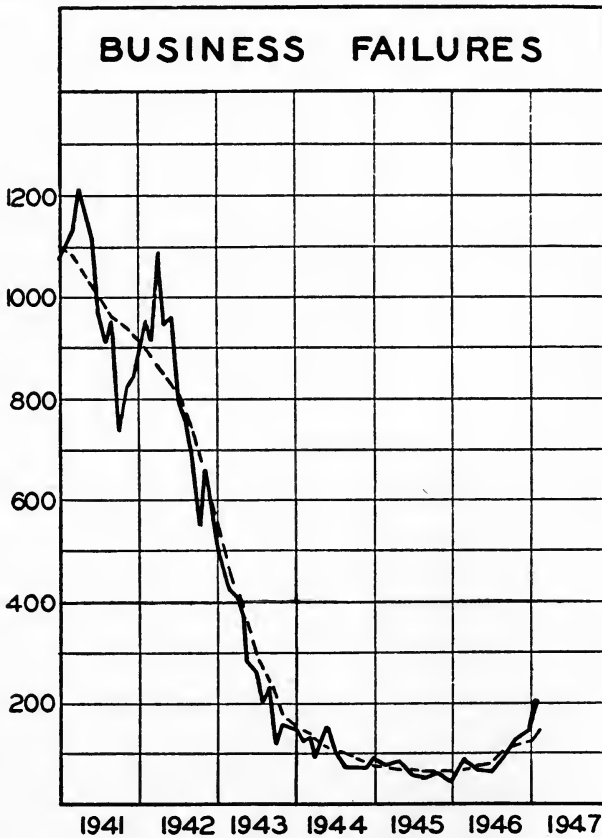


CHART 14. PLOTTING TO SPACE OR LINE.

## MOVING-AVERAGE CURVES

In Chart 15 the dash line represents a moving average of the monthly data. Moving-average curves are frequently added to indicate the approximate general trend, which is otherwise difficult to determine because of the irregular individual plottings. The solid curve in this chart shows the number of failures by months. The dash curve is the average, at successive entries, of the last twelve months. This average was recomputed each month by dropping the amount for the first month of the preceding twelve-month average and adding the data for the current month.



*Cleveland Trust Company Business Bulletin*

CHART 15.

Chart 16 shows another type of moving average, sometimes called a "progressive average," in which the additional curve represents an average of all the values to the date of each plotting. The amount for each year is averaged with all of the preceding entries. The lower curve represents an average of the placements to the current date.

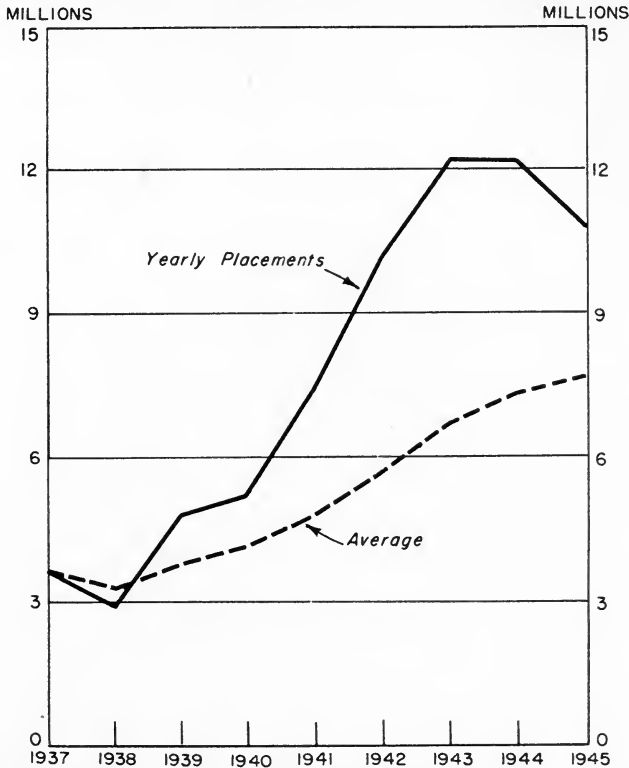


CHART 16. PLACEMENTS BY U.S. EMPLOYMENT SERVICE: 1937 TO 1945.

WEIGHT OF GRID LINES

The grid lines should be lighter than the curves, with the base line somewhat heavier than the others. All vertical lines should be of equal weight, unless the time scale is subdivided in quarters or other time periods, indicated by heavier rules. Very wide base lines, sometimes employed for pictorial effect, distort the graphic impression by making the base line the most prominent feature of the chart.

## BROKEN CURVE

If one curve in a chart of two or more contains a fluctuation so extreme that if plotted to scale it would dwarf the changes in the others, the curve may be broken as shown in Chart 17. When this is done, the point to which the curve would extend if shown in full should be lettered at the place where the break is made.

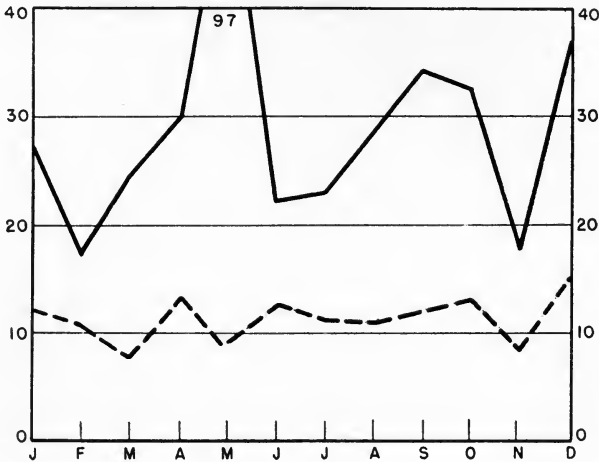


CHART 17. BROKEN CURVE.

## STOCK-PRICE CHARTS

A curve type employed for recording the movement of stock prices is shown in Chart 18. The range of prices is indicated by heavy vertical lines at the various plotting points, extending from the highest to the lowest price at which the stock was sold. The intersecting curve shows the closing price for the day.

Many stock charts include a column chart showing the volume of sales, placed below the price chart.

## CUMULATIVE-CURVE CHARTS

The cumulative-curve type, which is illustrated in Chart 19, is used when the purpose is to show over-all results through an extended period of time. Each plotting represents the sum of all the entries up to date.

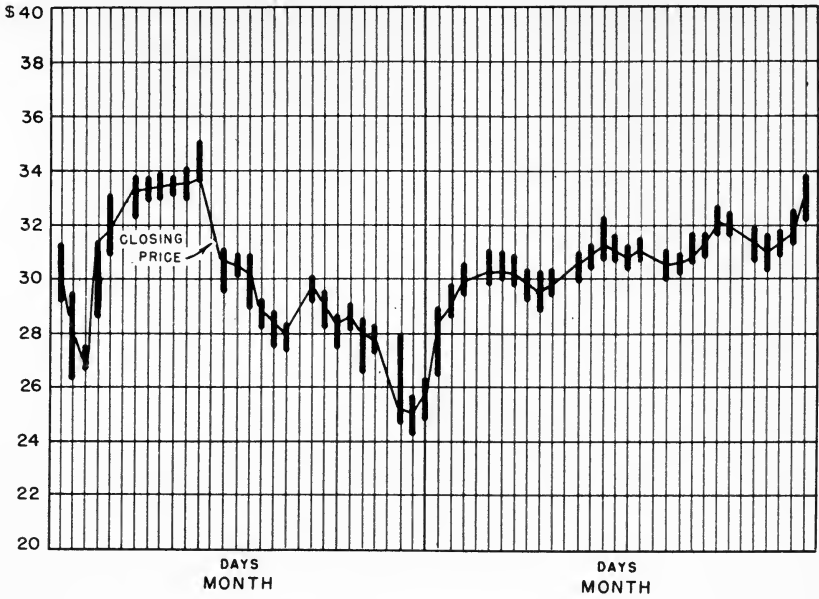


CHART 18. STOCK-PRICE CHART.

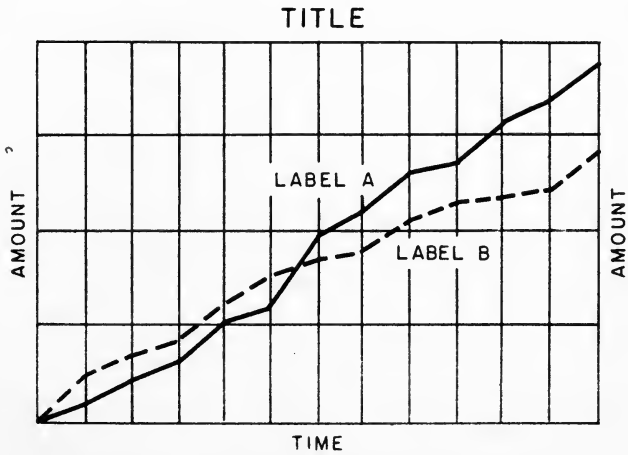


CHART 19. CUMULATIVE-CURVE CHART.

## MULTIPLE-SCALE CHARTS

The use of two or more amount scales for comparisons of series in which the units are unlike and, therefore, not comparable—for example, total wages paid compared with number of wage-earners, physical volume of production with total value of production, prices compared with total sales—generally results in an ineffective and confusing presentation which is difficult to understand and to interpret. Comparisons of this nature can be much more clearly shown by reducing the components to a comparable basis as percentages or index numbers.

## MULTIPLE-TIME-SCALE CHARTS

This type, which is illustrated in Chart 20, is employed frequently for comparisons of monthly data by years. The time scale, in months, is lettered below the grid. The curves represent the years included in the comparison.

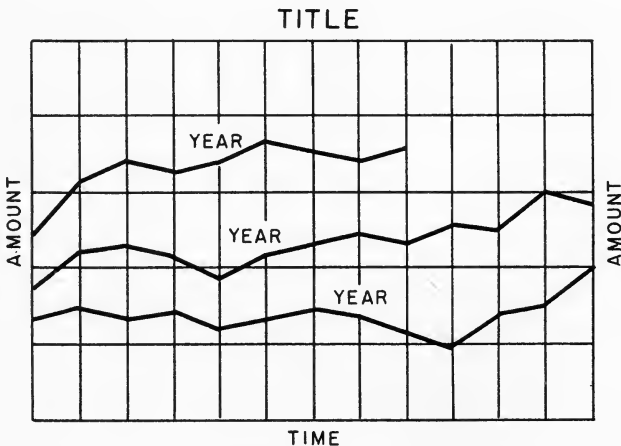


CHART 20. MULTIPLE-TIME-SCALE CHART.

## STAIRCASE-CURVE CHARTS

The staircase-curve designation is applied to a type in which horizontal and vertical lines are substituted for slope curves. Chart 21 is an example. The employment of this form of curve is generally limited to



charts of a single series. With two or more series the vertical lines of the curves frequently overlap.

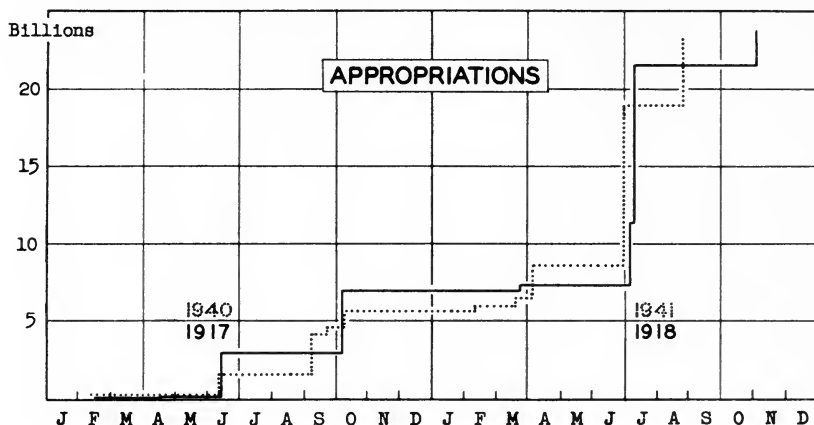


CHART 21. WAR APPROPRIATIONS: 1917-18 AND 1940-41. FROM *Manual of Statistics*, WAR DEPARTMENT, SOS.

KEYS

Keys for the identification of the curves in multicurve charts are seldom used or needed. Usually there is room to label the curves individually, without recourse to the key method of identification. The character and meaning of each curve should be instantly apparent. The use of keys hinders unnecessarily rapid reading and interpretation of the chart.



## SURFACE-CURVE CHARTS

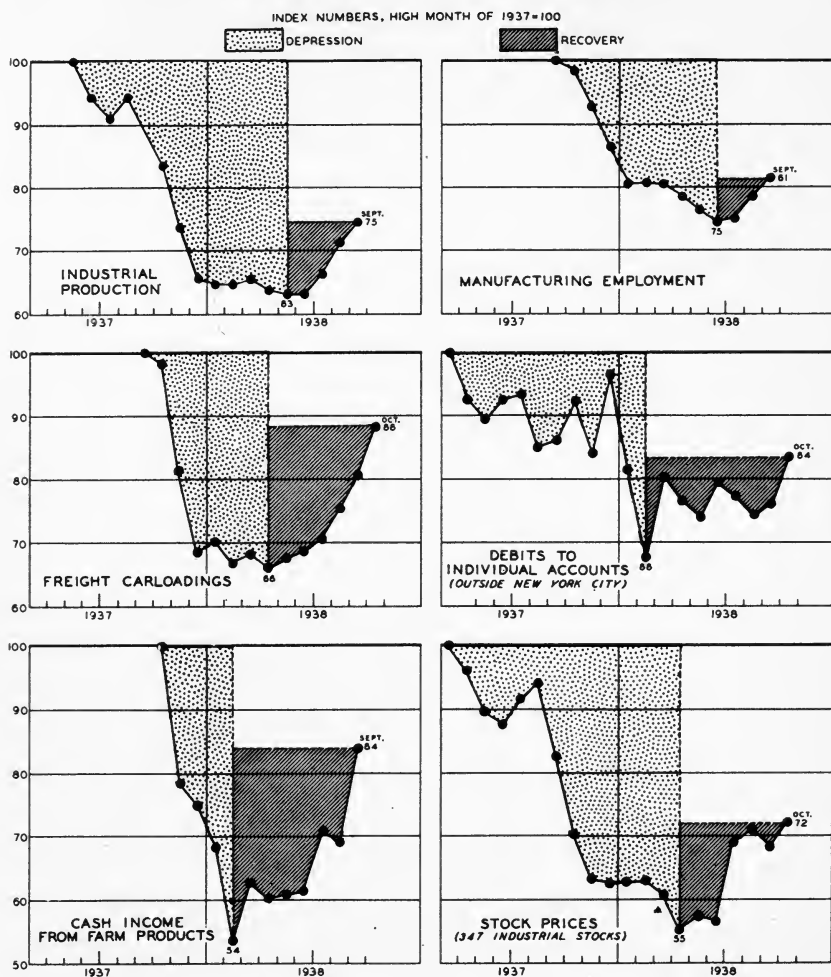
**C**URVE charts can be dressed up by filling in the space between curves with shading or color. If adhesive patterns are used, the extra work required is insignificant in proportion to the improvement in appearance and effectiveness.

### DIFFERENTIATION OF TRENDS BY SHADING

In Chart 22 the curves are supplemented with two patterns of shading. The dotted area extends from the high level reached in 1937 to the lowest point of the downward trend. The following recovery movement, outlined by the curves, is filled in with diagonal shading. The original from which this chart was copied is in color, red denoting depression and blue recovery.

A feature worth noting in this design is the economy of space gained by placing the titles within the grids. Another is the lettering of index figures at the points of greatest interest, which in this case are the turn of the trend and extent of recovery to the last date of the series.

## DEPRESSION AND RECOVERY UNITED STATES, 1937-1938



*National Industrial Conference Board*

CHART 22.

## STRATA CHARTS

The combination of surface with curves is especially effective in multicurve charts of the type shown in Chart 23, sometimes called

“strata” or “band” charts. The width of each band represents the size of the amounts measured from the total of the amount plotted below it. The total curve is made heavier than the curves of the subdivisions.

THOUSANDS

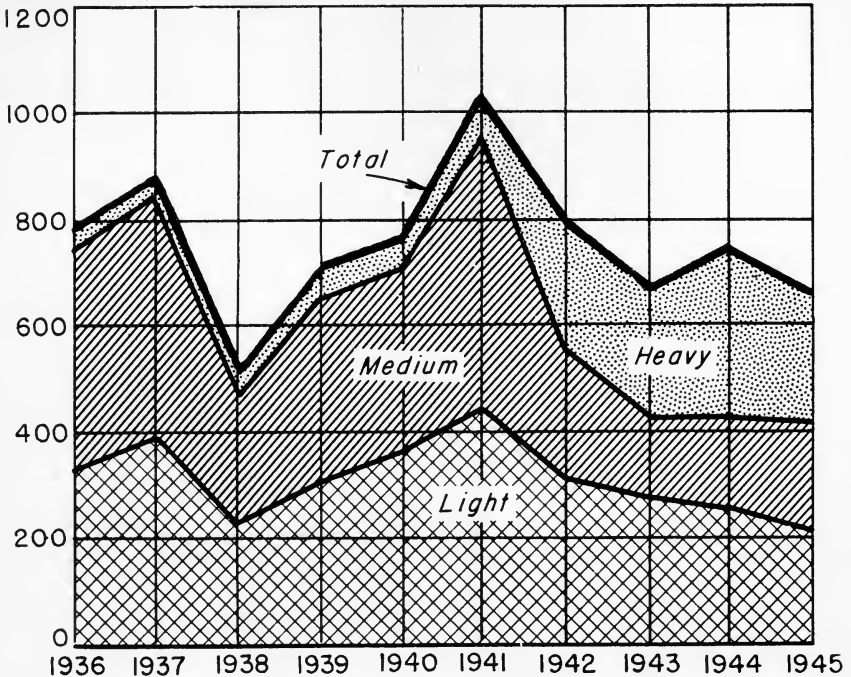


CHART 23. PRODUCTION OF MOTOR TRUCKS AND TRUCK TRACTORS:  
1936 TO 1945.

### DISTORTION PRODUCED BY STEEP CURVES

If a chart contains a number of series which vary widely in individual magnitude, optical distortion may result from the necessarily sharp changes in the angle of the curves. The space between steeply rising or falling curves always appears narrower than the vertical distance between the plotting points. This effect is illustrated in Chart 24, in which the vertical separation of the curves is the same at each plotting point. If the chart includes a number of series, the distortion may be increased by the cumulative irregularity of the curves.

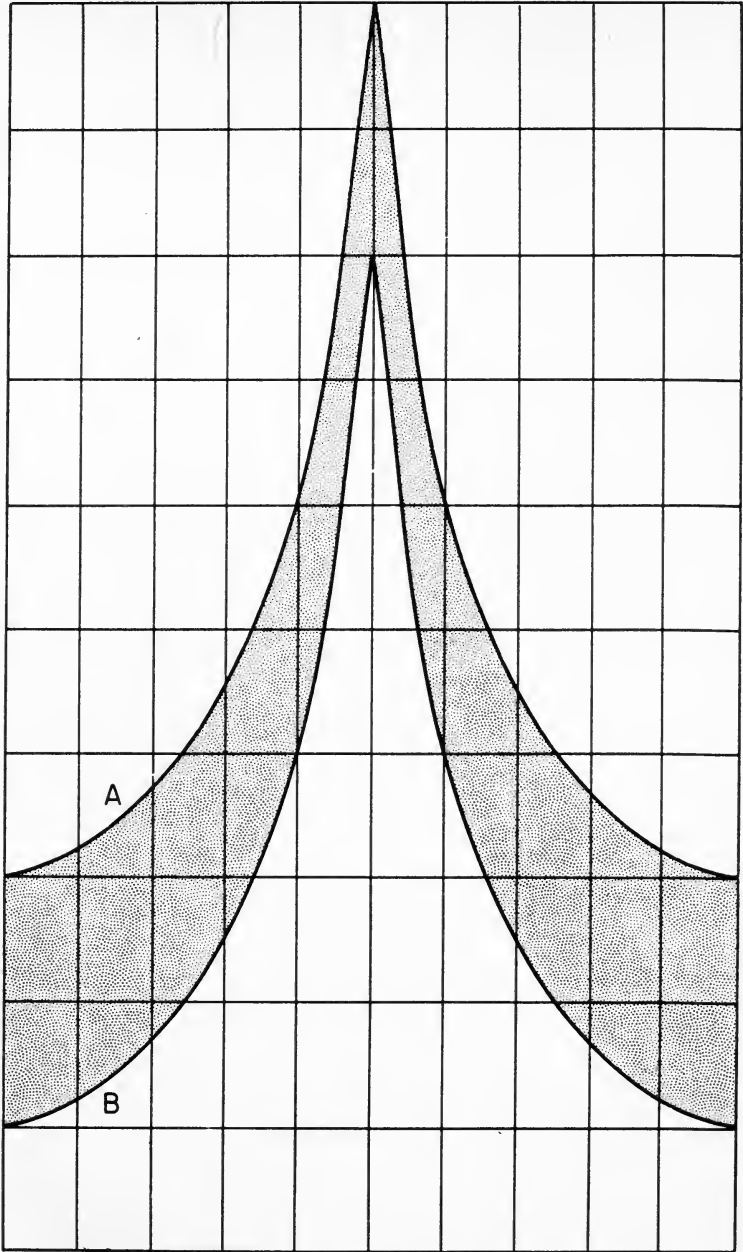


CHART 24. DISTORTION PRODUCED BY STEEP CURVES RISING OR FALLING AT A UNIFORM RATE.

## USE OF SHADING TO SHOW NET RESULTS

Chart 25 illustrates the use of shading to show net differences in trends. The data consist of two series of index numbers covering the period 1939 to 1945, based on 1939 as 100. The upper curve represents an index of average weekly earnings of wage-earners in manufacturing, the lower a consumers' price index of commodities and services bought by families of wage-earners and moderate-income workers in large cities. The net gain in real earnings, after deducting the rise in prices, is indicated by filling in the space between the upper and lower curves with shading.

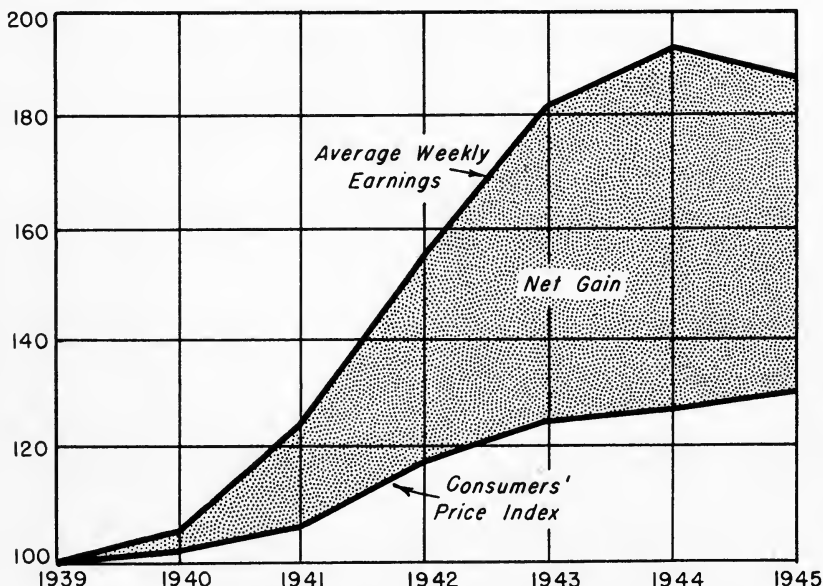


CHART 25. AVERAGE WEEKLY EARNINGS OF WAGE-EARNERS IN MANUFACTURING, AND CONSUMERS' PRICE INDEX: 1939 TO 1945.

## SHADING SIGNIFICANT TIME PERIODS

Shading is sometimes employed to call attention to those periods in the time scale which are of special interest or importance. Two patterns of shading are used for this purpose in Chart 26, in which the curve represents the amount of money in circulation per capita in each year

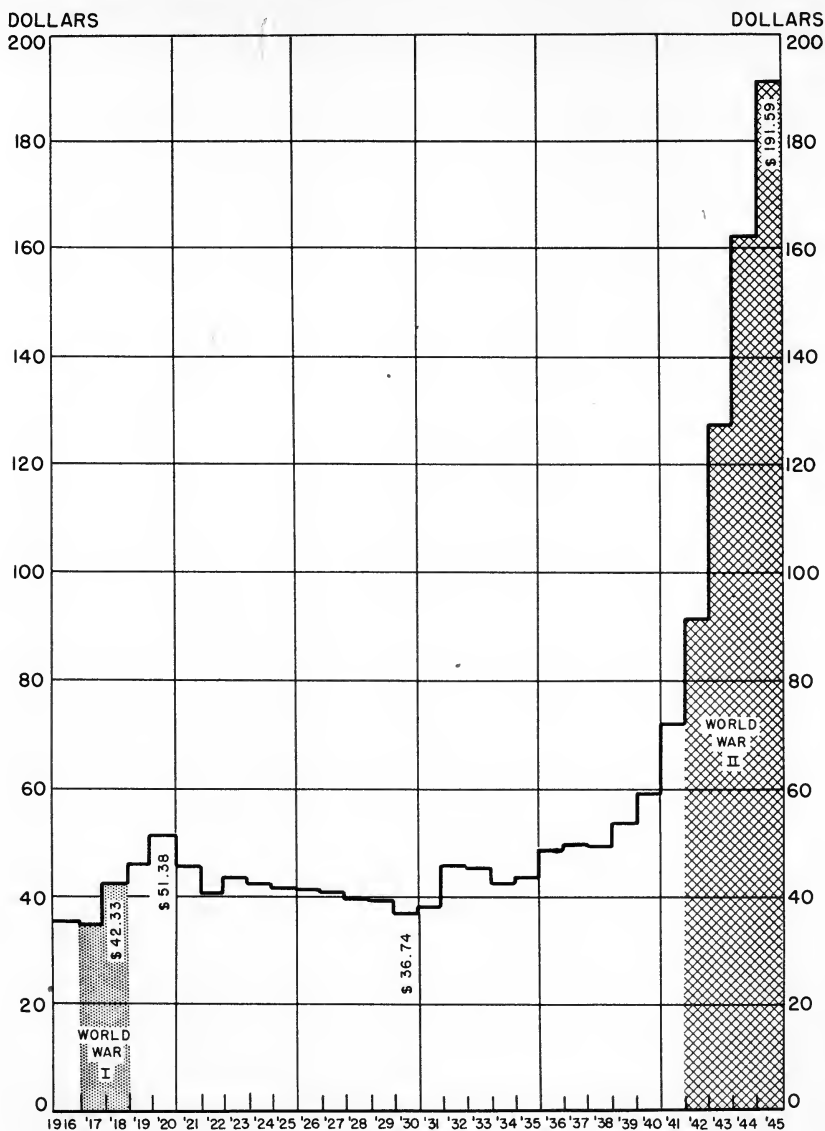


CHART 26. MONEY IN CIRCULATION, UNITED STATES, PER CAPITA: 1916 TO 1945.

from 1916 to 1945. The figures for the end years of the two wars and the high and low of the intervening period are lettered below the curve.

### CONTRASTING NET CHANGES

Different shadings or colors can be employed to contrast net changes where trends cross. The solid curve in Chart 27 represents the number of immigrant aliens admitted in the United States from 1932 to 1945. The departures over the same period are shown by the dash curve. The excess of departures over admissions, or net departures, is indicated by dotted shading. In 1936 the departures and admissions were approximately equal. The cross-hatched area shows the volume of net admissions from that year on.

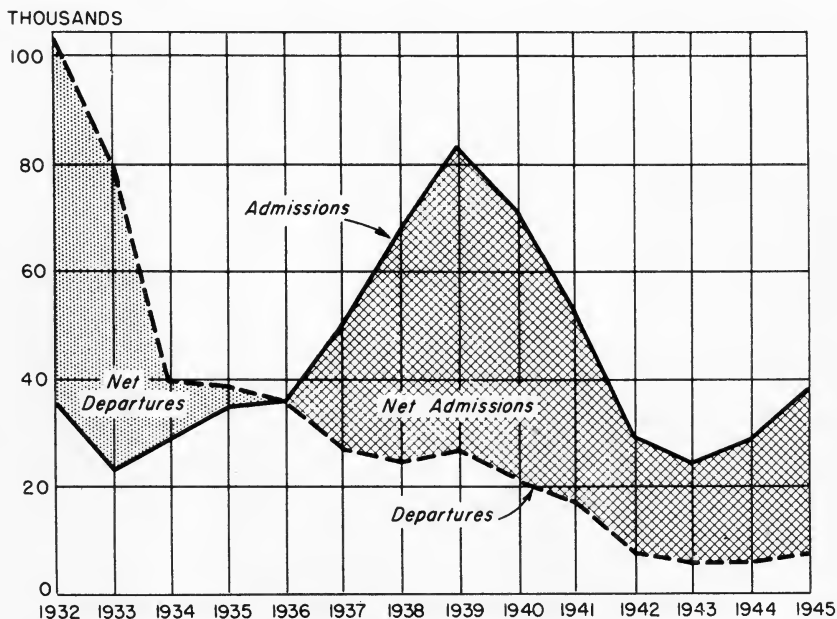


CHART 27. IMMIGRANT ALIENS ADMITTED AND DEPARTED: 1932 TO 1945.

### MINIATURE SURFACE-CURVE CHARTS

Designs of the type illustrated in Chart 28, which involve the combination in a single chart of a considerable number of time-series



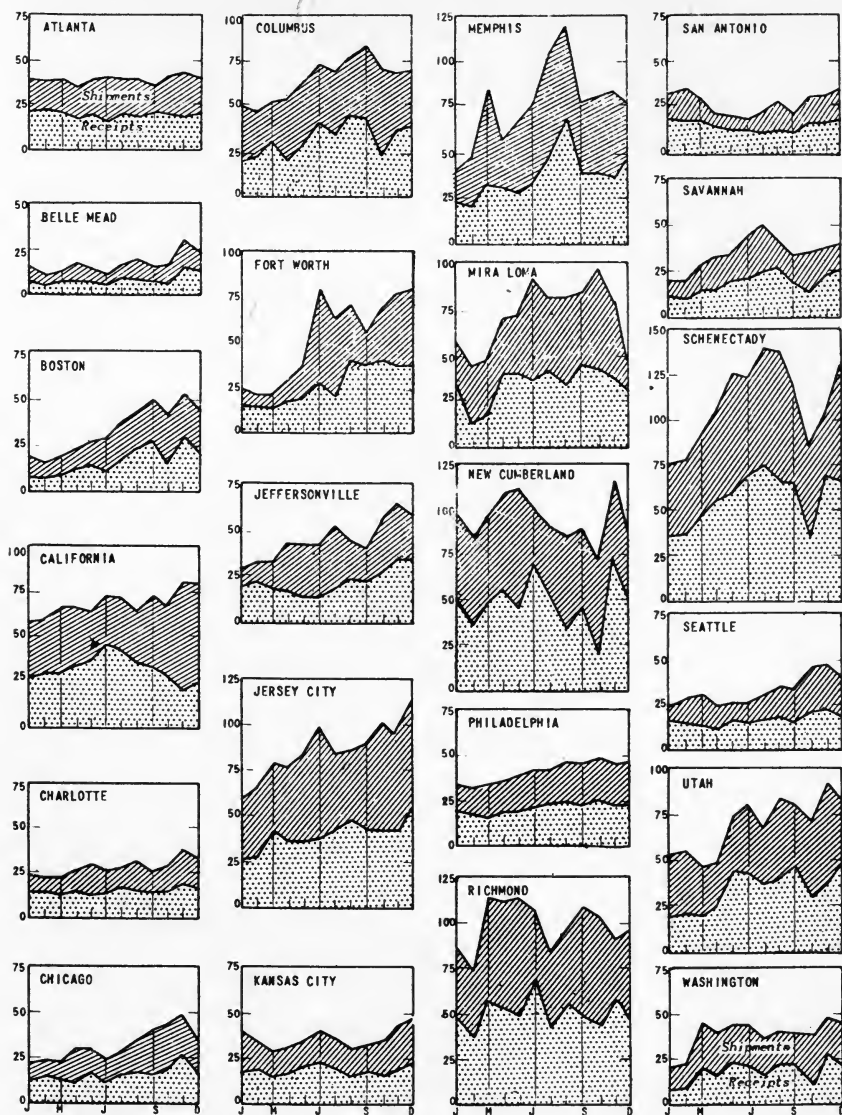


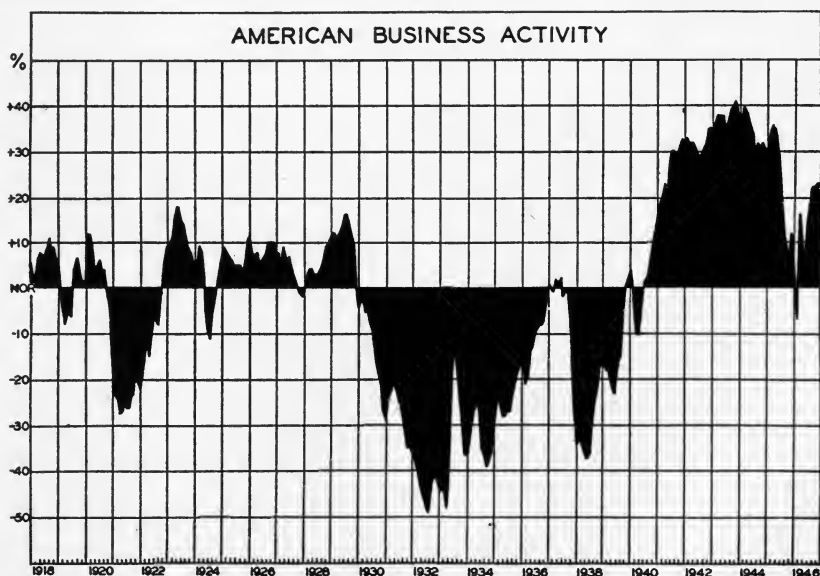
CHART 28. TONNAGE RECEIVED AND SHIPPED BY QMC DEPOTS: 1944 (THOUSANDS OF TONS). FROM *Statistical Yearbook*, QUARTERMASTER CORPS.

miniatures, present somewhat difficult problems in arrangement and lay-out. Of these, the most complicated are the space adjustments that are necessary to make all of the columns the same height and provide for equal spacing between the miniatures while at the same time adhering to a uniform plotting scale. The chart shows the movement of supplies in twenty-two quartermaster depots during the year 1944. The dotted and diagonal shadings represent receipts and shipments respectively.

### LONG-RANGE BUSINESS-ACTIVITY CHARTS

The design shown in Chart 29, "American Business Activity," is frequently employed for picturing economic movements over an extended period of time. The base is a computed normal, designated by the abbreviation "Nor." The curve shows the deviations, in percents, above or below this level.

This type is one of the most effective in presentations of data related to some central point, standard, or level, such as over or below an average, above or under 100 percent, in excess of or less than an estimate or forecast, above or below a given year.

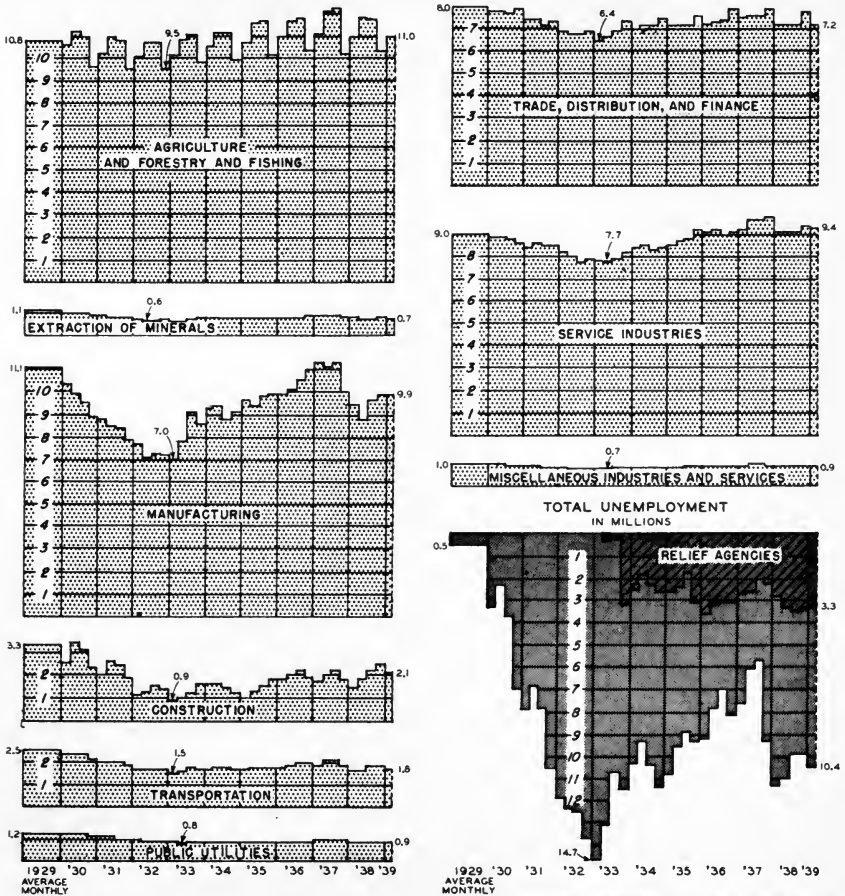


*Cleveland Trust Company Business Bulletin*

CHART 29.

# EMPLOYMENT AND UNEMPLOYMENT UNITED STATES, 1929 - 1939

EMPLOYMENT BY GROUPS  
IN MILLIONS



National Industrial Conference Board

CHART 30.

## SHADED STAIRCASE-CURVE CHARTS

Chart 30 is an example of the use of shading in a staircase-curve design. It presents a large volume of information, compressed by ingenious designing into a small amount of space. Nearly all the lettering is within the plotting field. Two time scales at the bottom of the page are made to serve for all ten charts.

## SHADING VERSUS SOLID BLACK

Chart 31 pictures the fluctuation in aerial activity on the French front during World War I. The use of solid black makes it difficult to identify points in the curve with the corresponding units in the time scale. Light transparent shading is preferable to black for charts in which, as occurs in this example, the variation is extremely wide.

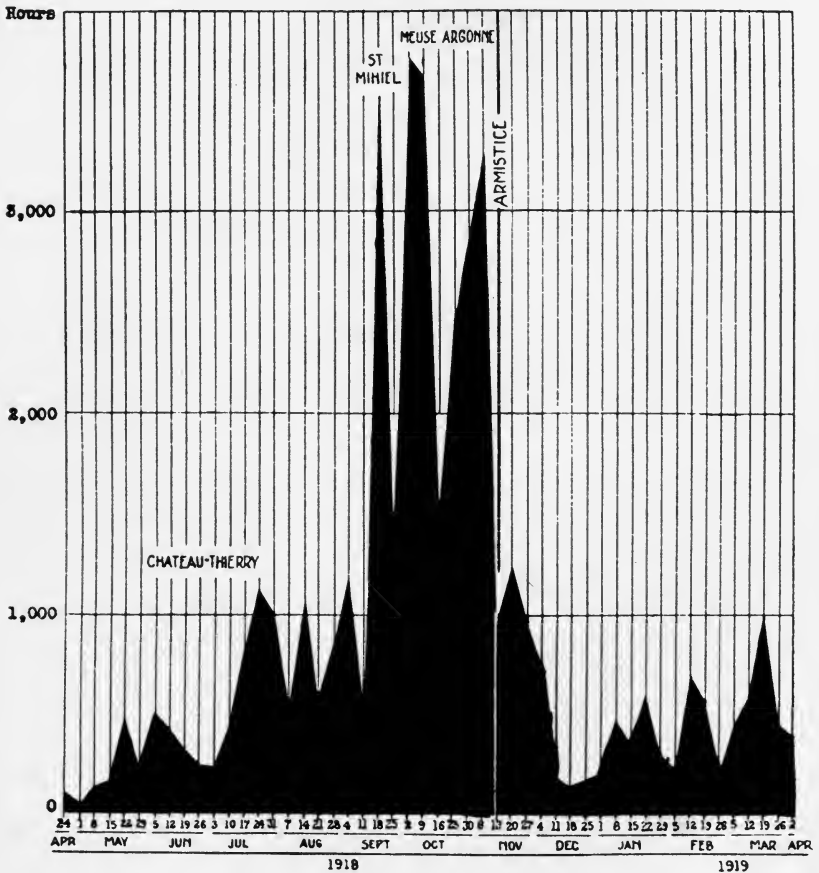
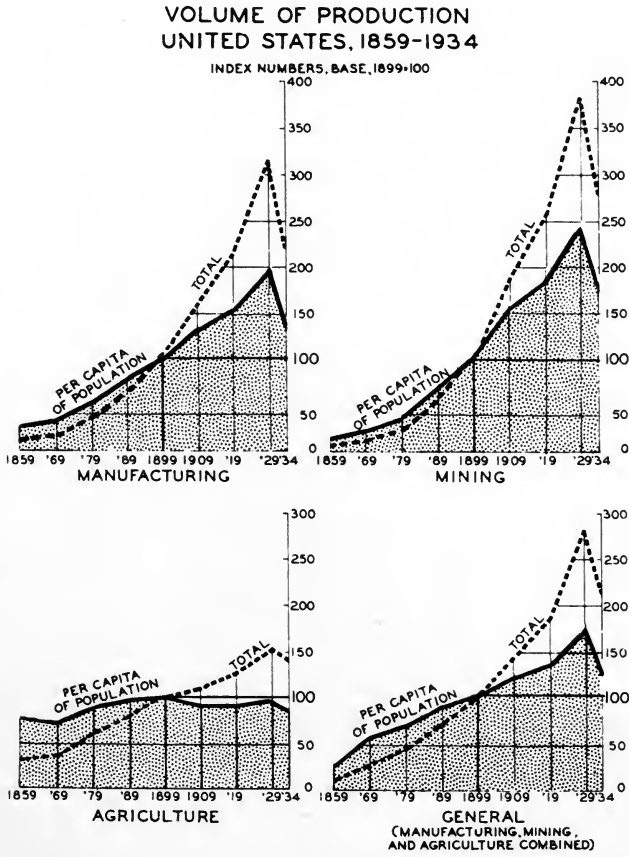


CHART 31. HOURS SPENT IN THE AIR BY AMERICAN SERVICE PLANES AT THE FRENCH FRONT DURING WORLD WAR I. FROM *The War with Germany*, BY LEONARD P. AYRES.

ECONOMY OF SPACE IN DESIGN

Two measures of increase in volume of production in the United States, total and per capita of population, are shown in Chart 32. Effective presentation of a number of charts in limited space is favored by the elimination of all scales and ruling not absolutely necessary, with labels lettered as closely as possible to the curves. If the curves represent marked growth or increase, a single right-hand amount scale is sufficient.



National Industrial Conference Board

CHART 32.

## ■ IV

### RATE-OF-CHANGE CHARTS

**O**THER terms employed to designate rate-of-change charts are “ratio,” “logarithmic,” and “semi-logarithmic.” “Ratio” and “rate-of-change” are most commonly used. The latter has at least the advantage that it is clearly descriptive of what this design purports to show.

#### GRID RULING

Arithmetic and rate-of-change scale rulings are compared in Chart 33. The spaces between the scale rulings in the arithmetic scale are equal. The corresponding spaces in the rate-of-change scale decrease in width with each successive ruling.

The second chart shows an example of a three-cycle rate-of-change grid. The amount scale of the first cycle is 10 to 100; the second, 100 to 1,000; and the third, 1,000 to 10,000. If a fourth cycle were required, the scale would be 10,000 to 100,000, and if a fifth, 100,000 to 1,000,000. In multicycle charts the amount scale in each succeeding cycle is ten

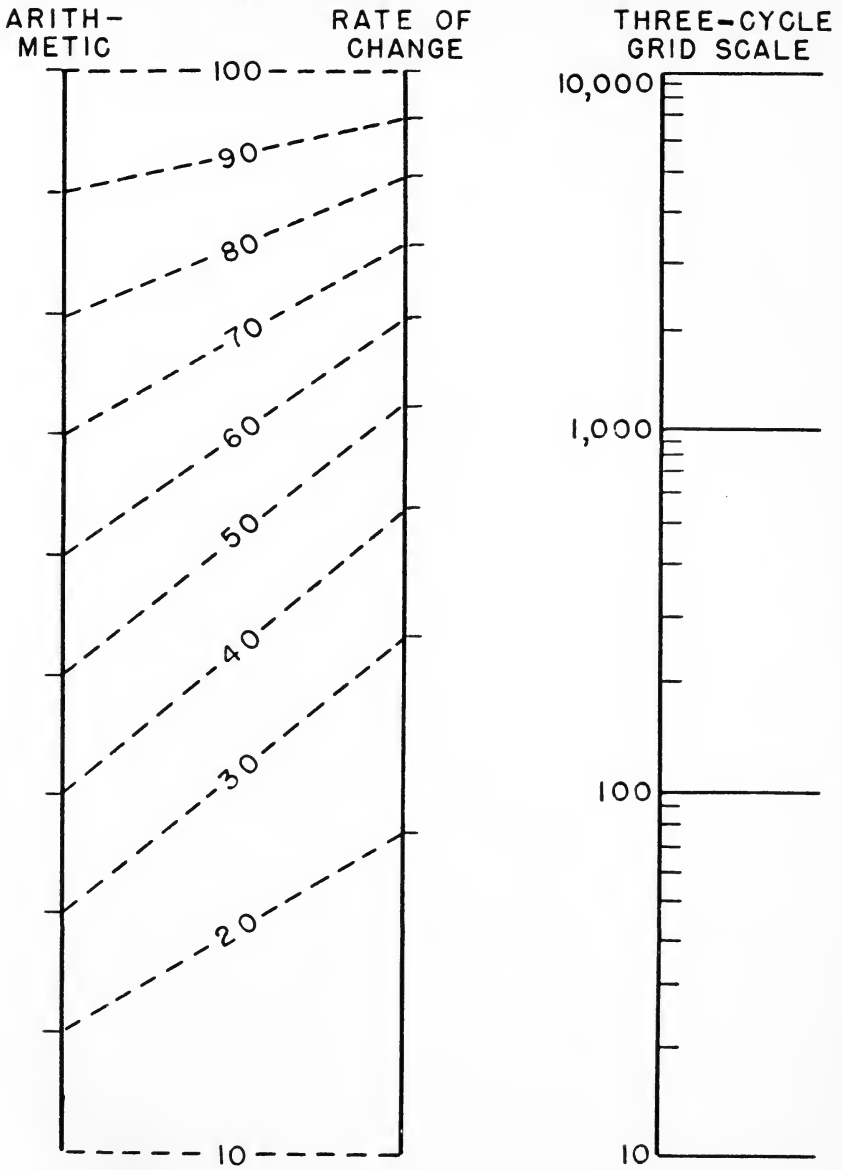


CHART 33. ARITHMETIC AND RATE-OF-CHANGE SCALES.

times the scale in the next cycle below it. The number of cycles required depends on the size of the component figures. As the rate-of-change design has no zero base, the bottom line is not, as in arithmetic charts, made heavier than the other lines of the grid.

#### OMISSION OF SCALE RULINGS

If space for the chart is limited, any part of the scale above or below the curve may be omitted. In Chart 34 the series covers a range of 400 to 748. The scale begins at 400 and ends at 800. To have included in the scale the full cycle from 100 to 1,000 would have made the chart over three times larger.

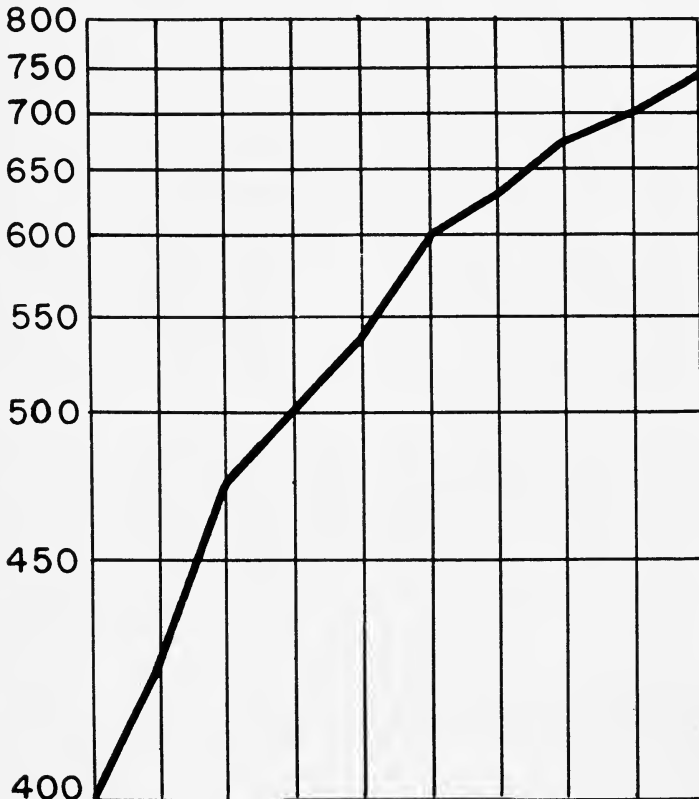


CHART 34. TOP AND BOTTOM OF CYCLE OMITTED.



RATE-OF-CHANGE VERSUS INDEX NUMBERS

In Chart 35 the rate-of-change method for picturing rates of increase is compared with index numbers. The series represent the populations of Puerto Rico and Hawaii in the census years 1930 and 1940, with estimates by the Census Bureau for the intervening period. Reduced to thousands, the figures for Puerto Rico were 1,552 in 1930 and 1,877 in 1940, and for Hawaii 368 and 426 in the same years. The first chart shows the data plotted on a rate-of-change grid. The difference in the slope of the curves is so slight that it is not clear which represents the higher rate of growth. The wide separation of the curves increases the difficulty of the comparison.

The second chart shows the two series converted to index numbers, the base, 100, representing the population in 1930. In this form the comparison is much clearer and more easily understood. It shows not only which had the higher rate in growth of population, but also facilitates close reading of the difference in rates of increase.

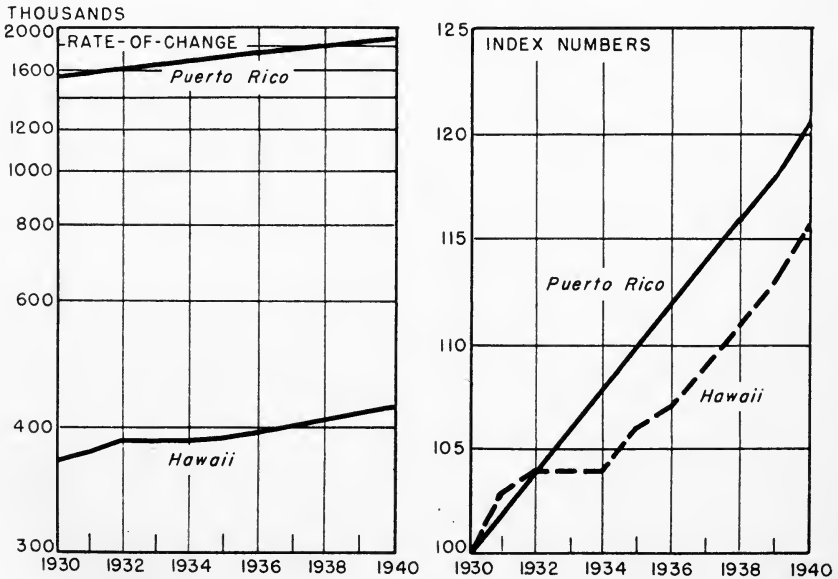


CHART 35. GROWTH OF POPULATION, PUERTO RICO AND HAWAII: 1930 TO 1940.

## METHODS FOR LAYING OUT GRIDS

A simple method for laying out the grids for small rate-of-change charts is illustrated in Chart 36. After determining the vertical dimension of the grid, secure a sheet of printed logarithmic paper on which the cycles are somewhat larger than this dimension. Place the printed cycle diagonally across the allotted vertical space and note the points for the ruling. If the series extends into numbers requiring more than one cycle, the others will duplicate the ruling of the first one.

Grids up to six inches in height can be laid out from the scale in Chart 37. A piece of paper the length of the vertical dimension is placed over the scale and moved to the left until the same dimension is reached. The lines of the scale indicate the plotting points for the grid. Grids of display size can be laid out by extending the lines in Chart 37 on a larger sheet of paper.

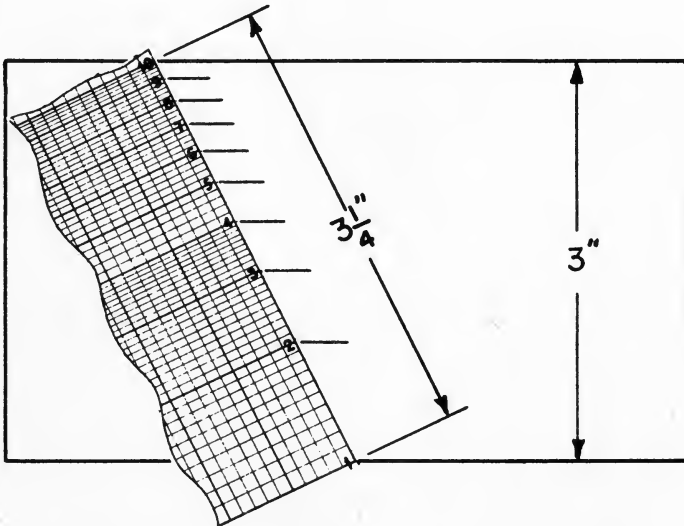


CHART 36. METHOD FOR LAYING OUT RATE-OF-CHANGE GRIDS WITH LOGARITHMIC PAPER.

## EXPLANATORY NOTE

To a great many persons the difference between arithmetic and loga-

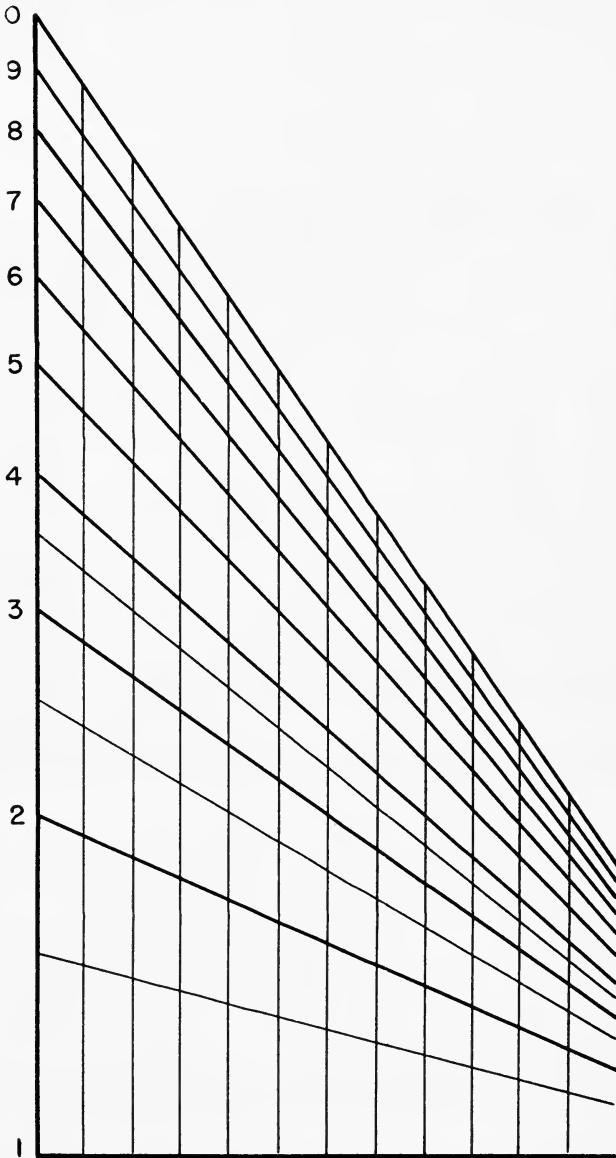


CHART 37. SCALE FOR LAYING OUT RATE-OF-CHANGE GRIDS.

rithmic scale rulings is puzzling and confusing, particularly where both types appear in the same chart. In order to prevent any possibility of misunderstanding it is advisable to include in rate-of-change charts a note, preferably lettered within the grid, that will inform the reader that the relation between plotting points represents ratios of change, increase or decrease, rather than differences in size or amounts. A form sometimes used for this purpose in charts of this type is: "The scale focuses attention on rate of increase," or "decline," "loss," "growth," or "change."

### UNITS VARYING IN SIZE AND KIND

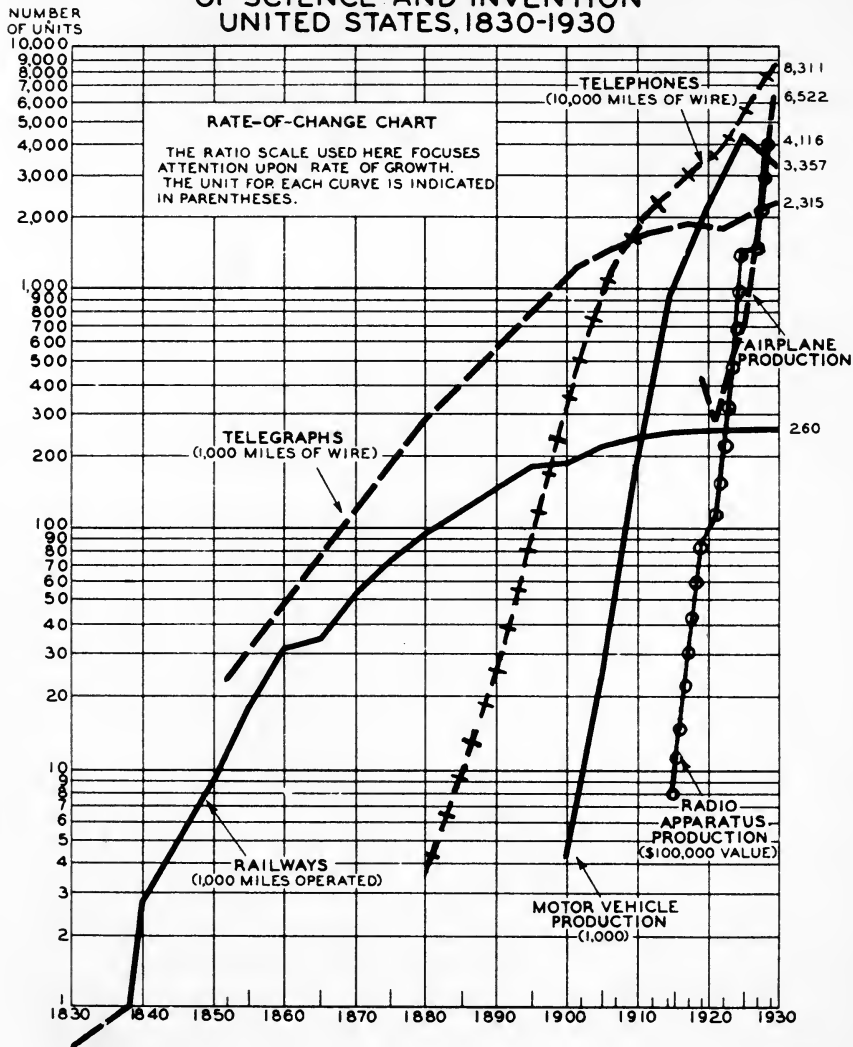
Multicurve rate-of-change charts do not require the reduction of units of a different nature to a comparable basis. Chart 38 presents an example in which rates of increase of such diverse measures as miles of railway and telegraph and telephone wire, number of motor vehicles produced, value of radio apparatus, and production of airplanes are compared in the same chart. The unit quantities are adapted to the scale, which extends only to 10,000, although the actual totals of the basic units, with the exception of airplanes, all exceed this number. The units for railways and motor-vehicle production are in thousands; for radio apparatus, \$100,000 value of production; and for telephones, 10,000 miles of wire.

### LIMITED USE OF RATE-OF-CHANGE DESIGNS

Notwithstanding the many efforts that have been made to popularize this method of graphic presentation, rate-of-change designs are seldom employed in statistical charts relating to business, industrial, and related activities. The position taken by the statistical authorities in the procurement agencies of the Army during the last war typifies the prevailing attitude concerning the use of this graphic type. *Standards of Presentation*, issued by the Statistics Branch, Control Division, Army Service Forces, for the guidance of its staff in the preparation of statistical reports, contains the following suggestive comment on the use of logarithmic charts:

"There are two dangers in using a log-scale chart: (1) that it will be used improperly, and (2) that it will be misread even if properly used. Therefore, although extremely valuable under appropriate conditions, this type is recommended only when the picture cannot be shown

# INDUSTRIAL CONTRIBUTIONS OF SCIENCE AND INVENTION UNITED STATES, 1830-1930



National Industrial Conference Board

CHART 38.

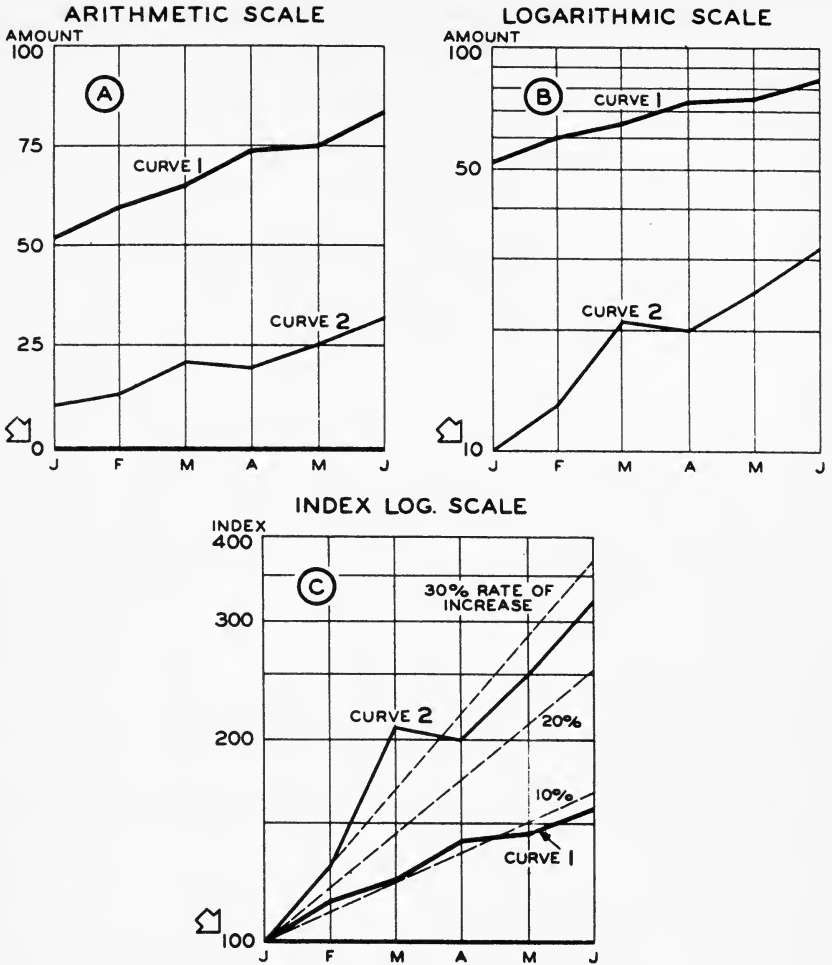


CHART 39. ARITHMETIC, LOGARITHMIC, AND INDEX LOG CHARTS. FROM *Standards of Presentation*, ARMY SERVICE FORCES.

satisfactorily by some other means, such as conventional percentage measurement.”

These recommendations were followed by a graphic comparison of three methods, arithmetic, logarithmic, and index logarithmic, which is reproduced in Chart 39.

The real test of these different methods is the impression the observer

gets from them. Viewing Chart A alone, he would probably conclude that the rate of increase in Curve 1 is greater than in Curve 2. Chart B shows which series increased at the faster rate, but affords no means for determining quickly by inspection the difference in the rates of increase. The comparison in Chart C is much clearer, with the advantage that the rates for both curves can be easily read from the scale. The light dash percentage-of-increase lines aid in reading the rates, but their inclusion in charts of more than two series is inadvisable, as the multiplicity of lines is likely to be confusing.



## BAR CHARTS



HE term "bar charts" as used here applies to horizontal-bar charts. Vertical-bar charts, commonly designated "column charts," are discussed in another chapter.

The bar type is one of the most frequently employed in graphic presentation and has many advantages. It is readily understood, even by those unaccustomed to reading charts, or who are not chart-minded. When the problem is one of comparing a large number of items, it is the only form that can be used effectively. It also possesses the outstanding advantage that it is one of the simplest and easiest to make.

### WIDE RANGE OF VALUES

Chart 40 illustrates a problem frequently met with in the drafting of bar charts. The amount represented by the upper bar, Minneapolis, is nearly twice the next in size and around thirty times larger than the last item of the series. In order to gain space for the smaller bars of the series, the largest bar is broken.



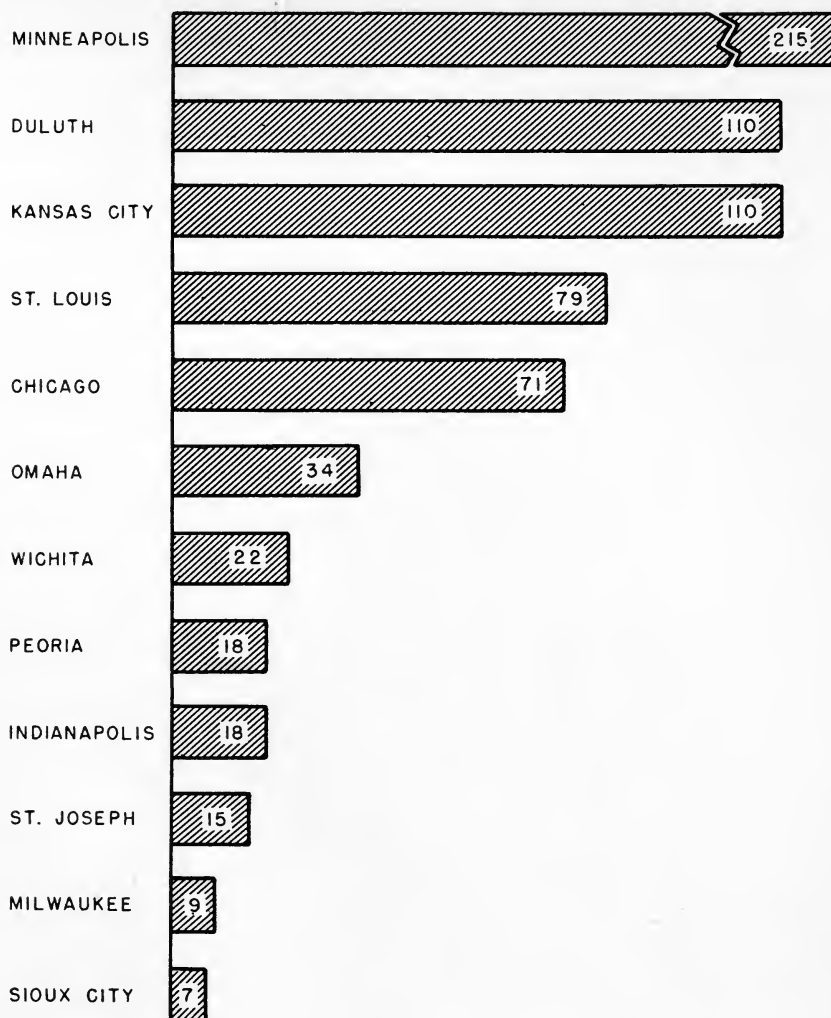


CHART 40. RECEIPTS OF WHEAT AT PRIMARY MARKETS: 1943  
(MILLIONS OF BUSHELS).

### LETTERING VERSUS SCALES

There is some difference of opinion among statisticians concerning methods for indicating the values in bar and column charts. Against the

practice of lettering the figures on the bars, it is argued that the lettering interferes with the graphic comparison, and where placed at the end of the bars, adds to their length, thereby distorting the impression of relative values. Those who object to lettering the figures in this manner prefer the use of a scale placed over the upper bar. This method is illustrated in Chart 41.

The real test of any method is how it functions in practical use and how far it meets the special needs of the person or persons for whom the chart is made. Assume, for illustration, that a display chart containing the data on criminal offenses drafted in Chart 41 is prepared for a hearing composed of Congressmen, lawyers, and enforcement officers. They are not likely to know much about graphics, and generally they think of statistics in terms of numbers. Also, the facts presented in the chart involve matters requiring legislative or other remedial action, for which the actual figures are likely to be essential.

Assume further, as an example of the type of difficulty often encountered in the use of scaled charts, that in the course of the hearing someone questions the accuracy of the high rate for aggravated assault in

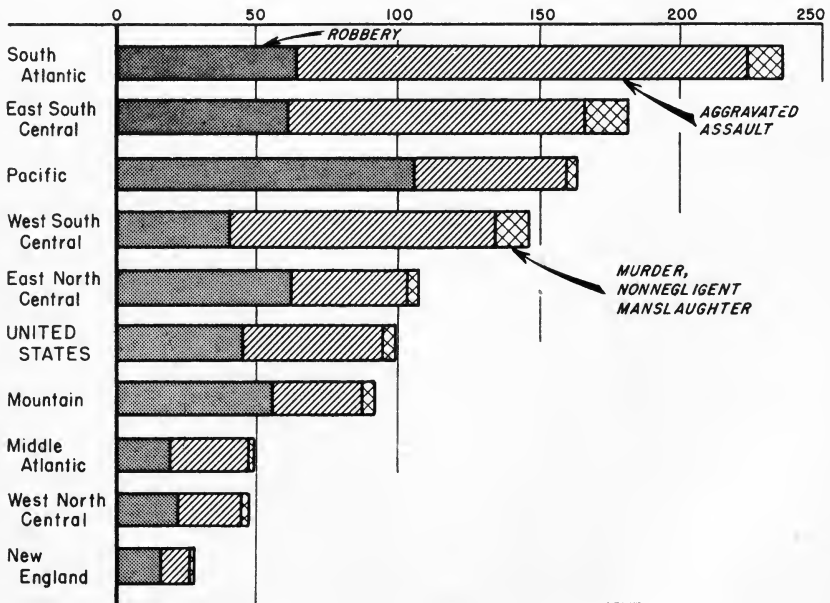


CHART 41. CRIME RATES IN URBAN COMMUNITIES (PER 100,000 POPULATION), BY GEOGRAPHIC DIVISIONS: 1943 (DATA SCALED).

the South Atlantic division, which greatly exceeds the rates for this offense in all the other divisions, and demands the exact data. Measured from the scale, the segment extends from a little beyond 50 to about half-way between 200 and 250. An estimate by the ordinary observer is likely to vary 10 to 25 percent from the true figure. Furthermore, under the conditions generally prevailing in hearings and conferences, both time and patience for estimates of this kind are lacking.

Chart 42 presents the same data as Chart 41, but with the amount corresponding to each segment clearly lettered on the bars. The segment labels are placed above the first bar. One disadvantage of scaled charts is the difficulty in labeling the segments so they can be easily identified. Unless the labels are inserted below the scale, which interferes with the use of the scale for measuring the size of segments and bars, they generally have to be lettered at irregular intervals in the blank space at the right of the bars.

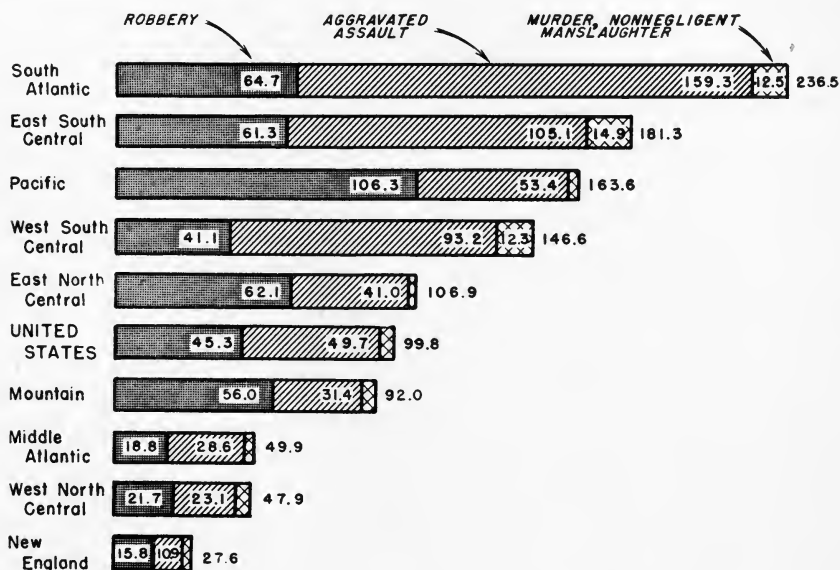


CHART 42. CRIME RATES IN URBAN COMMUNITIES (PER 100,000 POPULATION), BY GEOGRAPHIC DIVISIONS: 1943 (DATA LETTERED ON BARS).

There is nothing exaggerated or unusual about the foregoing example. The writer has witnessed many like it in hearings and conferences with congressional committees. The presentation of scaled charts, without

all the data readily available in worksheets or tables, nearly always resulted in requests for exact information that could not be immediately supplied.

In business conferences the chart may bear on matters of policy to be considered later by agencies or firms represented in the meeting. Yet if scaled charts are used to present the data, all the individual representative can carry away with him is his general impression of the graphic picture, with such approximations as he may have been able to make from the scale.

In lettering figures on bar charts two rules should be observed. If the lettering is within the bar, it should be small enough so that a strip of the shading or color shows above and below it. If at the end, the lettering should be less in height than the width of the bar and slightly separated from it. This will obviate the possibility of the observer comparing the combined length of bars and lettering, rather than the bars alone.

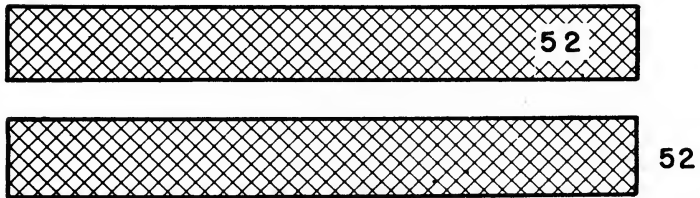


CHART 43. LETTERING WITHIN AND AT THE END OF BARS.

An example in which the first of these rules was not followed is shown in Chart 44. The lettering is so large that it cuts each bar in half. Also, it is centered on the bars, so that the figure on the first bar, 222, falls directly below 120 on the scale. Bars without subdivisions should be lettered near the end. In segmented bars the lettering may be centered on or placed at the end of the segments.

No scale was needed in Chart 44. The use of both lettered bars and a scale in the same chart is confusing. The ruling under each stub item is unnecessary. Except in charts with very wide stubs, connecting lines from stub titles to bars are not required.

## ORDER OF COMPONENTS AND RULING

Bar charts are sometimes arranged in the alphabetical sequence of geographical or other units, as, for example, the States or counties of a

State, but in this order are usually ineffective and hard to interpret. In nearly all cases a descending or ascending order of values will afford a clearer presentation and save the reader the effort of deciphering the relationship between components.

Ruling of bar charts other than that required for outlining the bars may be entirely omitted. Or it may be held down to a single rule connecting the left end of the bars. The question of more or less ruling is a

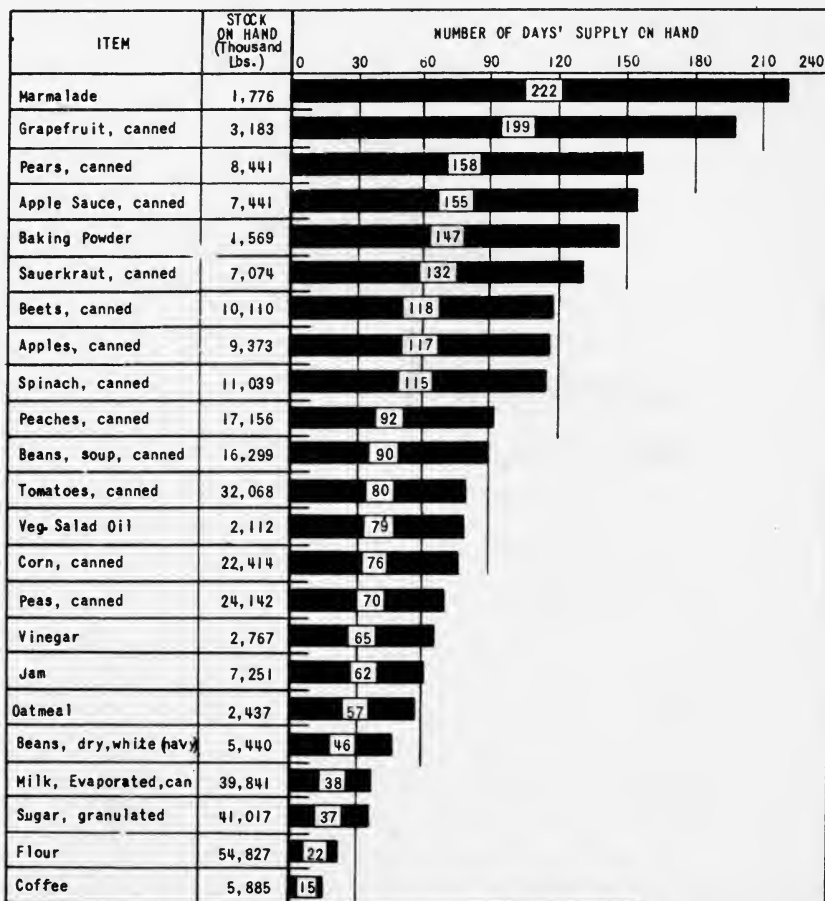


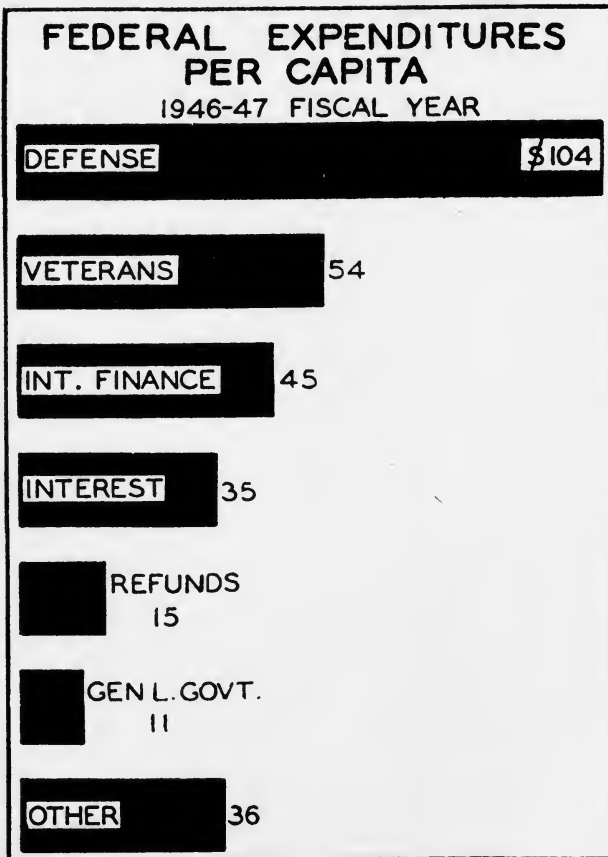
CHART 44. POST, CAMP, AND STATION STOCKS OF NON-PERISHABLE SUBSISTENCE ITEMS. FROM STATISTICAL REPORTS TO THE QUARTERMASTER GENERAL.

matter of taste and judgment, depending chiefly on whether it aids in understanding and interpreting the statistics presented in the chart.

The same criterion applies to the use of borders, a frame extending around the four sides of the chart, including the title and footnotes or sources below the grid. In crowded charts the margin between the border lines and the over-all chart area reduces the space available for the drafting.

#### LETTERING STUB ON BARS

In Chart 45 the names of the components, ordinarily placed as stubs



*Cleveland Trust Company Business Bulletin*

CHART 45.

at the left of the chart, are lettered on and at the end of the bars. Extreme condensation is sometimes necessary in charts for publication, where there is insufficient space for the conventional arrangement. In this chart lettering the component titles in stub form would have shortened the space for the bars by about one third.

JOINED-BAR CHARTS

Bar charts are easier to read and are of better appearance if space is left between the bars, but if the chart includes a large number of items, spacing may have to be omitted. Generally the values can be lettered within the bars. If the bars are too narrow to permit this, the choice is between lettering at the end or in a column at the left of the base line.

Chart 46, copied from a joined-bar chart of the forty-eight States, compares the two methods. In the upper chart the figures are lettered at the right of the bars, and in the lower, between the stub items and the base line. The position of the lettering is a matter of choice, although the first method is more generally used.

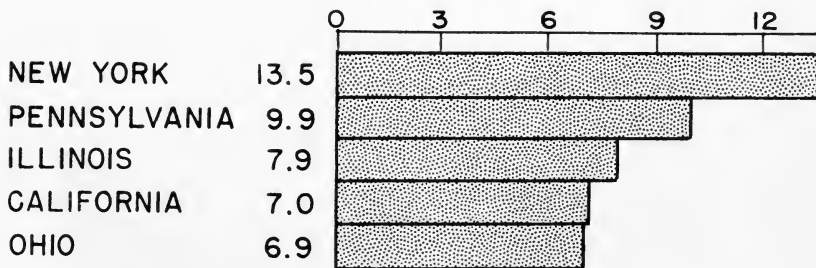
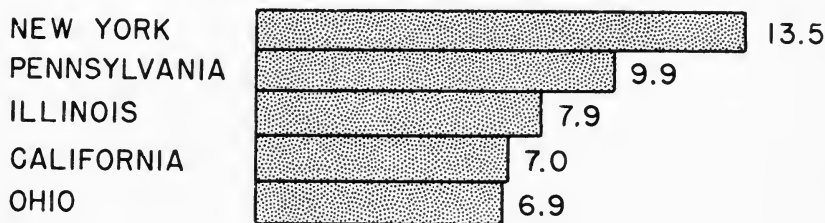


CHART 46. POPULATION OF FIVE LARGEST STATES: 1940 (IN MILLIONS).

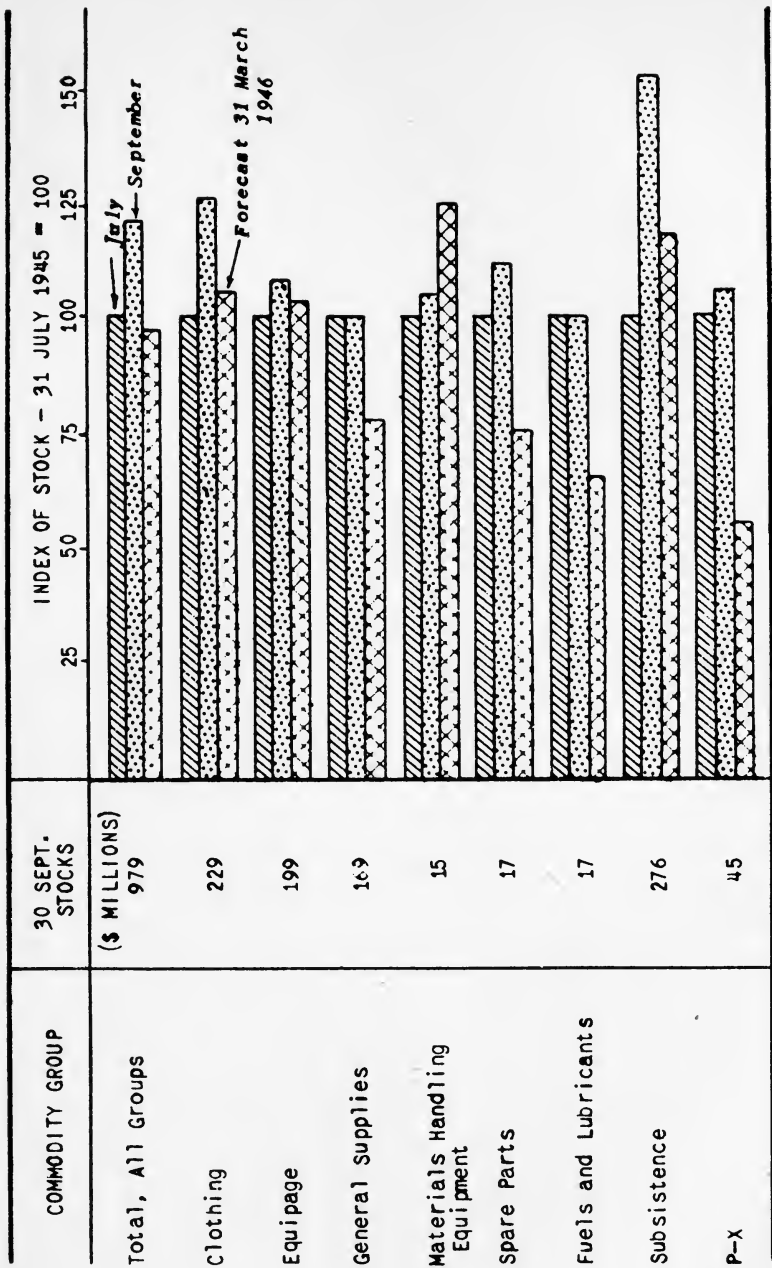


CHART 47. INDEX OF STOCKS, SECONDARY ITEMS. FROM STATISTICAL REPORTS TO THE QUARTERMASTER GENERAL.



GROUPED-BAR CHARTS

This type, illustrated in Chart 47, is employed frequently for picturing changes in two or more categories from one time period to another or for comparisons with an estimate, average, or forecast. In Chart 47 the diagonal bar represents the base of the index, 100, the dotted bar the September stocks, and the cross-hatched bar the forecast to March of the following year. While effective for comparing different aspects of a single component, comparisons between the components are difficult to interpret. In this example there are too many bars in each group and the groups are too close together.

The use of grouped-bar charts should be limited, as a rule, to groups of two bars, with shading or color for each bar in marked contrast. The separation between groups should be around three quarters of the combined width of the bars. Groups of three bars or over present the eye with too many different comparisons at one time.

KEYS

If the bars include a considerable number of small segments, it may be necessary to use a key. This is usually placed at the right of the bars in the body of the chart, if space is available, or it may be lettered above the grid. Both methods are shown in Chart 48.

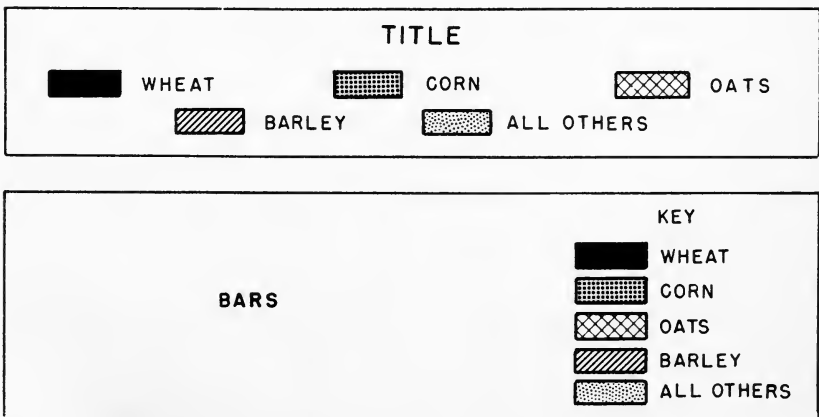
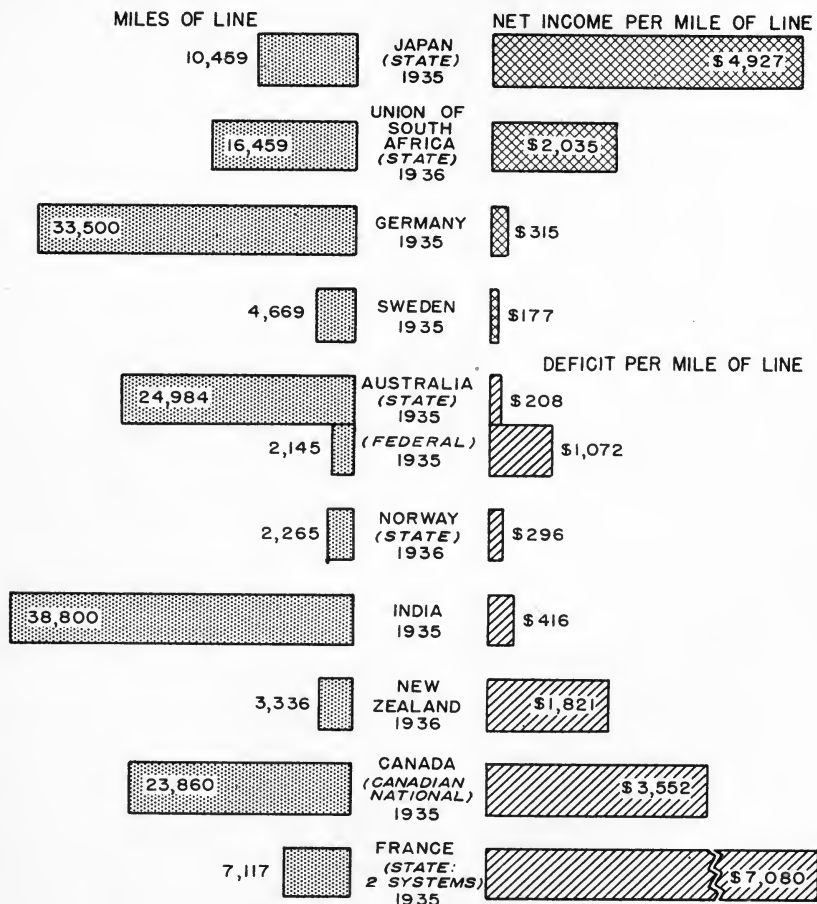


CHART 48. TWO METHODS FOR PLACEMENT OF KEYS.

The use of keys should be avoided as much as possible. Descriptive labels nearly always can be lettered over the first bar. Long labels may be lettered in two or three lines.

### PAIRED-BAR CHARTS

This type is frequently used for comparisons of derived and basic



National Industrial Conference Board

CHART 49. NET INCOME OR DEFICIT OF GOVERNMENTALLY OWNED OR OPERATED RAILWAYS IN VARIOUS FOREIGN COUNTRIES: 1935 OR 1936.

data. The purpose of the comparison in Chart 49 is to show the degree of success attained by various countries in the administration of governmentally owned or operated railways. The bars of the positive category, net income per mile of line, are arranged in descending order, from the largest to the least. The order of the negative category, deficits per mile of line, is reversed, the series beginning with Australia, which showed the smallest deficit, and ending with France, the largest. The bars on the left side of the chart indicate the size of the various railway systems.

COMPLETION OF TERMINATION INVENTORY WORKLOAD  
AUGUST - NOVEMBER 1945

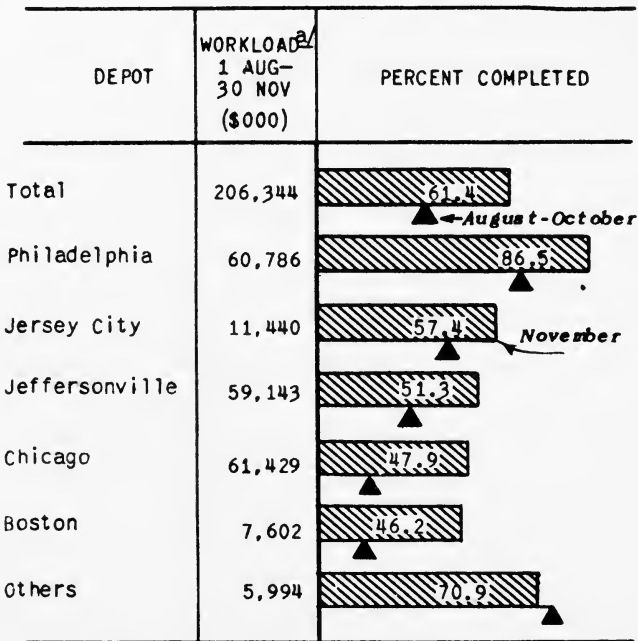


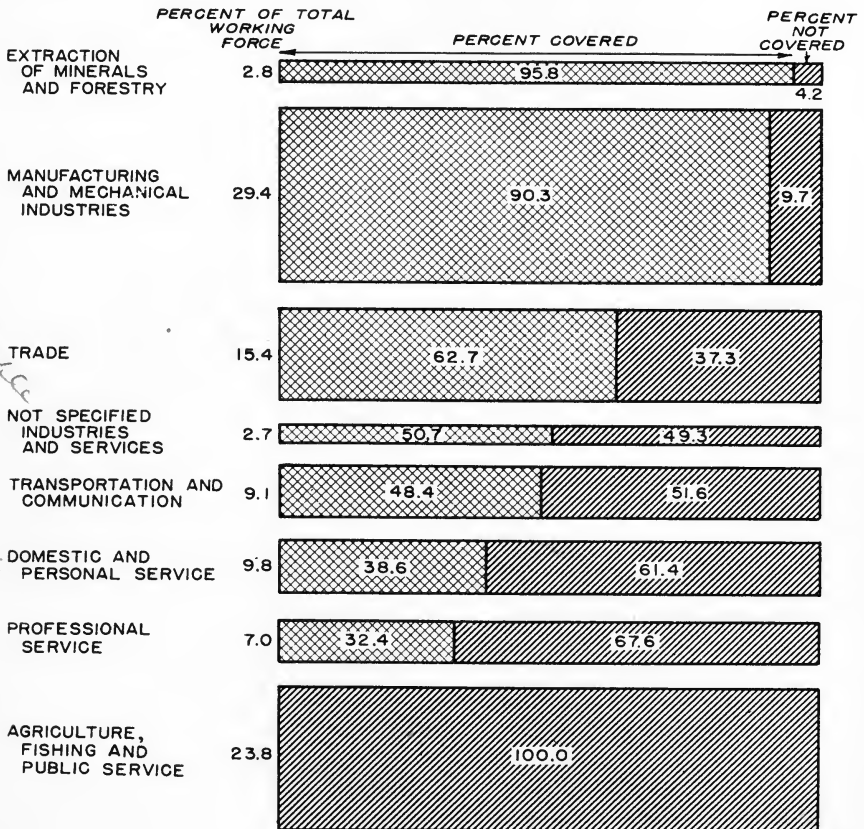
CHART 50. CONTRACTOR-OWNED TERMINATION INVENTORY. FROM STATISTICAL REPORTS TO THE QUARTERMASTER GENERAL.

BAR-AND-SYMBOL CHARTS

A combination of bar and symbol is sometimes used in charts of grouped data. In Chart 50 the bar represents the percent completed through August to November. The pyramidal symbol indicates the cor-

responding percent through August to October. Various types of symbols are employed. One frequently seen consists of a short vertical line intersecting the bar or placed at the right in line with it.

The symbol device is usually less effective than grouped bars. Only a rough approximation of the amount indicated by the symbol is possible, while a bar employed for the same purpose permits clearer plotting and lettering of the exact amount. Another difficulty is met with where the amounts represented by the symbols are greater than those of the bars. In such cases the symbol may be separated so far from the bar



National Industrial Conference Board

CHART 51. PROPORTION OF WORKING POPULATION COVERED BY THE OLD AGE PROVISIONS OF THE SOCIAL SECURITY ACT, USING THE DISTRIBUTION OF OCCUPATIONS OF THE 1930 CENSUS.

that the relation between the two is not clearly apparent. If there are a number of such items in the chart, the effect is extremely confusing.

AREA-BAR CHARTS

This form of 100 percent bar chart shows both the percentage distribution of the categories and the relative size of the components. In Chart 51 the figures in the bars represent the percent in each group which are covered and not covered by the provisions of the Social Security Act. The figures at the left indicate the proportion of the total working force in each group.

Unless the size of the component items is shown graphically in percentage-distribution charts, it is advisable to include in a column following the stub the figures from which the percents are derived. Comparisons of percentage distributions unaccompanied by the basic data do not provide sufficient information for a correct interpretation of the relative figures.

OPTICAL DISTORTION IN BARS

Care must be exercised in the choice of shadings to avoid combinations which produce optical distortions. Chart 52 shows the "bending" effect which results when two diagonal patterns are used and the apparent increase in the width of one segment when solid black and a horizontal line shading are combined.

If bar charts are to be printed, the use of solid black in segmented bars should be avoided. Shading comes out lighter in printing than in

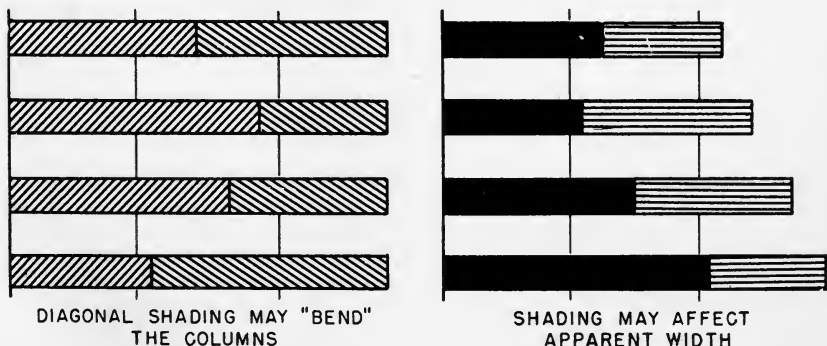


CHART 52. OPTICAL DISTORTIONS.

the drawing. When solid black and shading are used in the same bar, the black segment stands out more prominently than the shading, thereby overemphasizing the category it represents.

### INCLUSION OR OMISSION OF 100 PERCENT BASE

It is desirable in percentage charts to show a measure which repre-

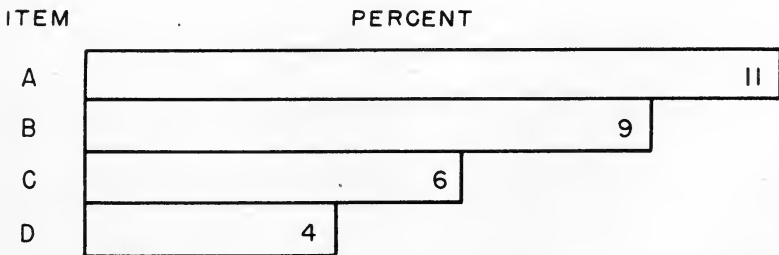
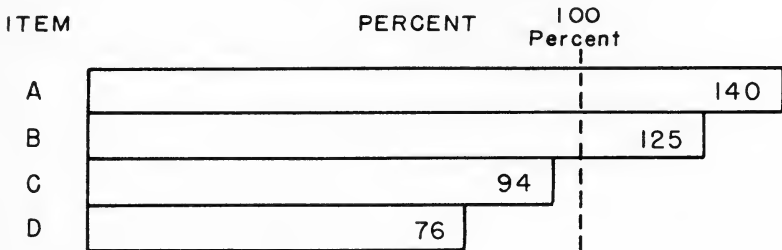


CHART 53. INCLUSION OR OMISSION OF 100 PERCENT BASE.

sents the 100 percent base. If the figures approach or exceed 100, as in the upper example in Chart 53, the base may be indicated by a vertical dash line. If all the percentage figures are small, however, the 100 percent horizontal scale is likely to leave too little space for an effective comparison, and in such cases it should be omitted. For example, the inclusion of a base line in the second chart dwarfs the length of the bars. In the lower chart the base has been omitted, thus permitting the full width of the chart to be utilized for a clearer comparison of the percentage figures.

DEVIATION-BAR CHARTS

This design is frequently used for comparisons of positive and negative quantities, increases and declines, losses and gains, or deviations from a standard or norm. The bars extend to the left and right of a vertical base line. The "positive" bars are generally arranged in descending order of sequence and the "negative" bars in ascending order.

Chart 54 illustrates a problem frequently encountered in charts of this type. The length of the negative "Subsistence" bar imposes a wide separation between the bars and stub titles of the other items of the series. This can be overcome by lettering the stub titles opposite the

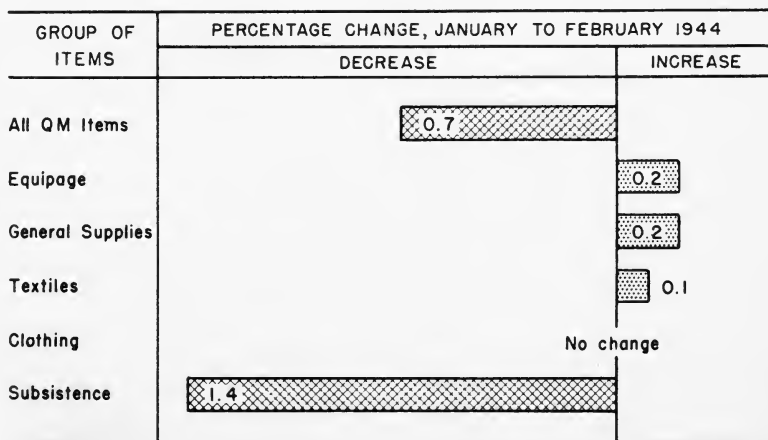


CHART 54. PRICE CHANGES. FROM STATISTICAL REPORTS TO THE QUARTER-MASTER GENERAL.

bars, within the body of the chart, as shown in Chart 55. By this method the stub titles are placed closer to the bars and more space is available for the graphic comparison.

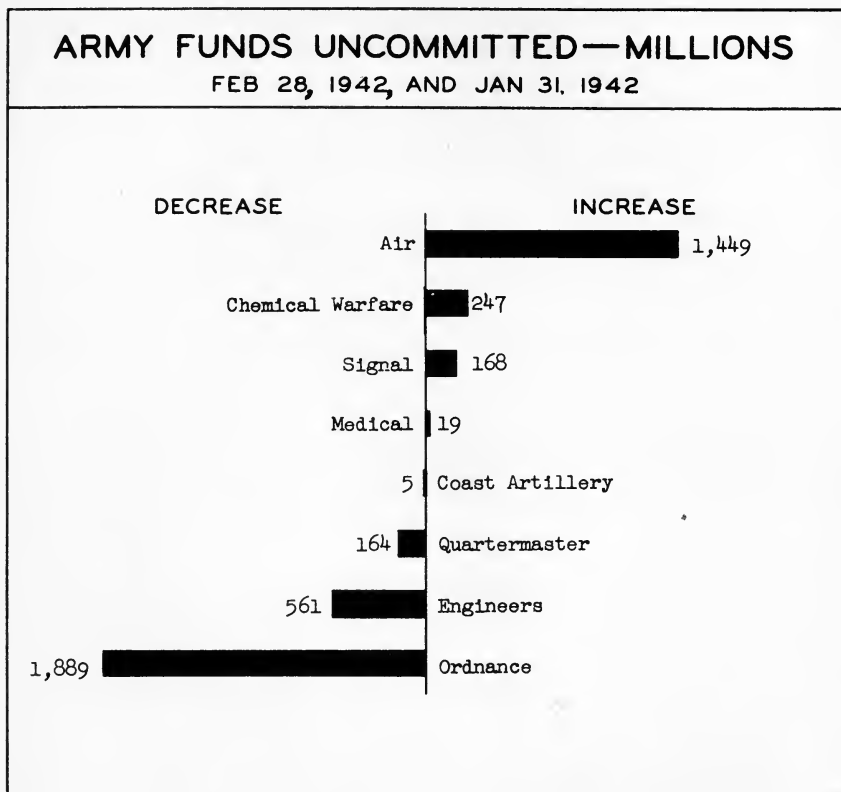
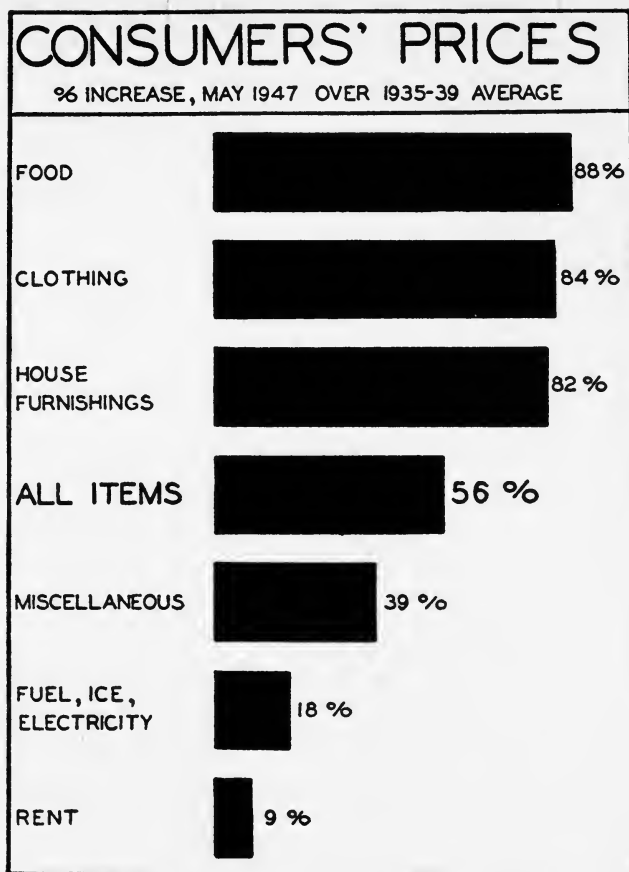


CHART 55. FROM *Manual of Statistics*, WAR DEPARTMENT, SOS.

### BASE FIGURES IN CHARTS OF RELATIVE NUMBERS

In bar charts of averages, percentages, or other relative numbers, the item representing the combined figure for the whole series may be set off, as in Chart 56, by larger lettering. Various other methods are employed to distinguish it from the accompanying items: wider space above and below its bar and stub, a different shading or color, a bar





*Cleveland Trust Company Business Bulletin*

CHART 56.

wider than the others; or by placing it at the beginning of the series instead of in order of size. A common practice, if the last method is used, is to extend a vertical dash line from the end of the "All items" or "Total" bar through the bars below it.

#### ADJUSTMENT OF STUB TO SPACE

One of the faults most frequently observed in bar charts results from the common practice of fitting the stub space to the longest component

title. As the bars constitute the graphic part of the chart, as much as possible of the horizontal space should be allotted to them. Long titles should be shortened by editing and abbreviation and, if necessary, by lettering in two or more lines.

Chart 57 shows a comparison of two charts with identical stubs, the first with all item titles lettered in single lines, and the second with the longer titles lettered in two lines. The effect of shortening the stub of the lower chart in this way increases the space for the bars nearly one half. The bars are brought closer to the item titles, with marked improvement in the general appearance of the chart.

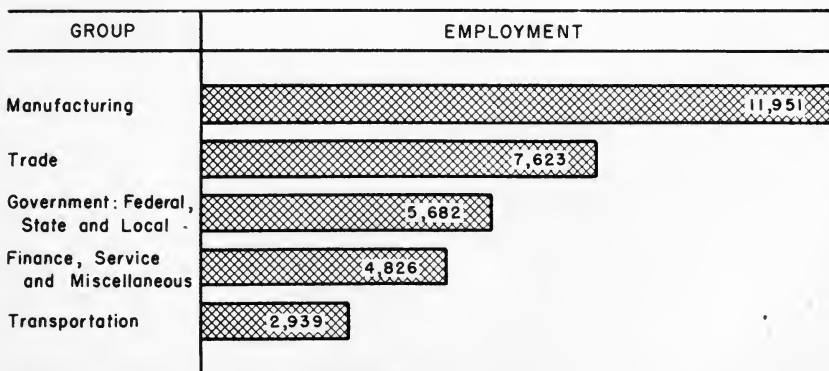
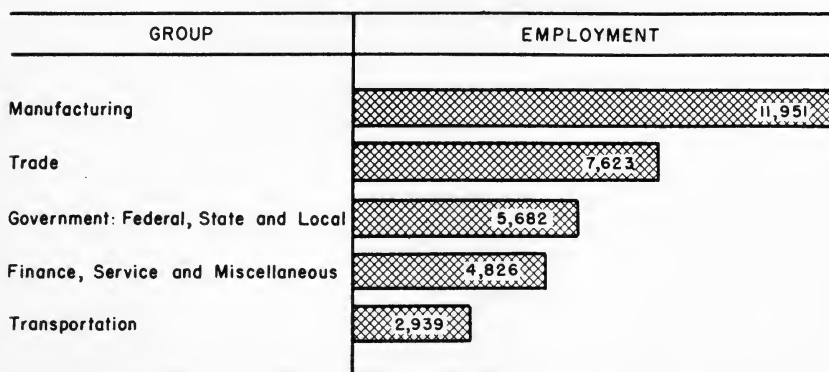


CHART 57. ESTIMATED NON-AGRICULTURAL EMPLOYMENT, FIVE LARGEST INDUSTRIAL GROUPS: LAST QUARTER, 1945 (IN THOUSANDS).

## STEP-BAR CHARTS

Chart 58 shows a design sometimes used instead of the conventional stub and bar arrangement for picturing the subdivisions of a total if their number is too large for an effective presentation in a single bar. The relation of the subdivisions to the total is somewhat clearer than if the bars were placed immediately following the stub titles.

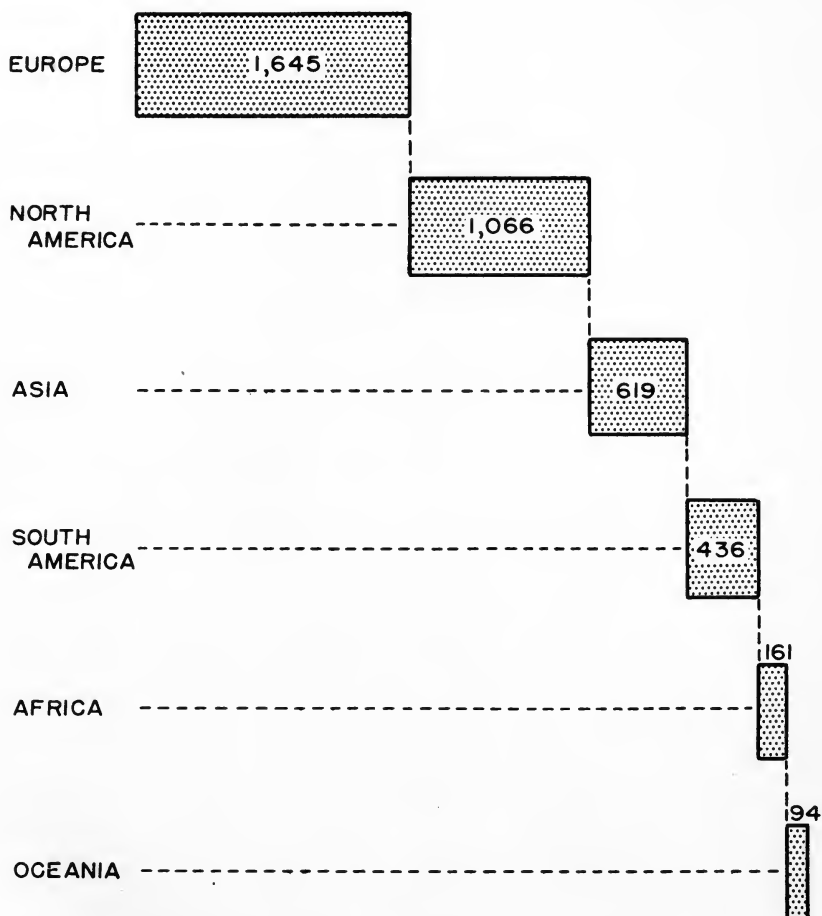


CHART 58. EXPORTS (INCLUDING REEXPORTS), UNITED STATES, BY CONTINENTS: 1940 (IN MILLIONS OF DOLLARS).

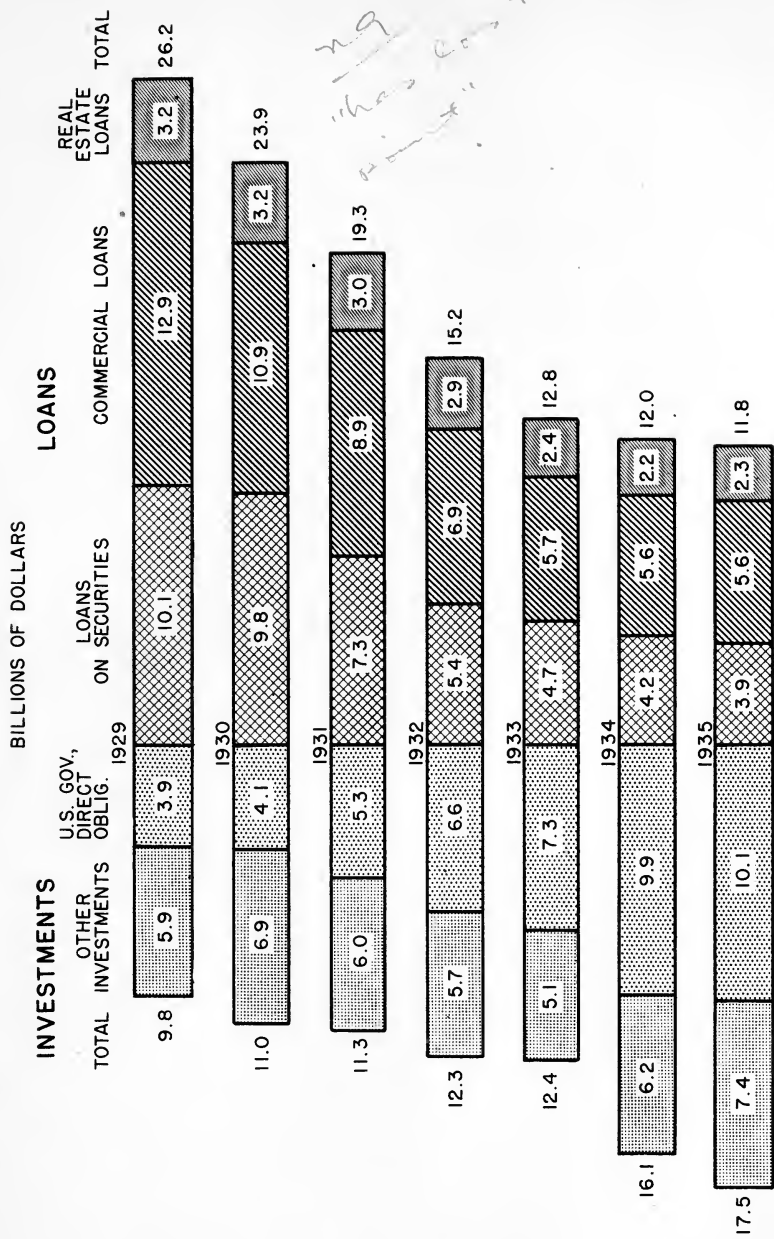


CHART 59. LOANS AND INVESTMENTS OF THE MEMBER BANKS OF THE FEDERAL RESERVE SYSTEM FROM 1929 TO 1935.

National Industrial Conference Board

## SLIDING-BAR CHARTS

A variation of the deviation-bar type, sometimes designated "sliding-bar," is shown in Chart 59. It presents a large volume of data condensed without sacrifice of simplicity and clarity within a small amount of space. Economy of space is secured partly through the elimination of all scales and ruling not absolutely essential and partly through lettering the stubs, in this case years, over the base line of the bars instead of at the side of the chart.

The original from which this chart was copied was in two colors, blue in two shades for investments and red in three shades for loans. Color offers many advantages over black-on-white shading for charts of multi-segmented bars.

## COLUMN CHARTS

**C**OLUMN charts are bar charts arranged vertically. Their most frequent use is for picturing comparisons of similar components at different times, while bar charts are generally employed to compare different components at the same time. The column design is particularly effective for the presentation of series which comprise a small number of time periods with few subdivisions of value. It is not well suited for comparisons of several time series nor for those which cover an extended period of time and have many plottings.

### COLUMN AND SEGMENT LABELS

Column charts are considerably more difficult to design than bar charts, chiefly because of the problems they present in labeling segmented columns. Segments in bar charts can be clearly labeled over the first bar, while in column charts the labels are lettered across the columns or at the left or right side of the chart. Lettering of segments on

the left side is usually not practicable if the first column is much shorter than the others nor on the right side if the chart is to be brought up to date at recurring intervals. In the latter case the labels, lettered on separate strips of paper, may be pasted with rubber cement at the right of the last column and shifted for future entries.

Chart 60 illustrates the method commonly employed for segment labeling at the left of the chart. The dash lines connecting the segments should be included in column charts, unless the spaces between the columns are very narrow or there is marked irregularity in the size of the segments.

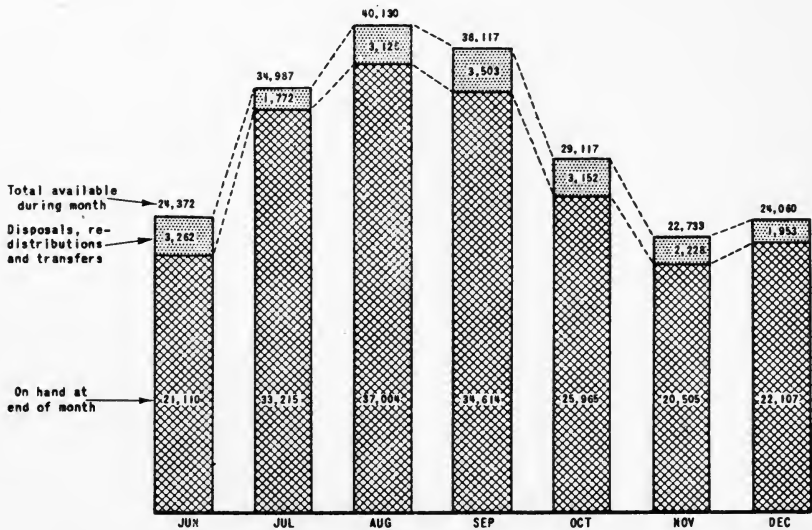


CHART 60. DISPOSITION OF SURPLUS PROPERTY: JUNE TO DECEMBER, 1944 (THOUSANDS OF DOLLARS). FROM *Statistical Yearbook*, QUARTERMASTER CORPS.

COMPARISON OF COLUMNS WITH CURVES

Since the introduction of adhesive shading and color, the column type has supplanted curves to a considerable extent in charts of time series. This has come about chiefly because making a column chart with the new material represents little if any more work than would be required for drafting the same data as curves, while improved appearance and more striking contrast can be secured through use of color or

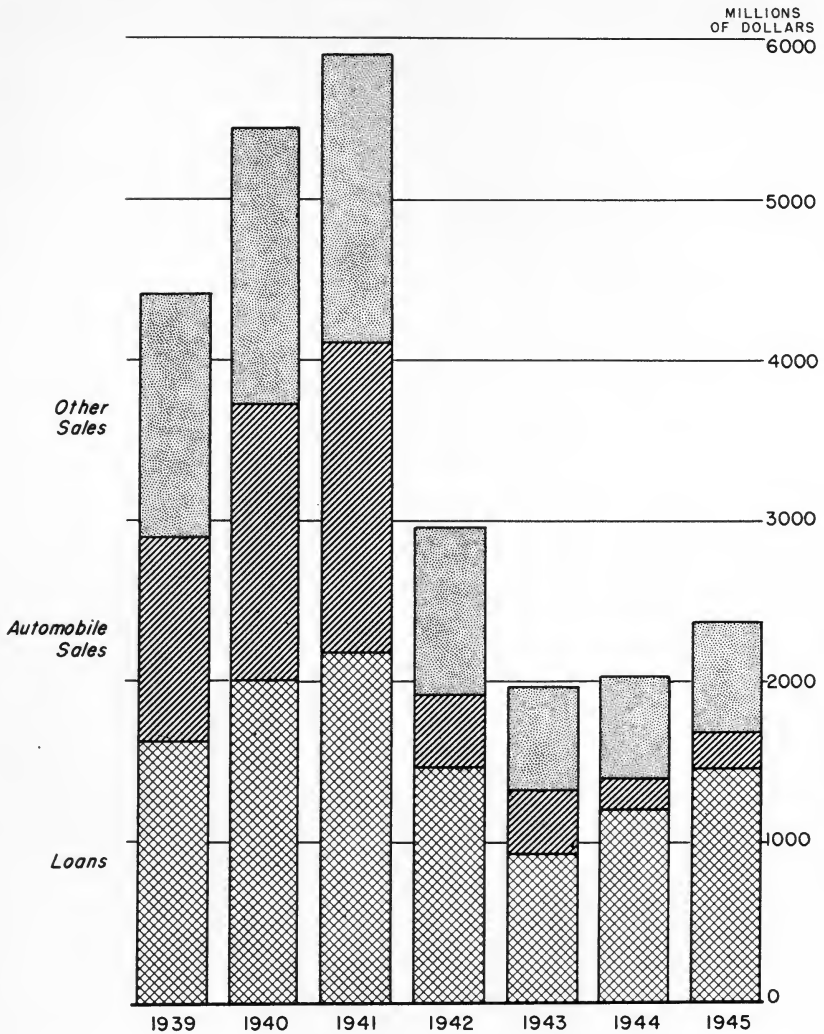


CHART 61. INSTALMENT CREDIT: 1939 TO 1945 (COLUMN DESIGN).

shading. To the non-statistical observer a series in columns appears simpler and easier to understand than the same data plotted in a curve design.

Charts 61 and 62 illustrate some of the advantages and disadvantages



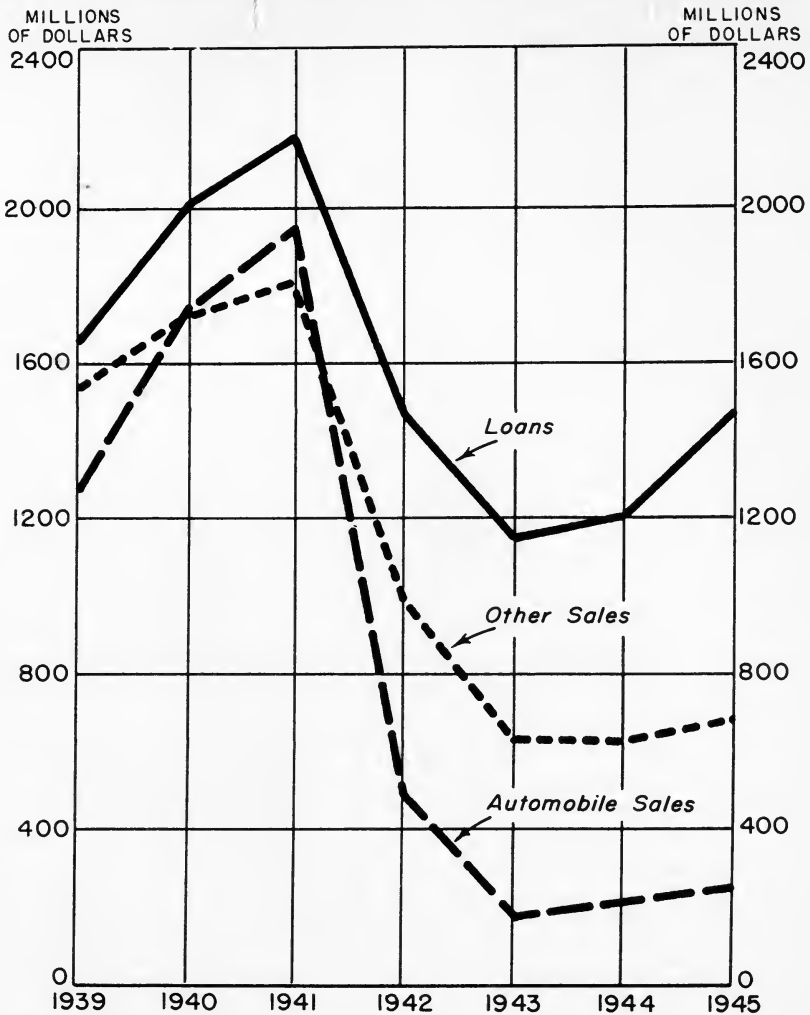


CHART 62. INSTALMENT CREDIT: 1939 TO 1945 (CURVE DESIGN).

of each type. The columns compare more effectively than the curves the *amounts* of credit extended in each category but, because two of the segments have no common base, do not indicate as clearly the *trend* or direction of change. For the latter purpose, in most cases the curve chart, in which all the curves are plotted from the same base, is generally preferred.

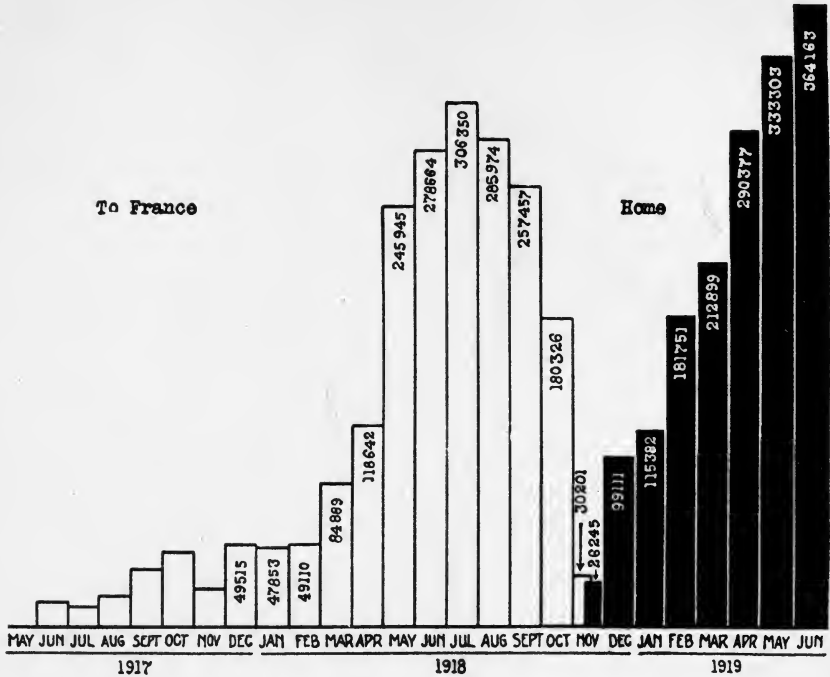


CHART 63. MEN SAILING EACH MONTH TO FRANCE AND HOME: 1917 TO 1919. FROM *The War with Germany*, BY LEONARD P. AYRES.

## HOLLOW COLUMNS

Hollow columns representing simple comparisons of size can be used effectively in charts intended for printed reproduction, as illustrated in Chart 63. The ruling and lettering of the black portion of the chart were done with white ink. The columns are so narrow and the figures so large it was necessary to disregard the rule against vertical lettering. Single letters might well have been substituted for the three-letter abbreviations in the time scale, which is too crowded for easy reading.

## COMBINATION OF SPACED AND JOINED COLUMNS

The spaced columns in Chart 64 represent yearly averages from 1939 to 1944. The joined columns show the data by months in 1945. The

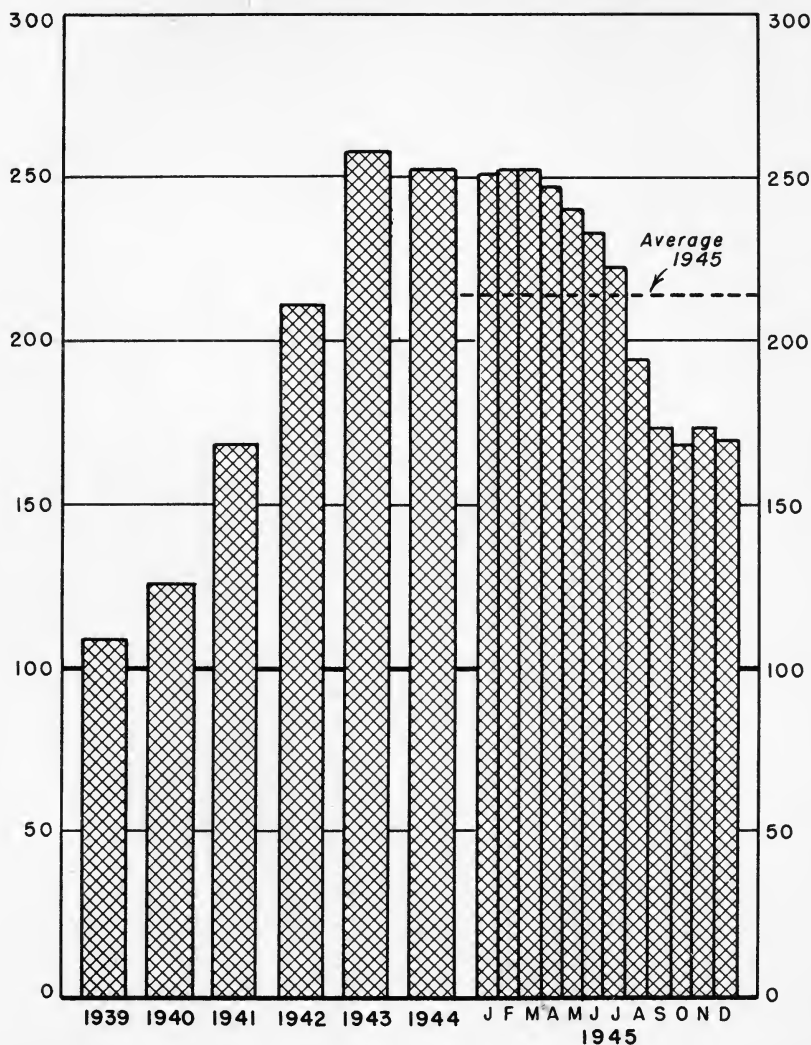


CHART 64. INDUSTRIAL PRODUCTION, MANUFACTURES: 1939 TO 1945  
(1935-39 AVERAGE = 100).

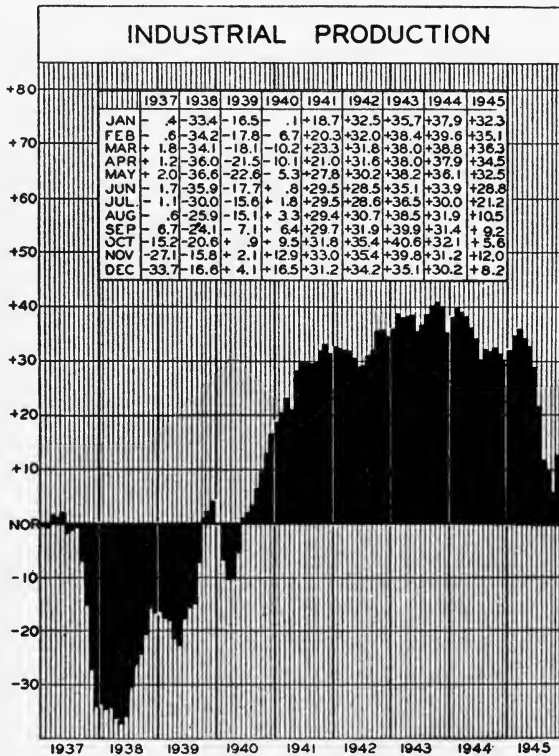
average is indicated by the dash line intersecting the monthly columns. Amount-scale ruling was necessary, as the monthly columns are too narrow for lettering the values. For the same reason the months in the

time scale are represented with single letters instead of the three-letter abbreviations usually employed for this purpose.

The choice between spaced and joined columns depends on the length of the time series. In long time series spacing necessarily is omitted. In short series fairly wide spacing between columns, at least the width of the columns, gives a better appearance than narrow spaces and wide columns.

### COMBINATION OF CHART AND TABLE

If the columns are too narrow for lettering, as in Chart 65, a table containing the data may be lettered within the grid field. This method is limited to small charts for publication or for desk use. It is not usually



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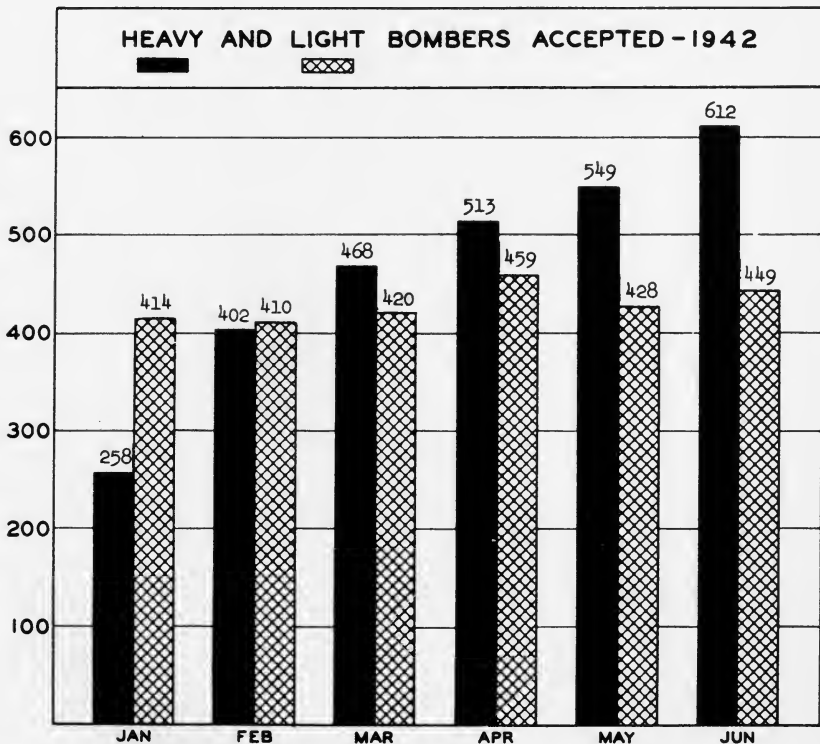
CHART 65.

practicable in display charts. If the lettering is large enough to be legible at some distance, the table will take up too much space.

GROUPED-COLUMN CHARTS

This type is fairly effective if the number of columns in each group does not exceed two. Groups of three or more complicate the comparisons between the categories in the various groups to the extent that interpretation of the chart becomes difficult. The columns should be clearly differentiated by contrasting colors or shading.

In Chart 66 keys are employed to identify the categories represented by the columns. The use of keys should be avoided, but the alternative in grouped-column charts—labeling the columns in the space above the groups—is equally objectionable. Key labels may be omitted, as in this



Don't group them  
 Don't number 2  
 number 5  
 prefer 5  
 curved

CHART 66. FROM *Manual of Statistics*, WAR DEPARTMENT, SOS.

example, by placing the key directly under the corresponding designation in the title. Another method, if color is used, is to letter the name of each component or category in the title in the same color employed to designate it in the chart.

In Chart 67 one category is represented by columns and the other by circles connected with lines. This method permits clear lettering of each category. It is most effective for comparisons in which the values do not vary widely in size.

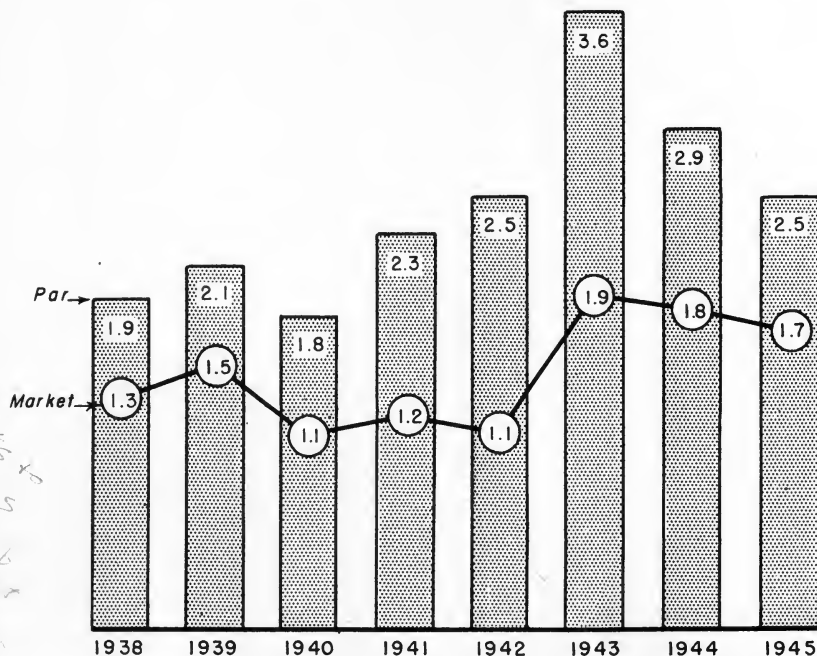


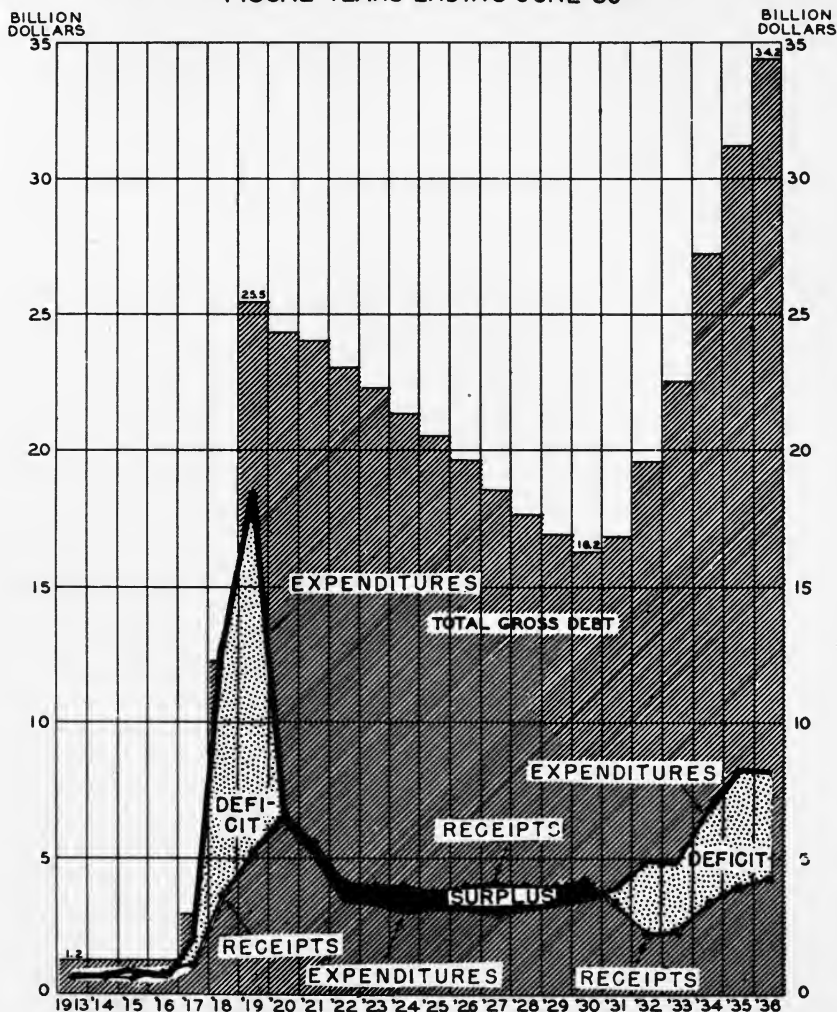
CHART 67. PAR AND MARKET VALUES OF BONDS SOLD ON NEW YORK STOCK EXCHANGE: 1938 TO 1945 (BILLIONS OF DOLLARS).

### COMBINATION OF COLUMNS AND CURVES

An example of joined columns combined with a curve and surface overlay is shown in Chart 68. The solid curve represents expenditures, and the ball-and-line curve receipts. The deficits from 1917 to 1920, when expenditures exceeded receipts, are indicated by dotted shading. The space corresponding to the surplus from 1920 to 1930,

## RECEIPTS, EXPENDITURES, AND NATIONAL DEBT FEDERAL GOVERNMENT, UNITED STATES, 1913-1936

FISCAL YEARS ENDING JUNE 30



*National Industrial Conference Board*

CHART 68.

when receipts exceeded expenditures, is filled in with a heavy black shading. Yearly deficits began again in 1931 and continued through 1936.

The amount scale is repeated at the right of the chart. This is usually desirable in charts covering long periods of time. The gross debt totals are lettered at the points of chief interest, the peak after World War I, the lowest point reached in the following eleven years, and the end year of the series.

### CHARTS SHOWING BOTH BASIC DATA AND PERCENTAGE DISTRIBUTION

In charts where the purpose of the presentation requires that both the basic data and the percentage distribution appear, various methods are used to show both sets of figures. A small table of the percents or the amounts, whichever is least important, may be attached to or lettered on the chart. This procedure is seldom used, however, as it does not tie the series together closely enough for convenient reference and comparison. Another method commonly employed, illustrated in Chart 69, consists in lettering both series on the columns. The basic figures are lettered above or within the columns and the percents below in smaller lettering, followed by the percent sign. The figures may be further differentiated by enclosing the percents within parentheses. Or the percents may be lettered immediately above the base line or centered on the columns.

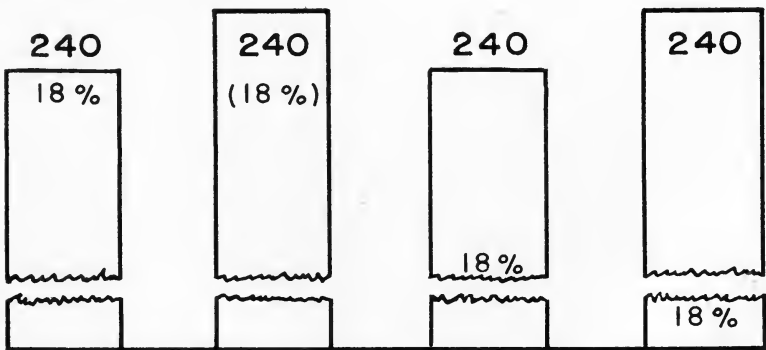
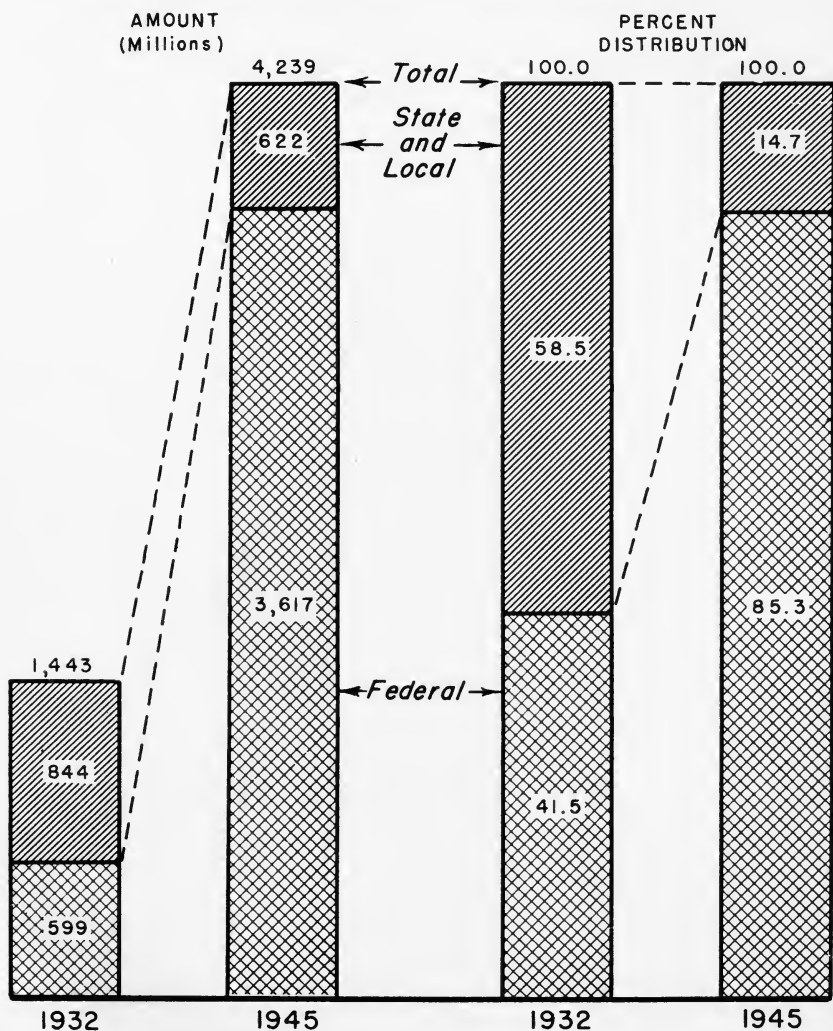


CHART 69. METHODS FOR LETTERING BASIC AND PERCENTAGE FIGURES ON COLUMN CHARTS.



The design shown in Chart 70 is frequently employed where a graphic comparison of the basic data with the percentage distribution is desired. The lettering of the segment labels between the charts, instead of at the left of each of them, one set of labels thus serving for both charts, saves space and facilitates the comparison.



dotted  
 m.g.  
 put for  
 when  
 below 3  
 DO NOT  
 MESSAGE  
 GIVE ON  
 BIT OR  
 AT A T

CHART 70. INTEREST PAYMENTS ON DEBT OF FEDERAL, STATE, AND LOCAL GOVERNMENTS: 1932 AND 1945.

## DEVIATION-COLUMN CHARTS

This type, consisting of columns above and below a common base line, is used, like the deviation-bar chart, for comparisons of positive and negative values and variations from a standard, estimate, or forecast.

Charts 71 and 72 show two arrangements of the time scale. In the first, space sufficient for lettering the years forms the base separating the columns. In the second, the years are lettered below the chart and connected with the columns by dotted lines.

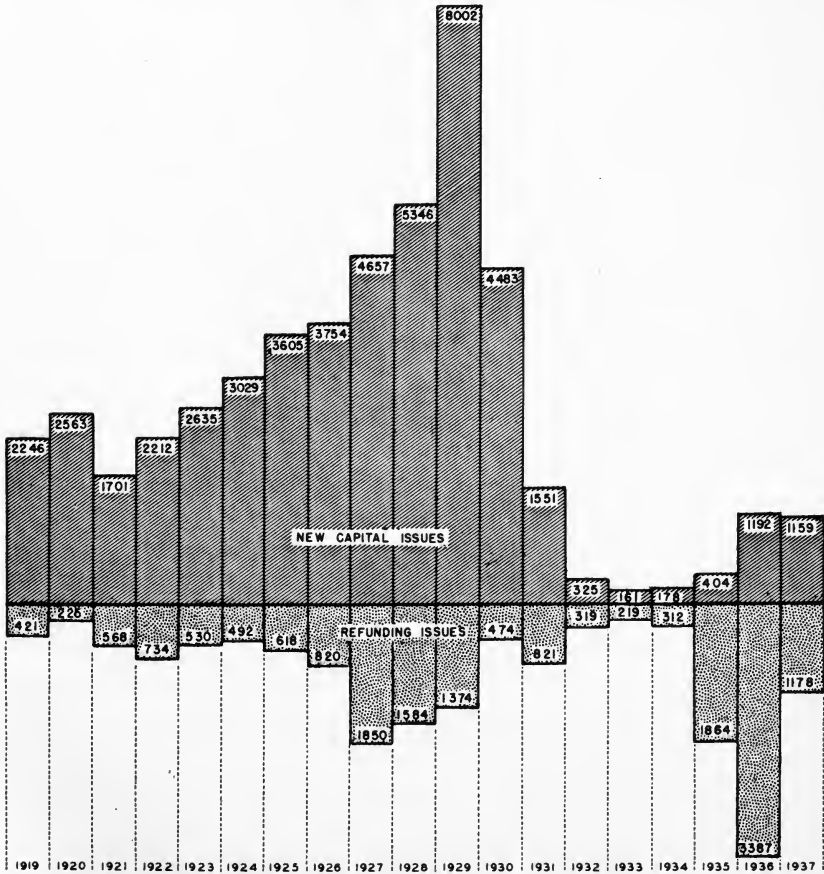


CHART 71. TOTAL EXPORTS AND IMPORTS OF MERCHANDISE: 1915, 1925, 1935, AND 1945 (MILLIONS OF DOLLARS).

If the chart is for printed reproduction, the figures of the time scale may be pasted on the base line between each pair of columns. The lettering should be small enough to leave a strip of shading or color between the figures and the column rulings. If the difference in the size of columns is extreme, as in Chart 72, lettering on the base line is impracticable.

## DOMESTIC CORPORATE SECURITY ISSUES UNITED STATES, 1919 - 1937

COMPARISON OF NEW CAPITAL ISSUES WITH REFUNDING ISSUES  
MILLIONS OF DOLLARS



*National Industrial Conference Board*

CHART 72.

## ■VII

### CIRCLE CHARTS

**C**OMPARISONS of size are much easier to interpret correctly from bars or columns than from circles, squares, cubes, or spheres. The use of various geometric forms for graphic purposes is compared in Chart 73. The second column in the first chart is exactly twice the height of the first column, but if the same amounts are drafted in the form of circles or squares, the difference between them appears to be considerably less. This effect is still more noticeable in the comparison of the same set of figures as cubes or spheres.

#### COMMON ERRORS IN DRAFTING CIRCLES

There is probably a higher percentage of errors in the drafting of circle charts than is found in any of the other graphic types, chiefly because of the complicated procedure for calculating the diameters of circles. The rule is: Divide the number represented by the circle by .7854 and extract the square root of the quotient. Unless the worksheet

## USE OF DIFFERENT GEOMETRIC FORMS IN COMPARING SIZES

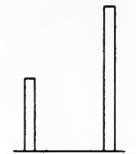
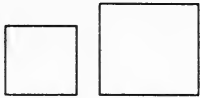
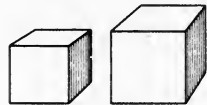
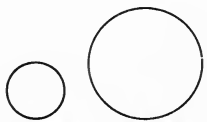
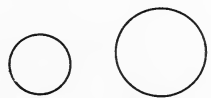

 <p style="font-size: small;">PLANES IN NOV. 5,000</p> <p style="font-size: small;">PLANES IN MAY 10,000</p>	 <p style="font-size: small;">PLANES IN NOV. 5,000</p> <p style="font-size: small;">PLANES IN MAY 10,000</p>	 <p style="font-size: small;">PLANES IN NOV. 5,000</p> <p style="font-size: small;">PLANES IN MAY 10,000</p>
<p style="font-weight: bold; font-size: small;">LINES, BARS OR COLUMNS</p> <p style="font-style: italic; font-size: x-small;">Easy to compare</p>	<p style="font-weight: bold; font-size: small;">AREAS</p> <p style="font-style: italic; font-size: x-small;">Difficult to compare</p>	<p style="font-weight: bold; font-size: small;">VOLUMES</p> <p style="font-style: italic; font-size: x-small;">Very difficult to compare</p>
 <p style="font-size: small;">PLANES IN NOV. 5,000</p> <p style="font-size: small;">PLANES IN MAY 10,000</p>	 <p style="font-size: small;">PLANES IN NOV. 5,000</p> <p style="font-size: small;">PLANES IN MAY 10,000</p>	 <p style="font-size: small;">PLANES IN NOV. 5,000</p> <p style="font-size: small;">PLANES IN MAY 10,000</p>
<p style="font-weight: bold; font-size: small;">DIAMETERS OF CIRCLES PROPORTIONAL TO NUMBERS</p>	<p style="font-weight: bold; font-size: small;">AREAS OF CIRCLES PROPORTIONAL TO NUMBERS</p>	<p style="font-weight: bold; font-size: small;">VOLUMES OF SPHERES PROPORTIONAL TO NUMBERS</p>
<p>All circle types are difficult to compare and should seldom be used.</p>		

CHART 73. FROM *Manual of Statistics*, WAR DEPARTMENT, SOS.

shows the correct diameters or radii, the draftsman, who has probably forgotten the rule if he ever knew it, is likely to fall back on the easier but erroneous method of making the diameters proportional to the size of the numbers.

Chart 73 shows an example of the distortion in circle charts where the diameters instead of the areas of the circles represent the numbers compared. The first chart in the lower row, in which the diameters of the circles are proportional to the numbers, greatly exaggerates the difference between the amounts compared.

### SHORT-CUT METHOD FOR CALCULATING THE SIZE OF CIRCLES

The use of the following method, combined with the table of square roots shown on page 93, will save time and tedious computation in calculating the size of circles.

## RULES

- A. Divide the smaller number by the larger. Express the quotient in a decimal of not more than two digits.
- B. Extract the square root of this quotient. (Table III lists the square roots of decimals from .01 to .99 to three places.)
- C. Multiply the square root by the predetermined diameter of the larger circle. The product will be the diameter of the smaller circle.

Example: Larger number, 500; smaller number, 100. Diameter of larger circle, 6 inches.

- A. 100 divided by 500 equals .20.
- B. Square root of .20 equals .447.
- C. .447 multiplied by 6 inches, diameter of larger circle, equals 2.7 inches, the diameter of the smaller circle.

Large numbers should be rounded to not more than three digits. This will shorten and simplify the calculation considerably, and the quotients will be the same, for drafting purposes, as if the full figures were used in the division. The extraction of the square root, which generally is the stumblingblock for the draftsman, is covered by the table.

Table II illustrates the procedure for calculating the diameters of a number of circles representing figures that vary widely in size. The assumed diameter of the largest circle is 9 inches.

TABLE II  
CALCULATION OF CIRCLE DIAMETERS

<i>Component</i>	<i>Amounts</i>	<i>Amounts Rounded</i>	<i>B, C, D Divided by A</i>	<i>Square Root</i>	<i>Square Root Times 9 Inches</i>
A	126,765	127			
B	88,441	88	.69	.831	7.5 inches
C	37,552	38	.30	.549	4.9 "
D	25,224	25	.20	.447	4.0 "

If a slide rule is used to compute the component ratios and multiplication of the square roots, the calculation of the circle diameters for a chart of five to ten circles should not take more than fifteen minutes. The diameters of the smaller circles (square roots multiplied by the diameter of the largest circle) should be rounded to one decimal place. Drafting to hundredths of an inch is impracticable.

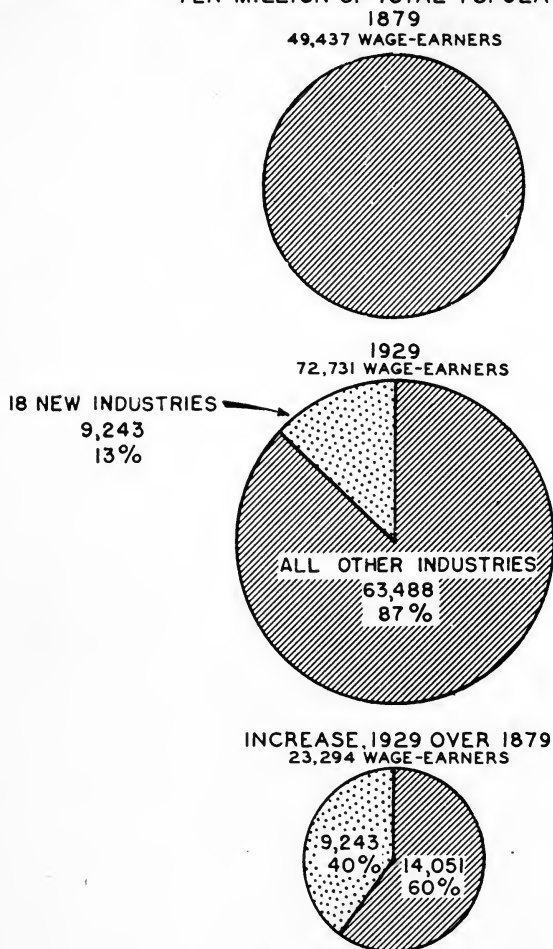
TABLE III

SQUARE ROOTS OF DECIMALS—.01 TO .99

<i>Deci- mal</i>	<i>Sq. Root</i>	<i>Deci- mal</i>	<i>Sq. Root</i>	<i>Deci- mal</i>	<i>Sq. Root</i>	<i>Deci- mal</i>	<i>Sq. Root</i>
.01	.1	.10	.316	.40	.632	.70	.837
.015	.125	.11	.332	.41	.640	.71	.843
		.12	.346	.42	.648	.72	.849
.02	.141	.13	.360	.43	.656	.73	.854
.025	.158	.14	.374	.44	.664	.74	.860
		.15	.387	.45	.671	.75	.866
.03	.173	.16	.4	.46	.678	.76	.872
.035	.187	.17	.412	.47	.685	.77	.877
		.18	.424	.48	.692	.78	.883
.04	.2	.19	.436	.49	.7	.79	.889
.045	.213						
		.20	.447	.50	.707	.80	.894
.05	.224	.21	.458	.51	.714	.81	.9
.055	.235	.22	.469	.52	.721	.82	.906
		.23	.480	.53	.728	.83	.911
.06	.245	.24	.490	.54	.735	.84	.917
.065	.255						
		.25	.5	.55	.742	.85	.922
.07	.265	.26	.510	.56	.749	.86	.927
.075	.274	.27	.520	.57	.756	.87	.933
		.28	.530	.58	.762	.88	.938
.08	.283	.29	.540	.59	.768	.89	.943
.085	.292						
		.30	.549	.60	.775	.90	.949
.09	.3	.31	.557	.61	.781	.91	.954
.095	.308	.32	.566	.62	.787	.92	.959
		.33	.575	.63	.794	.93	.964
		.34	.584	.64	.8	.94	.970
		.35	.592	.65	.806	.95	.975
		.36	.6	.66	.812	.96	.980
		.37	.608	.67	.819	.97	.985
		.38	.616	.68	.825	.98	.990
		.39	.624	.69	.831	.99	.995

## NEW INDUSTRIES AND EMPLOYMENT UNITED STATES, 1879 AND 1929

AVERAGE NUMBER OF WAGE-EARNERS, MANUFACTURING INDUSTRIES,  
PER MILLION OF TOTAL POPULATION



*National Industrial Conference Board*

CHART 74. NEW INDUSTRIES AND EMPLOYMENT (CIRCLE DESIGN).



## CIRCLES COMPARED WITH BARS

A comparison of circles and bars for picturing differences in size, with sectors and segments for subdivisions within components, is shown in Charts 74 and 75. The upper circle in Chart 74 represents the number of manufacturing wage-earners per million of population in 1879, the middle circle the corresponding number in 1929, and the lower circle the increase that took place over the fifty years covered by the comparison. The sectors show the proportions of the increase contributed by old and new industries.

Chart 75 presents the same data in a bar design. It shows more clearly than the circle chart the comparison between the totals for the two years and the extent of the increase contributed by new and old industries. Comparisons of size in the form of circles have the effect of lessening the apparent difference between the quantities compared. The amount represented by the 1879 circle, for example, appears to be not far below that shown by the 1929 circle, although the latter exceeds it by over 47 percent.

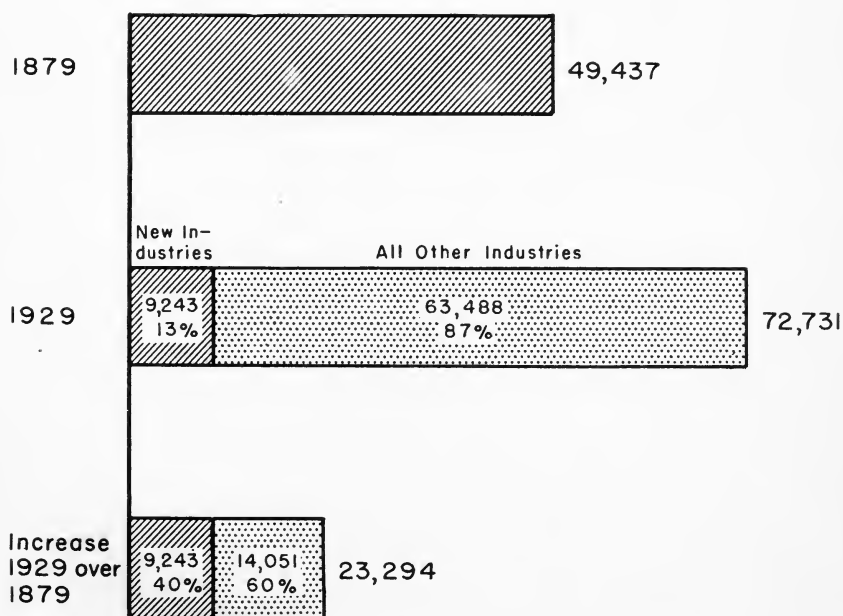


CHART 75. NEW INDUSTRIES AND EMPLOYMENT (BAR DESIGN).

# ■ VIII

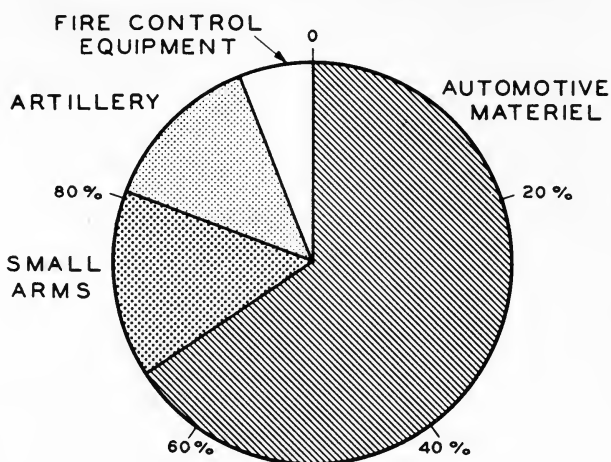
## SECTOR CHARTS

**A**MONG statisticians and draftsmen the common designation for a sector chart is “pie” chart. It is less effective than bar and column designs for accurate reading and interpretation, particularly if the series contains a considerable number of components or if the difference between components is slight. The components “Small Arms” and “Artillery” in Chart 76, which compares sector and bar designs, are an example. In the sector chart they appear to be almost the same size, while in the bar chart below the difference between them stands out clearly. The eye can compare linear measurements more accurately than it can areas of sectors or arcs of a circle.

### ORDER OF SECTORS

The standard practice in drafting sector charts is to begin with the largest sector at the central point of the upper half of the circle. The arrangement of sectors is from right to left in order of size. If the chart contains an “All Other” or “Miscellaneous” sector representing a num-

DISTRIBUTION OF VALUE  
OF EQUIPMENT - BY MAJOR GROUP



DISTRIBUTION OF VALUE  
OF EQUIPMENT - BY MAJOR GROUP

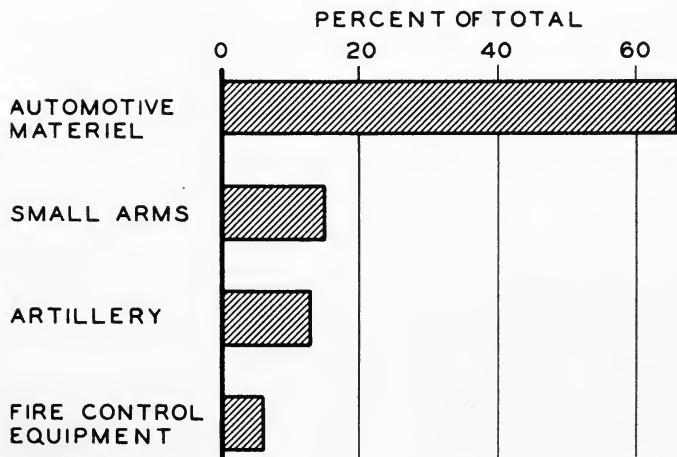


CHART 76. COMPARISON OF SECTOR AND BAR CHARTS. ADAPTED FROM  
*Standards of Presentation*, ARMY SERVICE FORCES.

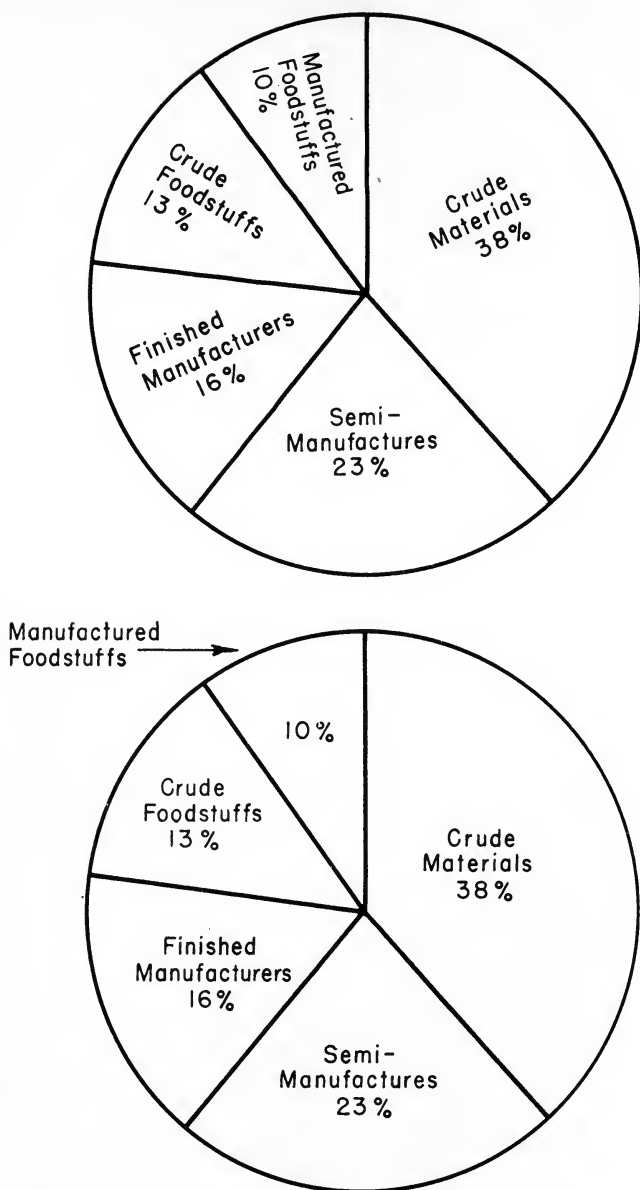


CHART 77. IMPORTS, UNITED STATES, BY ECONOMIC CLASSES: 1942.

ber of small components, this is placed last in the series of sectors, irrespective of its rank in order of size.

LETTERING OF SECTOR CHARTS

Sector charts should not be lettered radially, following the angle of the individual sectors. The lettering of component titles should be horizontal, within the sector if not too crowded, outside the circle if the sector is too small to carry the lettering horizontally. The figures should be lettered, if possible, within the sectors. The two methods are illustrated in Chart 77, which represents a percentage distribution, by economic classes, of United States imports in 1942. As the title of the last sector is too long for horizontal lettering within the circle, it is placed outside, with a connecting arrow to the sector.

GROUPING OF SECTORS

Grouping of sectors may be indicated in various ways. A curved line drawn outside the circle, extending between the limits of the group and lettered with the group designation, is commonly employed for this purpose. Another method, illustrated in Chart 78, consists of a narrow band of shading placed around the grouped sectors.

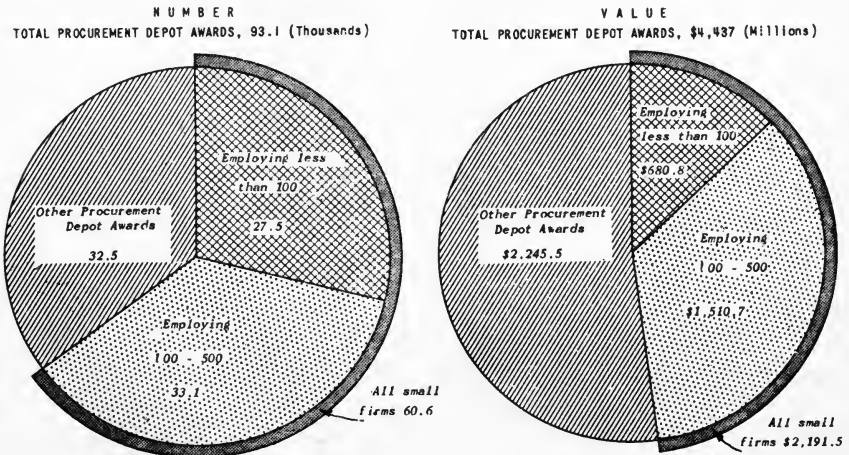


CHART 78. CONTRACT AWARDS TO SMALL FIRMS: 1944. FROM *Statistical Yearbook*, QUARTERMASTER CORPS.

MINIATURE SECTOR CHARTS

The sector type in miniature sizes may be used effectively for comparing in a single chart a considerable number of components subdivided into percentages or broken down on some other basis. The accompanying example, Chart 79, represents the troop distribution by source of sixteen National Guard divisions in World War I. The black portion of each circle shows the part of each division drawn from the National Guard, the shaded portion represents troops drawn from the National Army and other sources, and the unfilled gap the proportion each division was short of its authorized strength when it sailed from this country. The names of the States from which the National Guard

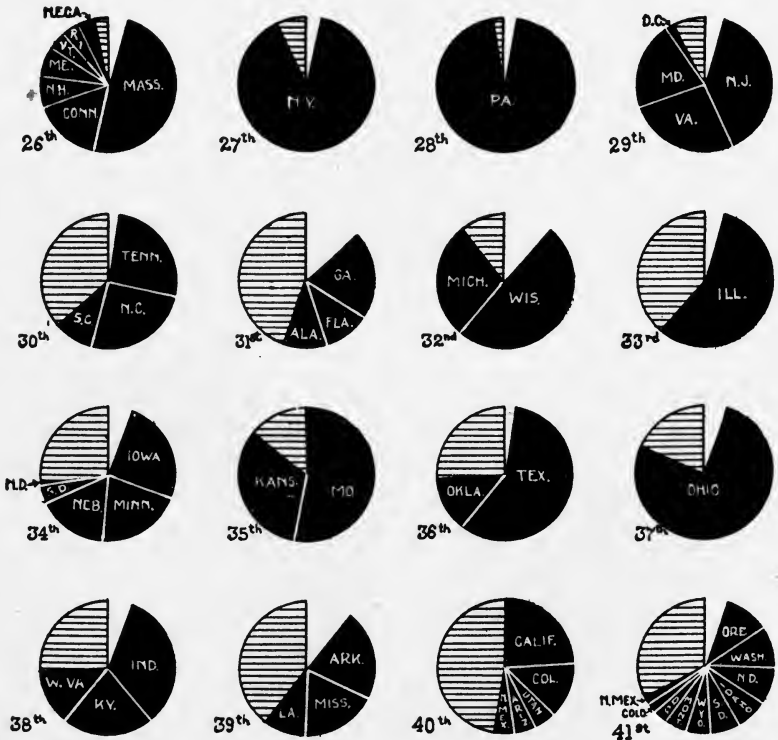


CHART 79. COMPOSITION OF NATIONAL GUARD DIVISIONS, WORLD WAR I. FROM *The War with Germany*, BY LEONARD P. AYRES.

contingents were drawn are lettered in white on the black sectors. The figures outside the circle to the left are the division numbers.

### SEPARATION OF SECTORS FOR EMPHASIS

The importance of an individual sector may be emphasized by the method illustrated in Chart 80. This variation in design is little used. It is frequently criticized as tending to concentrate the attention solely on a single feature of the chart.

### CAUSES OF DELAYS IN MAY DELIVERIES SIGNAL CORPS - 1942

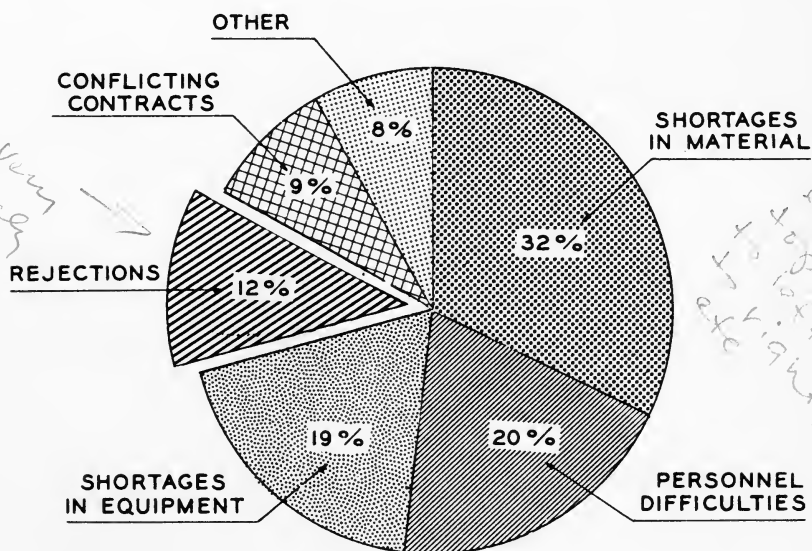


CHART 80. ADAPTED FROM *Standards of Presentation*, ARMY SERVICE FORCES.

### OMISSION OF SHADING

Sector charts do not require strong contrasts. Charts of this type with all shading omitted, although not as striking in appearance, are often quite as effective in conveying a correct impression of the relative values as would be secured with shading or color. If the titles are long, the

lettering will occupy so much space within the sectors that most of the advantage of contrasting shading is lost. In Chart 81, for example, the titles of the fourth and fifth sectors are so long that nothing would be gained by surrounding them with narrow strips of shading.

Overloading is the commonest fault in the planning and drafting of sector charts. If the number of sectors exceeds five or six, the lettering is likely to be crowded and confusing, with too many patterns of shading or varieties of color. Simplicity, the first essential in all charts, is of special importance in designs of this type.

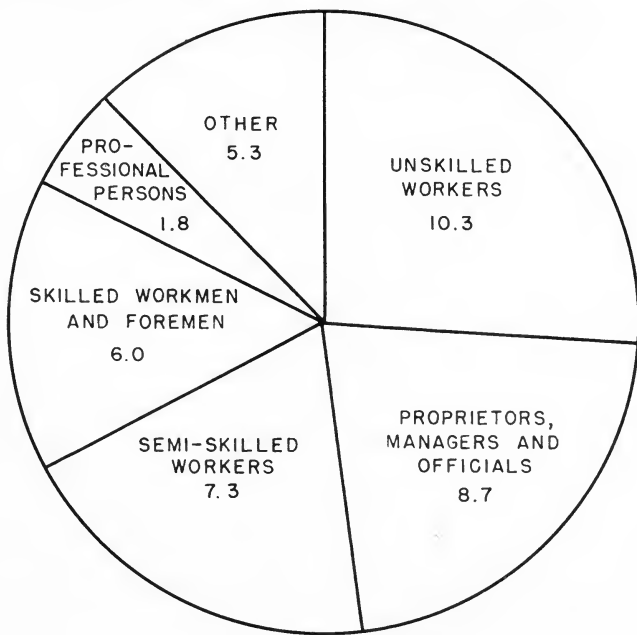


CHART 81. DISTRIBUTION OF MALE LABOR FORCE 14 YEARS OLD AND OVER, UNITED STATES: 1940 (IN MILLIONS).

### SECTOR TOTALS

Totals of a number of components should not be represented by interior arcs drawn across the sectors. Chart 82, in which the lower arc represents the sum of the expenditures by the War and Navy Departments, although the total corresponds in actual size to the larger arc of the circumference, is an example. Subdivisions of a total may be shown



by light dash lines, as in the second chart, or by different patterns of shading, but the total should be lettered outside the circle.

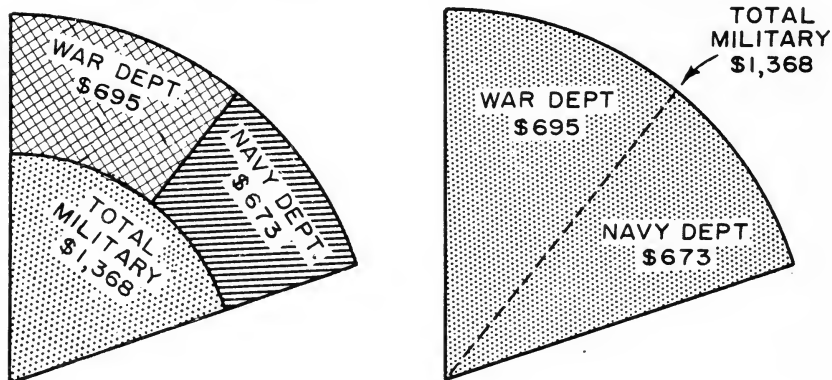


CHART 82. MILITARY EXPENDITURES, UNITED STATES: 1939 (MILLIONS OF DOLLARS).

## ■ IX

### STATISTICAL MAP CHARTS



**M**AP charts are employed to show the geographical distribution of statistical data. If they are to be small-sized, map charts are generally made with outline maps on which the boundary and division lines of the geographical units are printed. Outline maps on paper, ranging from letter size to several feet square, can be obtained from firms specializing in map production. The outlines for display maps on illustration board, where no copy of the size required is available, must be drafted. This is a difficult job, but a photostat of a small map blown up to the dimensions of the display outline will serve as a useful guide in the lay-out and drafting of the display-size map.

About all a small map chart can accomplish graphically is to indicate the geographical distribution of the data, with a rough measure of the gradation in size of the numerical components. Attempts to show fine distinctions and small differences are nearly always ineffective. They only complicate and render more difficult a clear understanding of the general purpose for which the chart is planned.

USE OF COLORS

Solid colors and colored shadings are generally used on maps not intended for printed reproduction, although the effect of gradual transition from high to low volume or size of the categories is not as clear as with black shadings. Red is often used to designate the highest category, blue and green for the next two, followed by shadings of these colors, with yellow for the lowest category. Care should be taken to avoid harsh color contrasts. Light tints are more effective and have a more pleasing appearance than dark colors.

MAPS WITH SURFACE DESIGNATIONS OF CATEGORIES

The method most generally used for charting statistical data in maps is illustrated in Charts 83 and 84. Chart 84 is a section of a United States

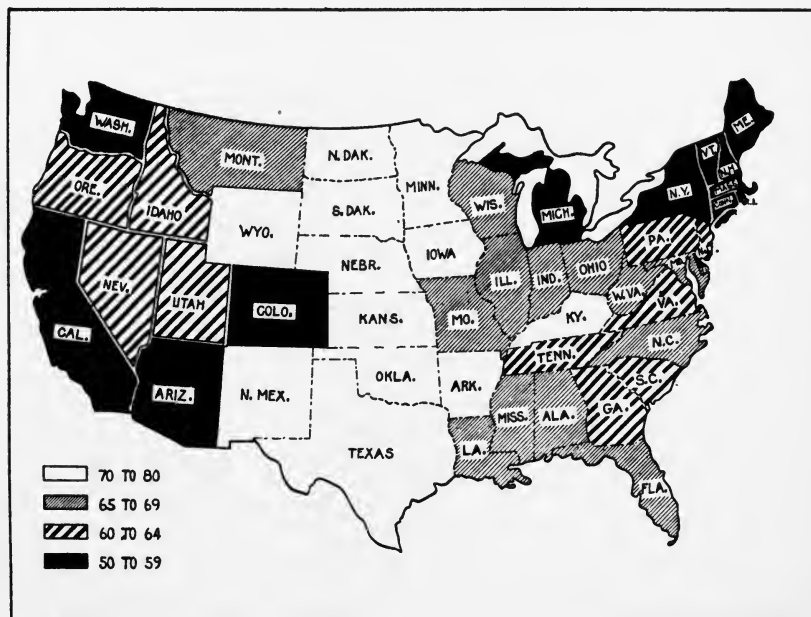


CHART 83. PERCENT OF DRAFTED MEN PASSING PHYSICAL EXAMINATION, BY STATES, WORLD WAR I. TAKEN FROM *The War with Germany*, BY LEONARD P. AYRES.

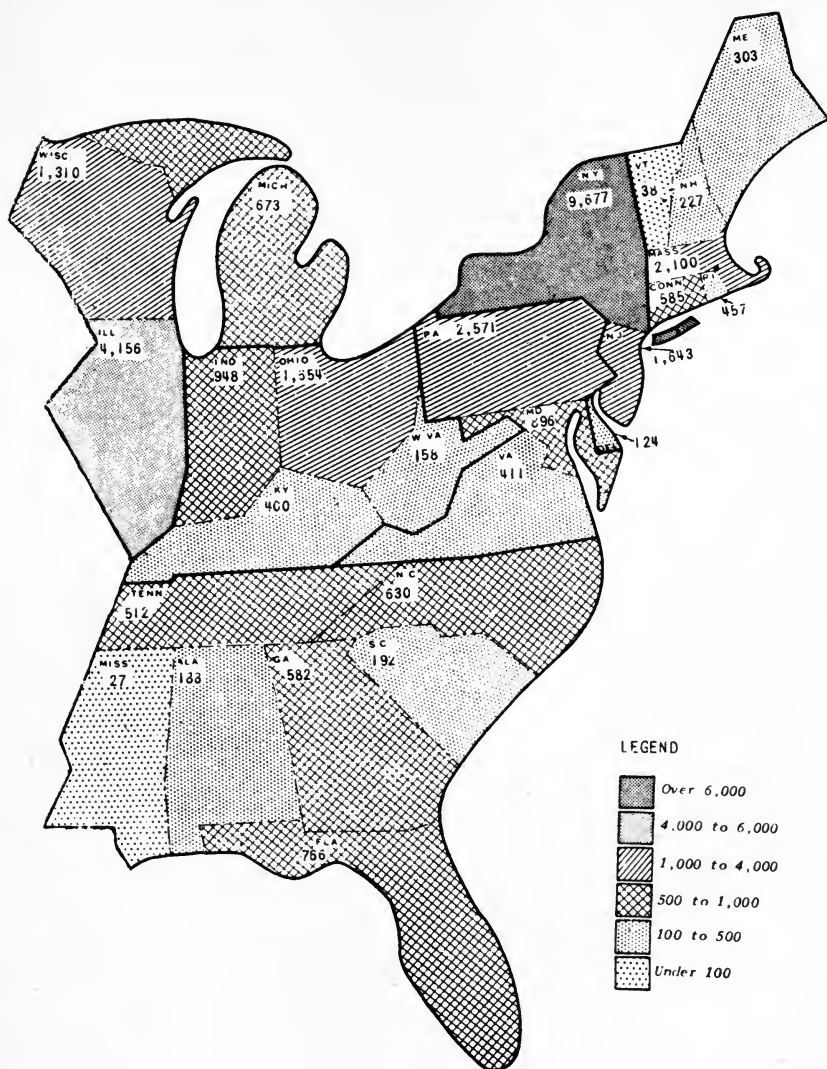


CHART 84. NUMBER OF CONTRACTS AWARDED IN EACH STATE IN 1944.  
 FROM *Statistical Yearbook*, QUARTERMASTER CORPS.

map representing the distribution by States of quartermaster depot contract awards in 1944. The grouping of the data in six categories is indicated by the key at the lower right of the chart.

This type of map chart is the clearest and easiest to read and costs the least in labor and time for drafting. As the adhesive colors and shadings come in large sheets, an application for a single category may cover half or, with small maps, all of the surface. The areas which are not in that particular category can be cut out in a few minutes. If figures for each geographical unit are shown, the color or shading is afterward cut out around them so they will stand out clearly. Or the figures, lettered on strips of white paper, can be pasted in each geographical unit.

The outline for Chart 84 was smoothed to save the time required for duplicating the exact configuration of the bays and inlets of the Atlantic Coast and the windings of State river boundaries.

The use of white space to represent one of the categories is illustrated in Chart 83, page 105. It is fully as effective as the addition of a fourth shading would have been.

## DOT MAPS

In Chart 85 the distribution of values is shown by small dots of equal size plotted by localities within the States. The drafting of a chart of this type is laborious and time-consuming. Each dot represents an indi-

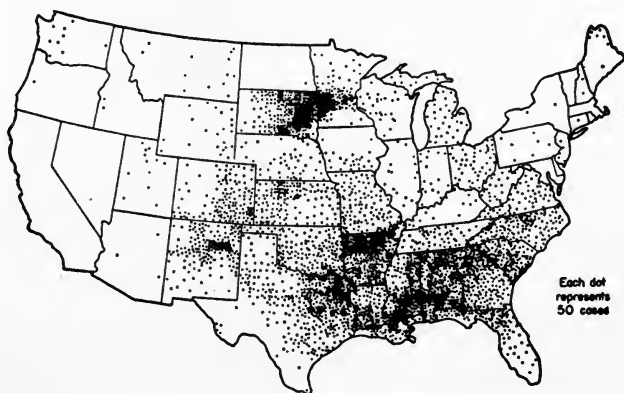


CHART 85. RURAL REHABILITATION CASES RECEIVING ADVANCES OF CAPITAL OR GOODS: 1935. FROM *Rural Youth on Relief*, WPA, DIVISION OF SOCIAL RESEARCH, 1937.

vidual plotting. The number of plottings in this chart runs to over one thousand.

The use of dots on map charts is open to the objection that in localities of high concentration, where the dots overlap, no variation in the data can be shown. The area becomes a black cloud on which no additional plottings will register.

## MAPS WITH CIRCLES

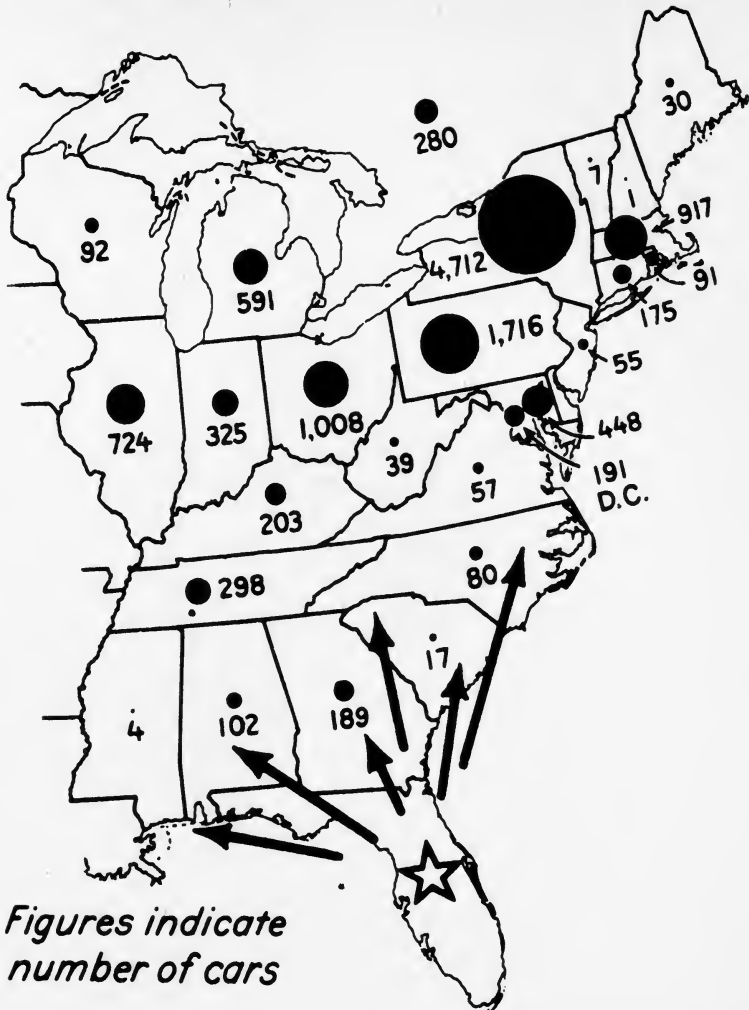
Chart 86 is a section of a map published by the Bureau of Agricultural Economics representing the distribution of Florida grapefruit in the 1932-33 season. The figures accompanying the circles add greatly to the clarity of the presentation. The circles alone, due to the difficulty of comparing circular areas, do not convey a clear impression of the difference in the amounts. For example, the circles in Illinois and Ohio appear to be nearly the same size, yet the figure for Ohio exceeds that for Illinois by 40 percent.

Objections to the use of circles for extended series in map charts are the length of time required for the calculation of the diameters and the close plotting of minute differences in size. Even employing the shortcut method described in Chapter VII, the various steps that must be gone through to compute the diameters of circles for forty-eight States consume several hours of time. The plotting and inking of forty-eight circles, if accurately done, takes at least as long. When the ineffectiveness of circles for comparisons of size is added, there is not much to be said in favor of their use in map charts containing a considerable number of geographical units.

The difference in the size of the States presents a problem in drafting United States map charts if the data are to be shown with circles. In most economic distributions the numbers for the New England and contiguous States are likely to be large. A circle which in the States of the South or West may be a mere dot has to be made so large in the lower New England States that it blots out all other details. Frequently the circles for Rhode Island, Connecticut, and Delaware must be placed at the right of the chart, outside the State boundaries.

## MAPS WITH COLUMNS, BARS, OR CURVES

On map charts comparisons of size in the form of columns are diffi-



U.S. Department of Agriculture

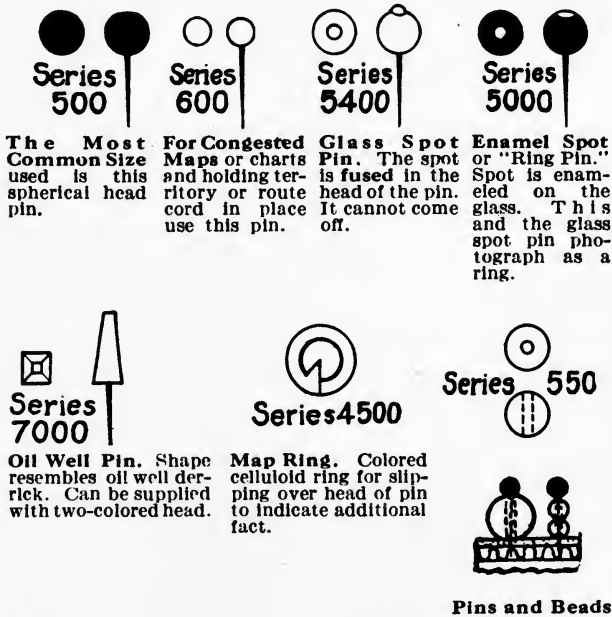
CHART 86. DISTRIBUTION OF FLORIDA GRAPEFRUIT IN THE 1932-33 SEASON.

cult to interpret, due to the lack of a common base. Time series shown as curves, columns, or bars are open to the same objection. They complicate the chart by presenting too many types of comparisons at the same time. The primary purpose of a statistical map chart is to show two things: geographical location and differences in size. The inclusion

of additional aspects of the data, difficult to read and compare, tends to obscure a clear impression of the main objective of the chart.

## PIN AND TACK MAPS

Geographical distributions on wall maps may be shown by means of map tacks or pins of various forms or colors. Strings of beads or colored yarn may be employed for connecting lines or for curve effects. The facility this method offers for quickly making changes and adding new data makes it especially adapted for a continuing record of changing conditions. No skill or knowledge of drafting is needed for the preparation and maintenance of such charts. Figure 2 illustrates some of the map tacks in current use.



*Educational Exhibition Company, Inc.*

FIGURE 2. MAP TACKS FOR LARGE MAP CHARTS.



## FLOW MAPS

This designation covers an extensive variety of designs and purposes. Some types, such as traffic maps, show direction of movement with connecting lines. Both direction and volume may be shown by thickening the portions of the line or curve representing heavy volume of traffic or by repeating the curve in parallel or converging lines. The latter method is frequently used for charting ocean routes of travel or commerce. Map charts in which certain localities, cities, or centers of distribution are connected with other points on the map by single straight or curved lines to show a particular relationship are also classed as flow maps. Many of these types are simple in design and in drafting. Those in which the thickness of the curve or line represents varying magnitudes of the data are difficult to plot accurately, as the variations on such a small scale are necessarily minute.

## KEYS

Nearly all map charts require the addition of keys to identify the colors or shadings in the chart. If the distribution of the data by size is markedly irregular, the selection of categories may have to be made without much regard for uniform gradation in amounts. The number of keys should be kept down, if possible, to not more than five or six.



## PICTORIAL CHARTS

**T**HE value of pictorial charts for presenting statistical facts depends chiefly on how and for whom they are used. They are well suited for illustrations in newspapers and magazines and for any type of audience requiring novelty in form of presentation to attract attention and interest. The use of pictorial figures does not give the best results, as a rule, in charts prepared for business or professional men, who generally prefer the simpler conventional types of design, without ornamental or pictorial trimmings.

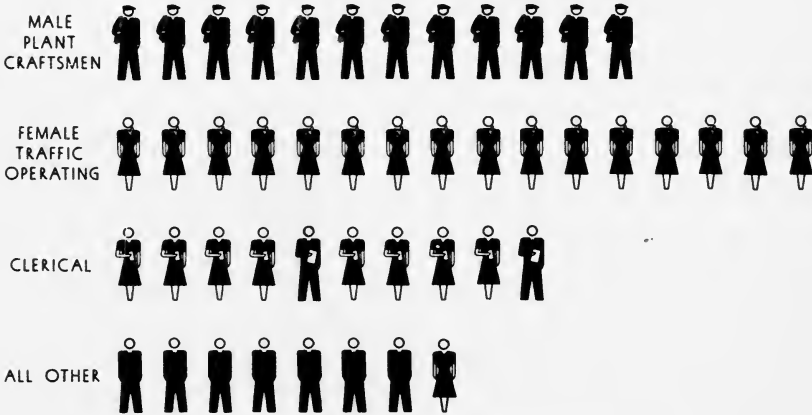
Pictorial charts may be used effectively, if they are accurately drawn, in showing simple comparisons of size. However, many published pictorial comparisons representing the human figure are misleading, due to the fact that in the drafting only one dimension, that of height, is taken into account, while the impression received by the observer is that of volume or bulk. Drawings of this kind, based on a single dimension, always exaggerate the difference between the numbers compared.

BAR PICTORIAL CHARTS

A bar pictorial design frequently used is made up of rows of small figures or symbols equal in size, each representing a stated number of units. The chief problem in planning a chart of this type is the selection of figures or symbols sufficiently representative of the components to make the association obvious to the observer. Otherwise they are less effective than the ordinary rectangular-bar designs. Examples as far-fetched as a spool of thread to represent the textile industry or an ax for the lumber industry are occasionally seen.

Chart 87, representing the employee distribution in a large telephone company, is an example of the bar pictorial type. The figures in each bar suggest the type of occupation designated in the stub.

NUMBER OF EMPLOYEES



EACH SYMBOL REPRESENTS 1000 EMPLOYEES.

*American Telephone and Telegraph Company*

CHART 87. TYPICAL DISTRIBUTION OF EMPLOYEES IN A LARGE TELEPHONE COMPANY.

A large variety of pictorial symbols printed in sheets may be obtained from firms engaged in the production of material for this type of graphic presentation. A few samples are shown in Chart 88. Charts representing industrial data are sometimes made of small drawings of machinery, materials, or products. If special designs are required, they

should be drawn oversize and reduced photographically for duplication by photostat or offset printing.



*The Pictograph Corporation*

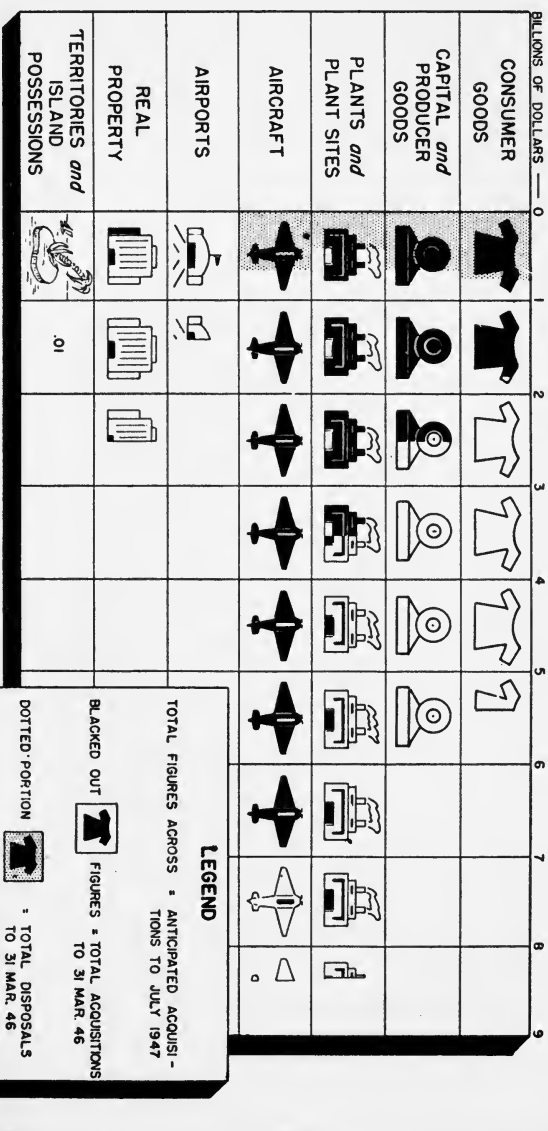
CHART 88. PRINTED SYMBOLS FOR USE IN BAR PICTORIAL CHARTS.

Both the advantages and the disadvantages of the pictorial method are illustrated in Chart 89. The chart was copied from the first quarterly report of the War Assets Administration in 1946. It is unquestionably much more striking in appearance than a plain bar chart of the same data would be. The pictorial figures for "Plants and Plant Sites" and "Aircraft" probably aid the reader to some extent in visualizing these components. It is doubtful whether the others add anything to the presentation. An undershirt is hardly representative of the thousands of miscellaneous items listed as consumer goods, nor a motor of the huge variety of surplus capital and producer goods.

# Outlook

## FOR SURPLUS PROPERTY DISPOSALS

BILLIONS OF DOLLARS — 0



### LEGEND

TOTAL FIGURES ACROSS : ANTICIPATED ACQUISITIONS TO JULY 1947

BLACKED OUT FIGURES : TOTAL ACQUISITIONS TO 31 MAR. 46

DOTTED-PORTION : TOTAL DISPOSALS TO 31 MAR. 46

War Assets Administration

CHART 89.

## ■ XI

### MISCELLANEOUS TYPES

**T**HE types of design described in the preceding chapters comprise those that are most commonly used for the graphic presentation of statistical facts. The examples discussed in this chapter include a number of variations and adaptations of the basic types, employed to bring out clearly special aspects of the subject-matter.

#### RANKING CHARTS

Charts 90 and 91 present two methods for comparing series in which the components are arranged by order of their rank in a common attribute. In Chart 90 a number of commodity groups are ranked at two different periods on the basis of wholesale-price levels. In the first column the groups are ranked on the monthly average in 1939, and in the second, on the price level in December, 1945. The change between the two periods is indicated by the connecting dash lines. This method is effective with short series, but if the chart includes a

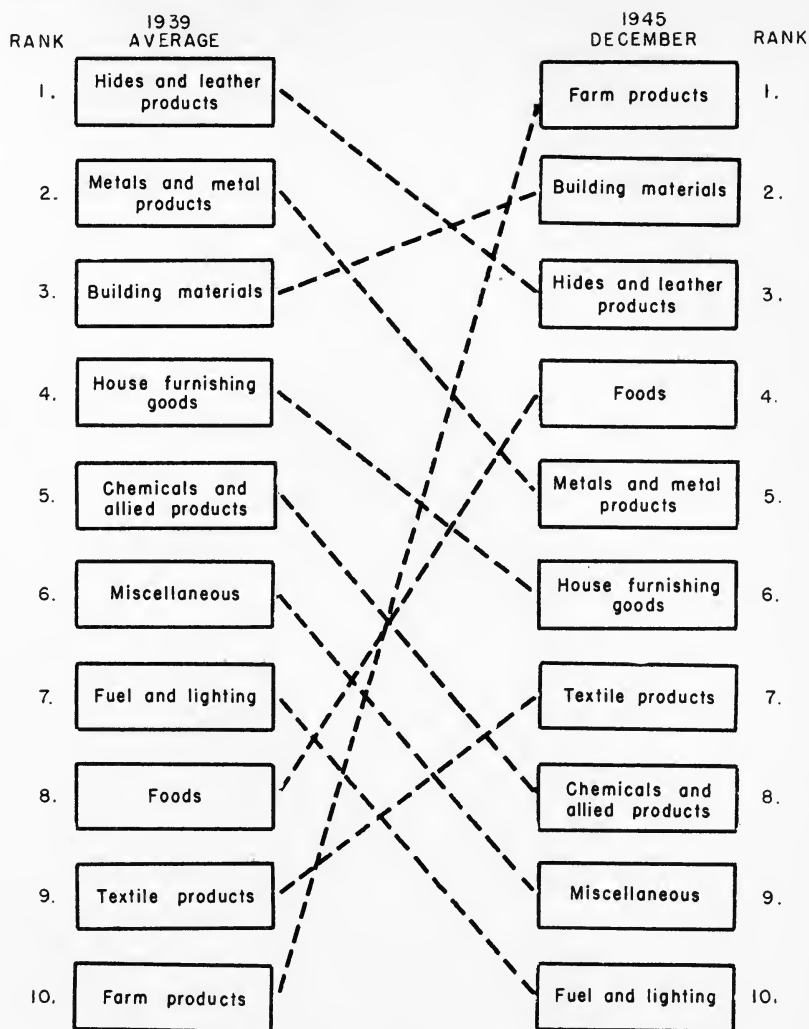


CHART 90. RANK OF COMMODITY GROUPS BASED ON WHOLESALE PRICES: 1939 AVERAGE AND DECEMBER, 1945.

large number of components, the criss-crossing lines become too confusing for easy reading.

In Chart 91 the States are arranged in order of total ranking in ten educational features. The range in each feature for the whole country

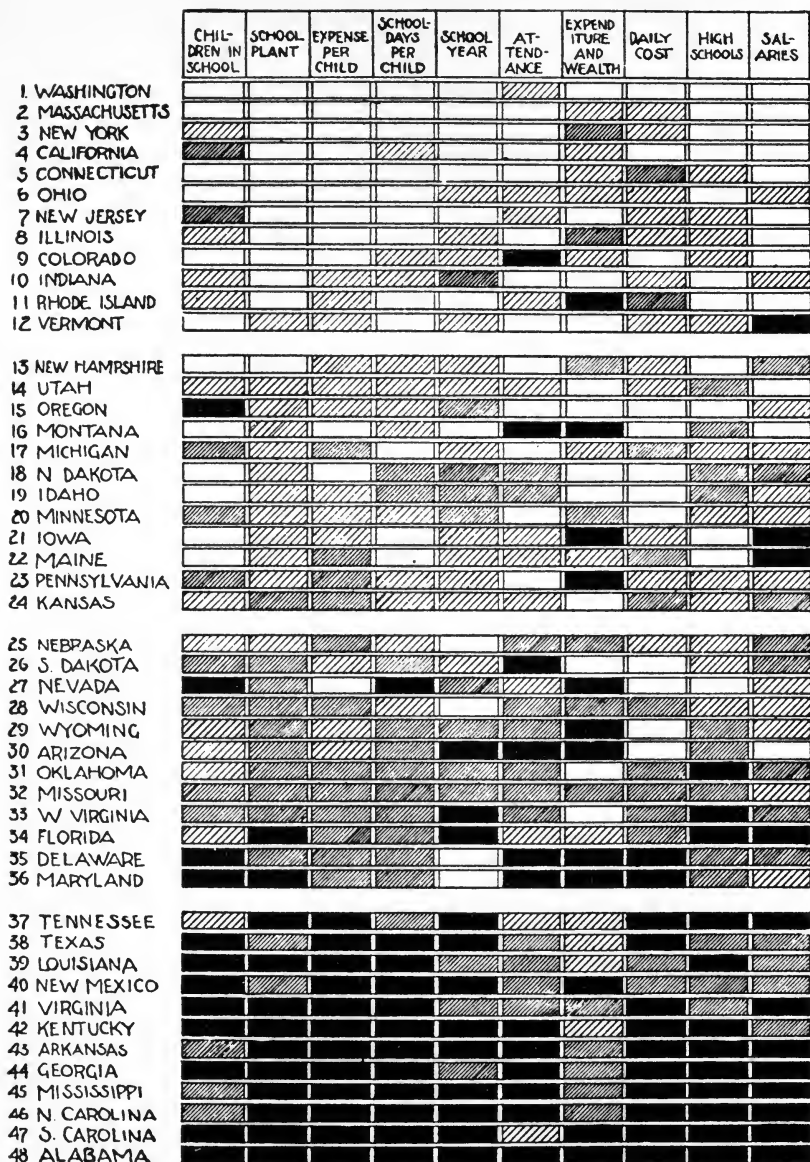


CHART 91. RANK OF EACH OF THE UNITED STATES IN TEN EDUCATIONAL FEATURES: 1910. FROM GREENWICH EDUCATIONAL SURVEY.



was first determined. If a State ranked in the upper 25 percent of this range, it was represented by a white oblong, if in the next 25 percent, by a light diagonal shading, if in the third, by a darker shading, and if in the lowest group, by a solid black oblong.

This method of classification placed Washington at the head of the list of States, with only one feature rated below the upper 25 percent. Alabama came last, its ratings in all ten features falling within the lowest percentage group.

FREQUENCY-DISTRIBUTION CHARTS

The planning and drafting of frequency-distribution charts follow closely the methods employed in charting time series in curve and column designs. The chief difference is that the horizontal scale represents categories of size, value, or some other attribute, instead of periods of time. If the basic units are too numerous for individual plotting, they are grouped in class intervals. This method is illustrated by Chart 92, in which each unit of the scale represents a class interval of five years.

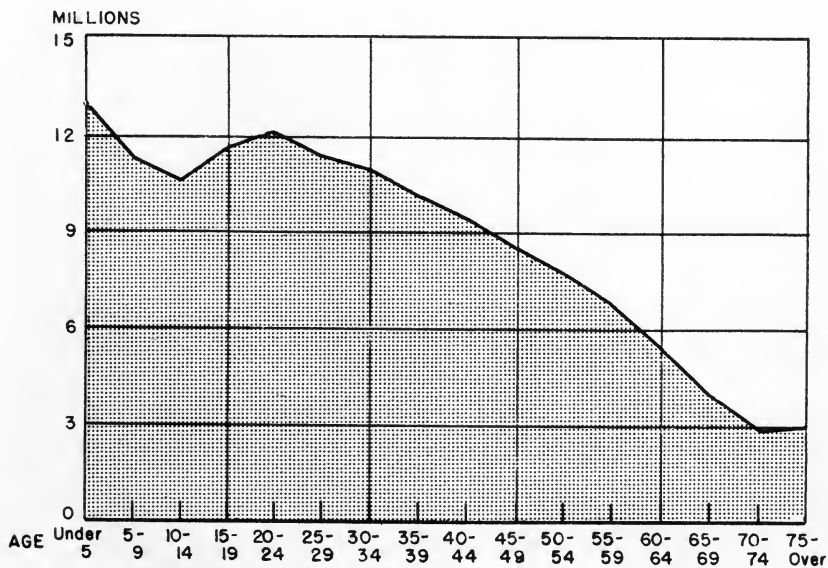


CHART 92. ESTIMATED POPULATION, UNITED STATES, BY AGE GROUPS: 1945.

The curve design is generally employed for frequency distributions of long series which require close plotting. The use of columns for short series is illustrated in Chart 93. The data are estimates by the Census Bureau of the weekly hours worked during the third quarter of 1945 by employees fourteen years old and over in non-agricultural occupations. The horizontal scale represents the categories of hours worked, and the columns the number of employees in each category.

The zero base should not be omitted from the amount scale in charts of this type. The horizontal scale may begin at any point selected as the first unit or class interval of the range covered by the series.

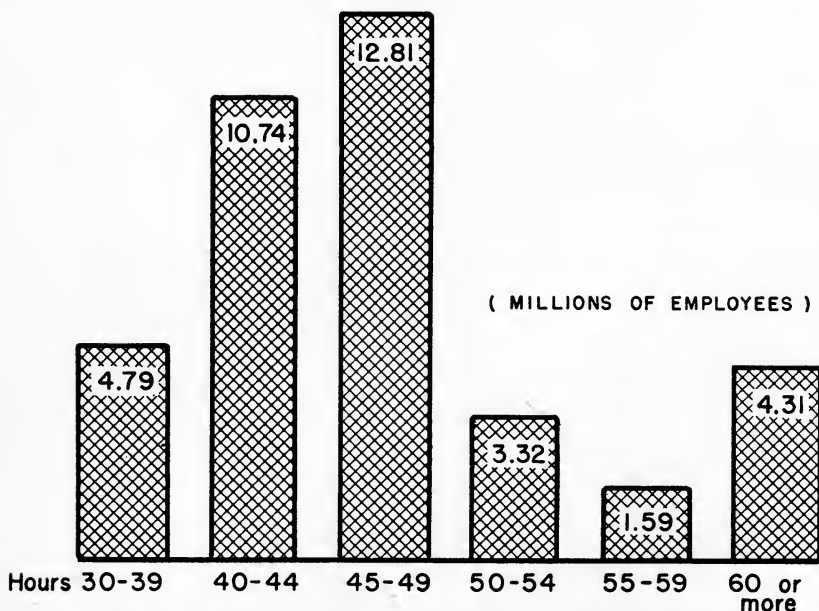


CHART 93. ESTIMATED WEEKLY HOURS WORKED, NON-AGRICULTURAL EMPLOYMENT: THIRD QUARTER, 1945.

### RELATIVE-VARIATION CHARTS

A type of chart which was used extensively during the last war for comparing monthly fluctuations of stocks and procurement of equipment and supplies is illustrated in Charts 94 and 95. The grids

of the components in Chart 94 are equal in size. In all of them the highest amount of the monthly series was plotted at exactly the same distance below the upper line of the grid. The amount scales were then adjusted to this measure and the remaining points of the curves plotted to the adjusted scales. For example, the highest figure of stocks in the first item of Chart 94, "Blankets, Wool, OD, M-1934," was 5,936,000, reached in February. This high point was plotted one eighth of an inch below the upper grid line. In the second chart, "Cutter, Wire, M-1938," the high point for the year was 85,000, which was reached in October. This amount was plotted at the same height above the base as the maximum variation in the first chart. The same procedure was followed with the other equipment items. In all of them the high point of the series occupies the same vertical position.

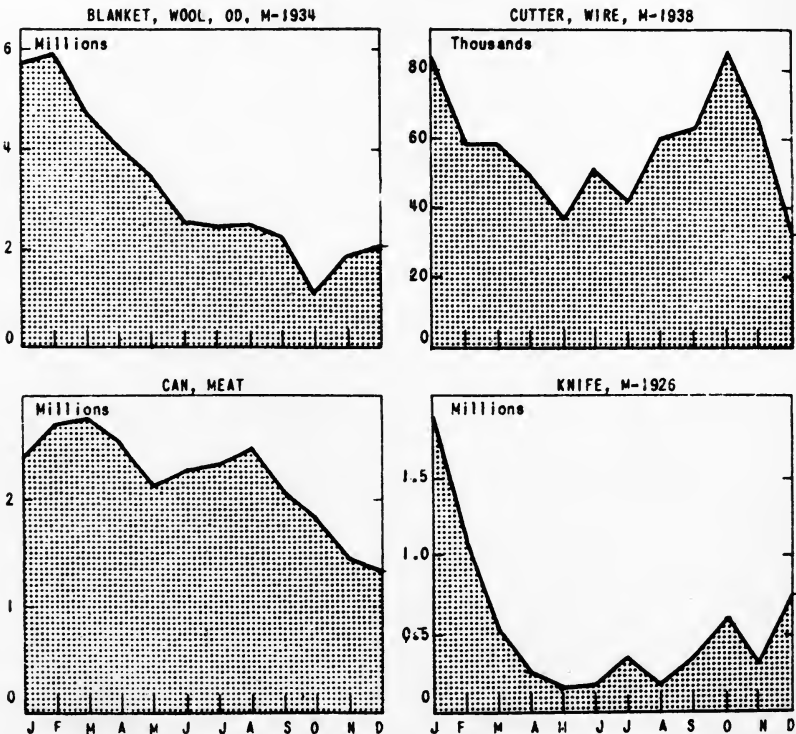


CHART 94. RELATIVE MONTHLY VARIATION—STOCKS, SELECTED EQUIPMENT ITEMS: 1944. FROM *Statistical Yearbook*, QUARTERMASTER CORPS.

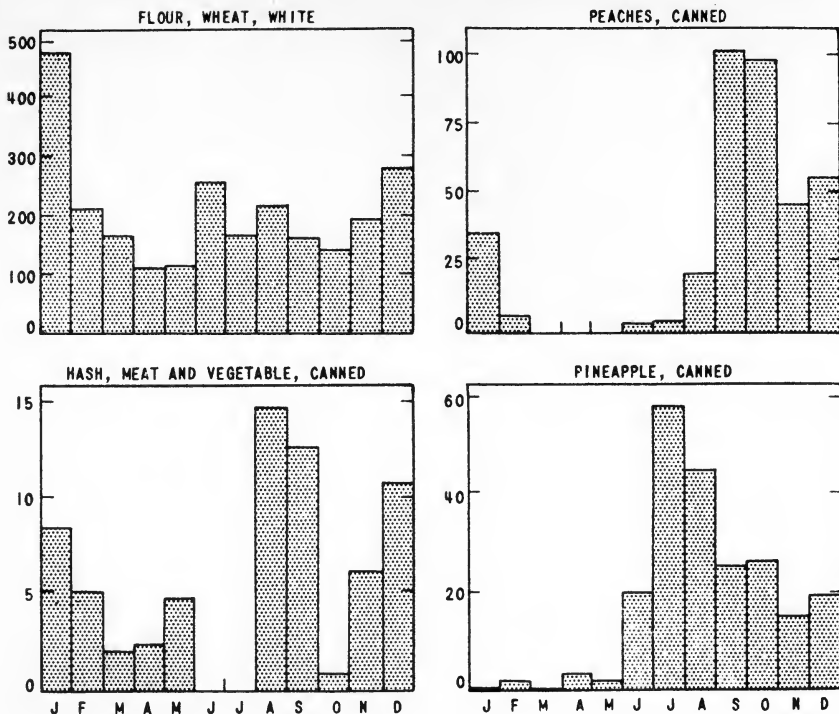


CHART 95. RELATIVE MONTHLY VARIATION—NON-PERISHABLE SUBSISTENCE PLACED ON CONTRACT, SELECTED ITEMS: 1944. FROM *Statistical Yearbook*, QUARTERMASTER CORPS.

Chart 95 shows the same type of comparison in a column design. It represents the quantity, in millions of pounds, of various non-perishable subsistence items placed on contract each month in 1943. The highest columns in all the charts are exactly the same height, although the quantities they represent range from 13 million to 479 million pounds.

These examples were copied from printed sheets 7½-by-10½ inches in size, each containing twelve charts. They are quite as effective for comparing relative changes in series of different magnitudes as the rate-of-change type of design and are more easily understood. Compared with the employment of percentages or index numbers, this method has the advantage that it obviates the necessity for conversion of the basic data to relative numbers.

ORGANIZATION CHARTS

Distributions of functions and personnel may be shown graphically in a wide variety of designs. Chart 96, representing a theoretical distribution of executive and administrative functions in an industrial corporation, is an example of the type frequently employed for this purpose.

The chart units may be represented by oblongs or circles. Oblongs are generally preferred if names of personnel are to be lettered within the units. Colored inks may be used to differentiate various types of functions, the units grading from a strong color for the higher executive positions to lighter tints or colors for the minor units.

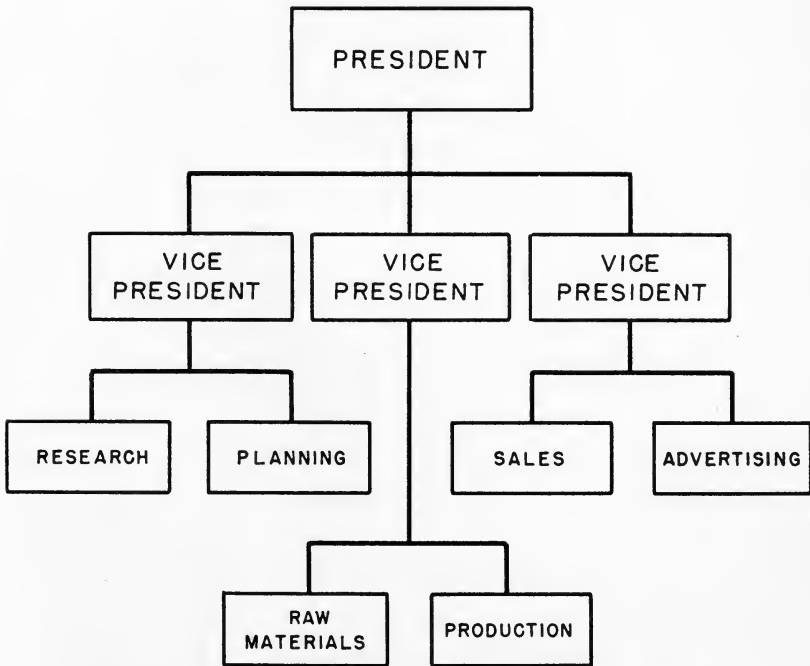


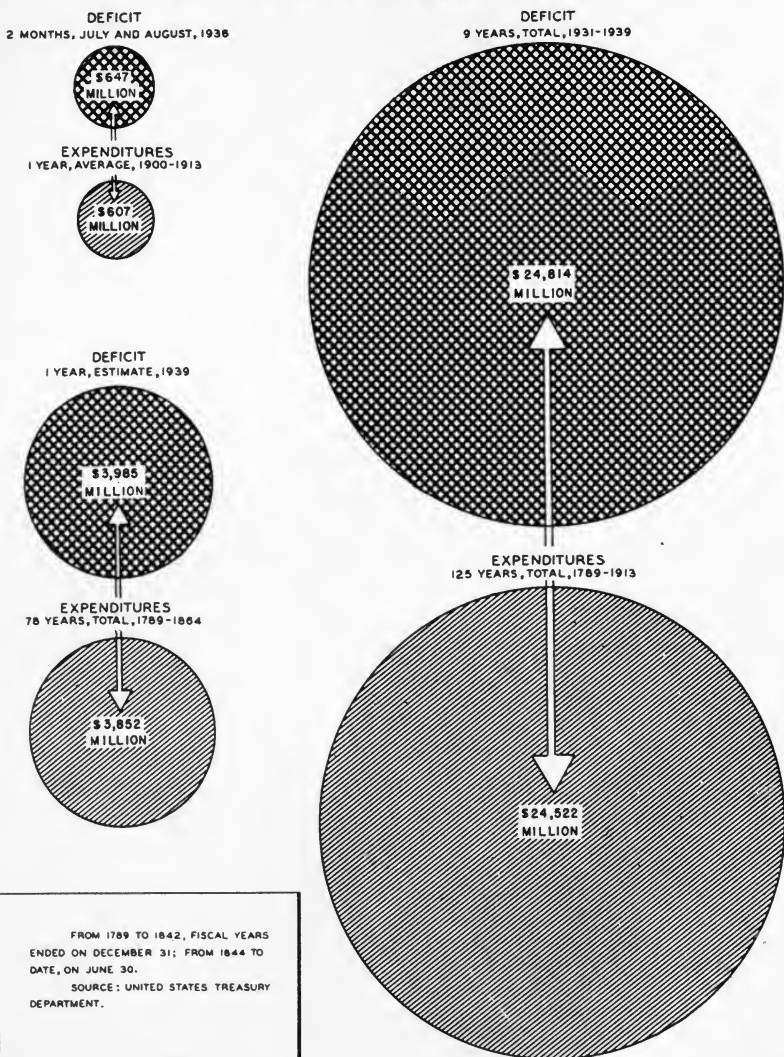
CHART 96. TYPICAL ORGANIZATION-CHART DESIGN.

COMPARISON OF EQUAL AMOUNTS WITH CIRCLES

Chart 97 is an example of the employment of circles for the com-

## THE DEFICIT IN PERSPECTIVE

### COMPARISON OF FEDERAL GOVERNMENT EXPENDITURES AND DEFICITS, FISCAL YEARS



*National Industrial Conference Board*

CHART 97.

parison of amounts which are approximately equal in size but which differ inherently in a given attribute. The upper and lower circles in the first chart represent respectively the Federal deficit for two months in 1938 and the average yearly expenditures from 1900 to 1913. The second chart is a similar comparison of the estimated deficit in 1939 with the total expenditures over the 76-year period from 1789 to 1864. The third chart compares the total deficit for the nine years from 1931 to 1939 with the total expenditures over a period of 125 years, 1789 to 1913.

CIRCULAR-BAR DESIGN

In Chart 98 a circular arrangement of the bars representing the values is substituted for the vertical sequence usually employed in bar

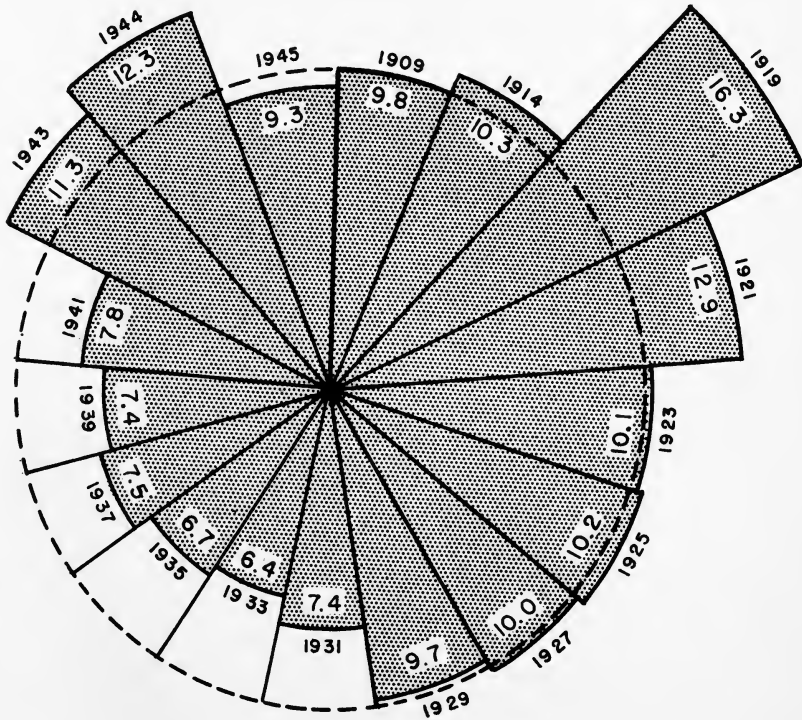


CHART 98. EXPORTS, U.S. MERCHANDISE, AS PERCENT OF TOTAL EXPORTABLE GOODS: 1909 TO 1945.

charts. The percent figures lettered on each bar show the proportion of total exportable goods represented by American exports of merchandise at various periods from 1909 to 1945.

Apart from its pictorial quality, this design offers little if any advantage to the reader over the conventional bar arrangement. It is not as easy to read and understand. However, striking variations from the standard forms, of this or other types, are sometimes desirable in charts for publication in newspapers and popular magazines, where novelty in design is required to catch the attention of the casual reader. They should be limited to a single aspect of the data, and are usually not adapted for presentations involving the use of more than one pattern of shading or color.



## ■ XII

### ELEMENTARY TRAINING METHODS

**T**HE preceding chapters describe the main types of design employed in statistical charts. The remaining chapters are devoted to suggestions and instruction for readers who may be interested in preparation for work of this character.

The simple course outlined in this and the following two chapters was planned for beginners who have had no experience in designing or drafting statistical charts. Special emphasis is placed on study and practice in planning, lay-out, and plotting methods. Manual skill in the use of drafting instruments, although essential, is secondary to a thorough understanding of these fundamental procedures. The use of ink should be postponed until a fair degree of proficiency is reached in designing and plotting charts in pencil.

A start can be made with no other equipment than a supply of printed graph paper, an ordinary ruler, and a typewriter. Practice with ruled forms affords a means for acquiring some knowledge of elementary principles without the complication of handling unfamiliar drafting instruments at the same time.

## CHARTS ON PRINTED GRAPH PAPER

Printed graph paper can be obtained in a variety of rulings. Samples of five different rulings are shown in Figure 3. Of these, the most useful for chart purposes are the 5 and 10 per inch. The 6 ruling corresponds to vertical typewriter spaces, and the 12 and 10 to horizontal spaces of elite and pica type.

In Chart 99 the grid ruling and curve plotting were done before the typing of the title and scales. The time scale covers 12 years, but, as the plotting is to line, the grid lay-out covers only 11 spaces. The ruling of the graph paper is 5 to the inch. Allowing 2 rulings per space, the grid measures 22 fifths or  $4\frac{2}{5}$  inches wide. The amount scale, at 1 vertical space per billion dollars, takes almost 13 spaces, but, in order to keep the scale in multiples of 5 and leave some space above the highest plotting, it was extended to 15 fifths or 3 inches. The curve and grid lines were drawn with ruler and pencil.

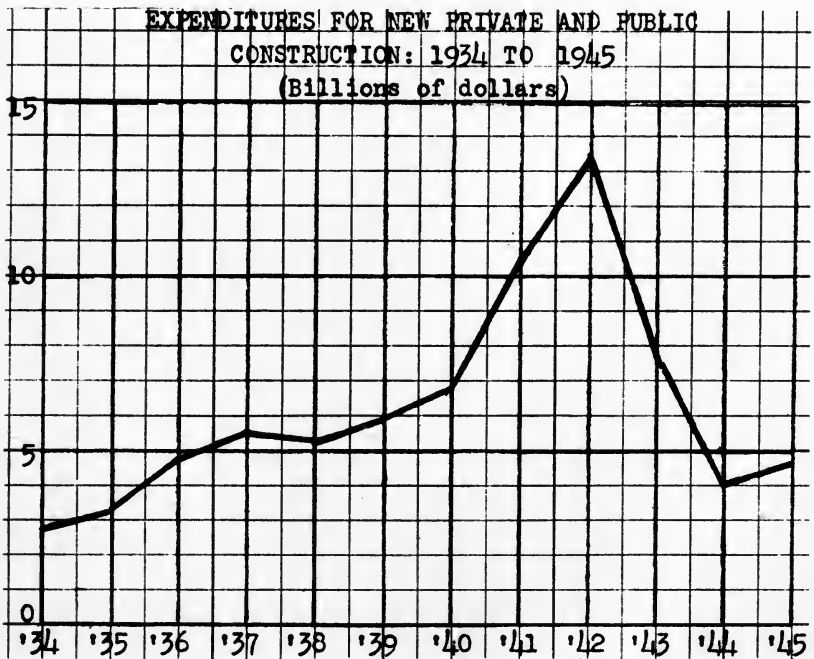
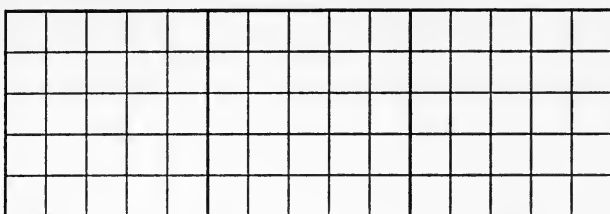


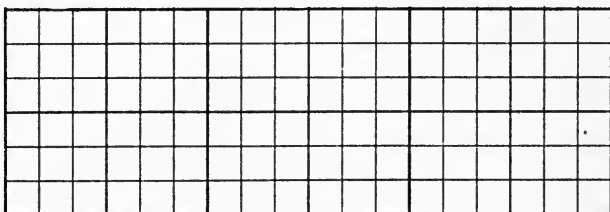
CHART 99.

SUBDIVISIONS  
PER INCH

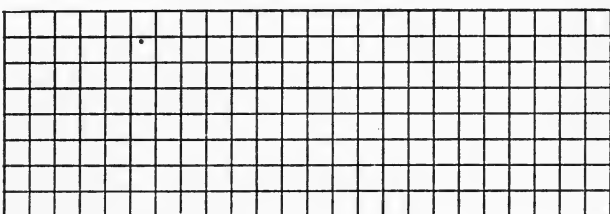
5



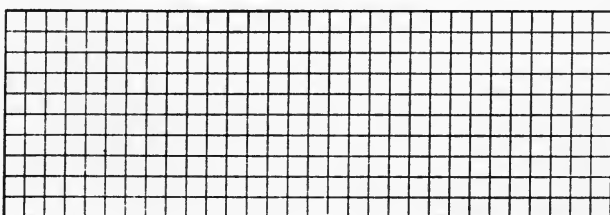
6



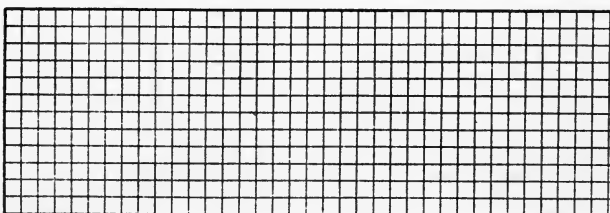
8



10



12



*Codez Company, Inc.*

FIGURE 3. SAMPLES OF GRAPH-PAPER RULING.

After the grid ruling and curve plotting were finished, the title and scales were lettered on the typewriter. Special care must be taken with typewritten lettering to secure exact centering of time- and amount-scale numbers to the corresponding rulings.

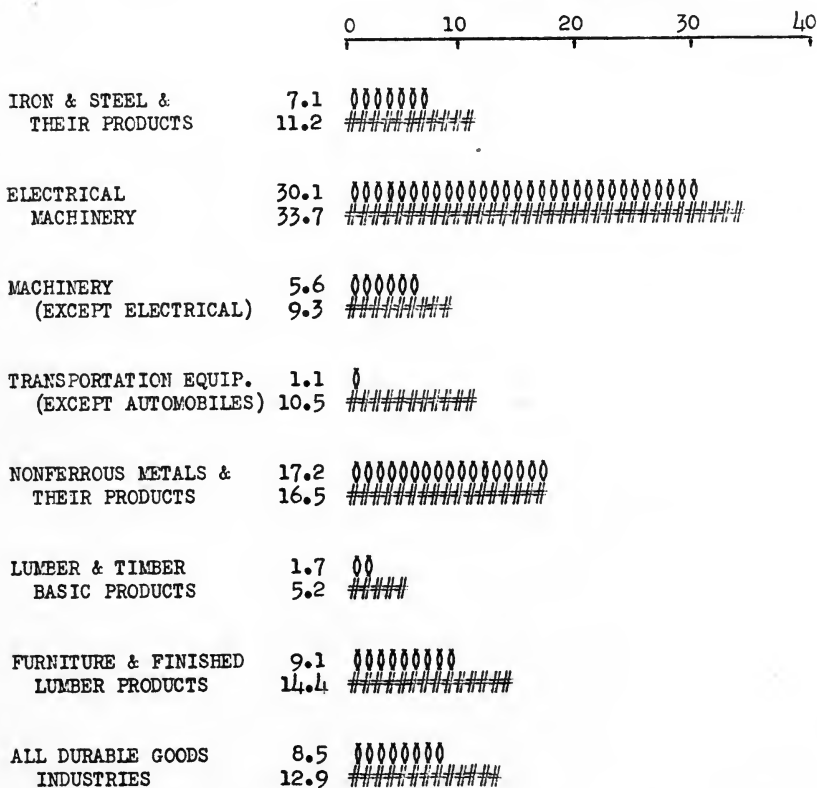
In multicurve charts effective contrast can be obtained by using different colored pencils for drafting the curves. Graph paper in light-blue

E M P L O Y M E N T    O F    W O M E N

SELECTED DURABLE GOODS INDUSTRIES

0000 OCT 1941                  #### OCT 1942

Percent of Wage-Earners



*War Manpower Commission*

CHART 100.

ruling is best if the charts are intended for photostat or printed reproduction. The ruled background in this color will not show in photostat negatives or printing plates.

Drafting of bar and column charts on graph paper is equally simple. With the variety of rulings available, any combination of bars and spaces can be worked out with little difficulty.

## TYPEWRITTEN CHARTS

Chart 100 is an example of a bar chart done entirely on the typewriter. All of this chart was made without removing the paper from the machine. The vertical spacing is in single and double space. Each bar is plotted by striking the appropriate key as many times as there are units in the figure at the left of the bar.

The title is in spaced capitals underlined, the subtitle in underlined capitals. The key for identifying the symbols in the bars is placed immediately below the subtitle. The upper bar of each pair is made of superimposed parentheses, and the lower bar of the number sign. The dollar sign is sometimes used in typewritten bar charts, if the values are in money.

The bars represent rounded numbers. Rounding is necessary in typewritten charts, as each symbol stands for a complete unit. In the item "Electrical Machinery," for example, the 1941 figure, 30.1, is rounded to 30 symbols and the 1942 figure, 33.7, raised to 34.

Column and curve designs take more time and care than the bar type. The vertical plotting required in typed column charts involves backspacing for each unit in the columns. Curve charts present difficult problems in plotting, and the vertical ruling for the grids, unless the charts are very small, can be done only on a long-carriage machine.

## ■ XIII

### SMALL CHARTS ON UNRULED PAPER

**T**HE next step involves the drafting of small charts on unruled paper, without the aid of typewriter spacing or printed ruling. A thorough understanding of the methods employed in planning, grid ruling, and plotting of such charts is of the greatest importance, as they will be used constantly in all future work.

#### EQUIPMENT

The additional equipment needed comprises a drawing board, a T-square, two triangles, and a ruling pen. A drawing board about 12-by-17 inches will be large enough. The wood should be of good quality. It is important that the ends and sides be exactly parallel. The T-square should be 15 to 18 inches long, with transparent edges. Two triangles of transparent material, one 4" 90° and one 6" 30°, will be required. A small French curve for drawing curved lines, although seldom used, may be added. Larger equipment will be needed for

work on charts of display size, but is awkward and inconvenient to handle in drafting small charts.

## GRID LAY-OUT

The instructions and examples that follow apply to the lay-out in pencil, which should be done before the drafting in ink is begun.

The initial problem, and the one which usually stumps the beginner, is how to lay out the grid ruling for the scales in curve charts and the bars and spacing in bar and column charts. Assume, as a simple example, that the grid of a curve chart 5 inches wide is

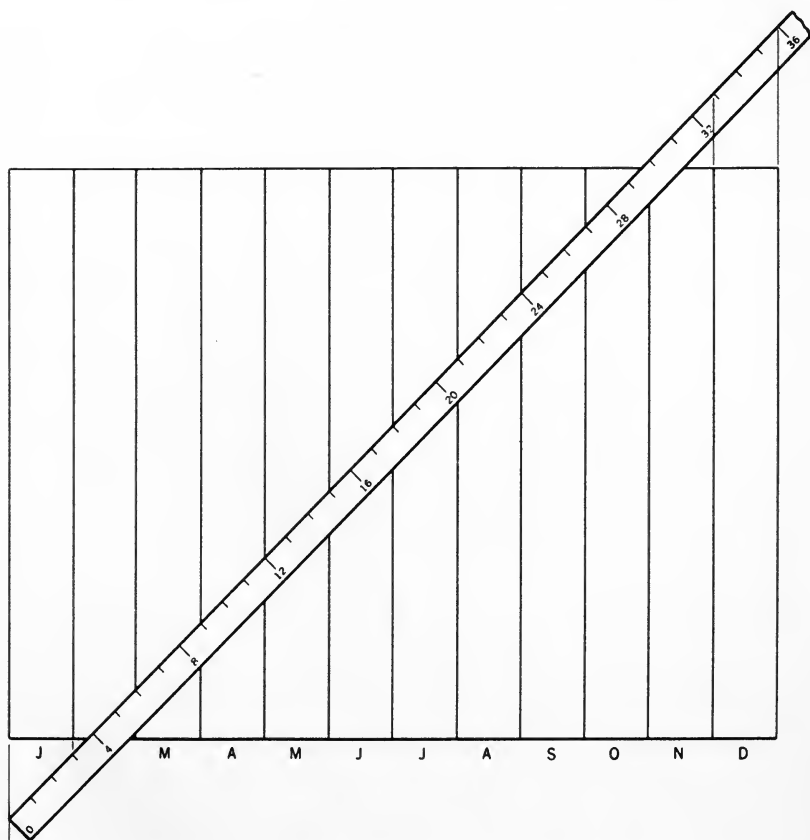


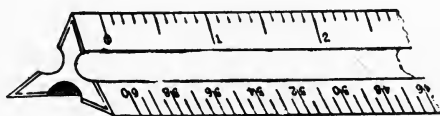
CHART 101. USE OF SCALE IN GRID LAY-OUT.

to be ruled for a time scale of 12 months, thus requiring 12 spaces for the curve plotting. How is the width of the spaces to be determined?

One can, of course, divide 5 by 12, but the quotient, 0.41666 and so on to infinity, is not a practicable unit for drafting. A little elementary geometry will solve the problem quickly and more accurately than any amount of arithmetical calculation. Place diagonally across the grid any measure containing 12 equal spaces that is slightly longer than 5 inches. Adjust the angle until the first and last lines or graduations coincide with the outside vertical lines of the grid. Mark the subdivisions with pencil dots and rule with T-square or triangle. The method is illustrated in Chart 101, page 133. Any measure with equal spacing will serve, ruled correspondence paper, an ordinary foot rule, or printed graph paper.

## TYPES OF SCALES

The triangular decimal scale shown in Figure 4 is commonly used by draftsmen for lay-out and plotting. It has six scales, with graduations ranging from 10 to 60 to the inch. Usually one of these will fit the data. If not, multiples of the required number of spaces on one of the scales can be used.



*Keuffel and Esser Co.*

FIGURE 4. TRIANGULAR DECIMAL SCALE.

Lacking a scale of this type, a series of scales can be made from Figure 5 that will serve the purpose just as well or better. Each of these scales is six inches long. The first has 10 graduations to the inch and the succeeding three, 20, 30, and 40. The scales can be adapted for use in drafting and lay-out by copying the figures and graduations on tapes of tough paper or light cardboard, extending the length to about ten inches. This length will be sufficient until work on display charts is undertaken, when tapes two or three feet long may be needed.

In some respects tapes have been found to be much more convenient



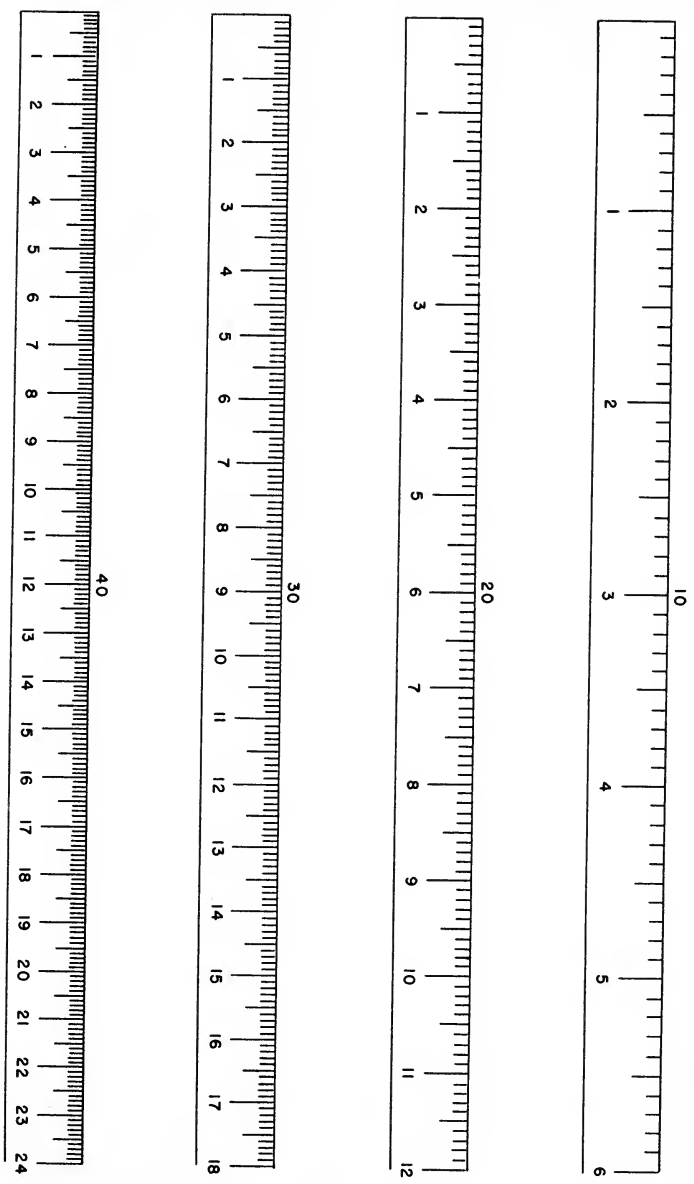


FIGURE 5. TAPE SCALES.

than the triangular scale. One objection to the latter is that it will not stay put. When used in scaling or plotting, it must be held in the required position, as it is apt to slide about on the chart, particularly if the drawing board is set at a convenient slant for drafting. With tapes, however, this tendency is obviated by securing each end of the scale with adhesive tape. This tape is backed with a light adhesive which permits removal of the scale without defacing the paper. It may be used also instead of thumb tacks for fastening the paper to the drawing board. Another advantage of tapes over scales of wood or metal is that they permit free movement of the T-square and triangles over the surface of the chart without disturbing the position of the scale.

### JOINED-BAR LAY-OUT

The method for laying out the bars vertically is illustrated in Chart 102. The chart contains 5 bars. The scale is laid diagonally across the grid, with 5 on the upper line of the first bar and zero on the bottom line of the fifth bar. The subdivisions are noted from the scale and lined with T-square and pencil.

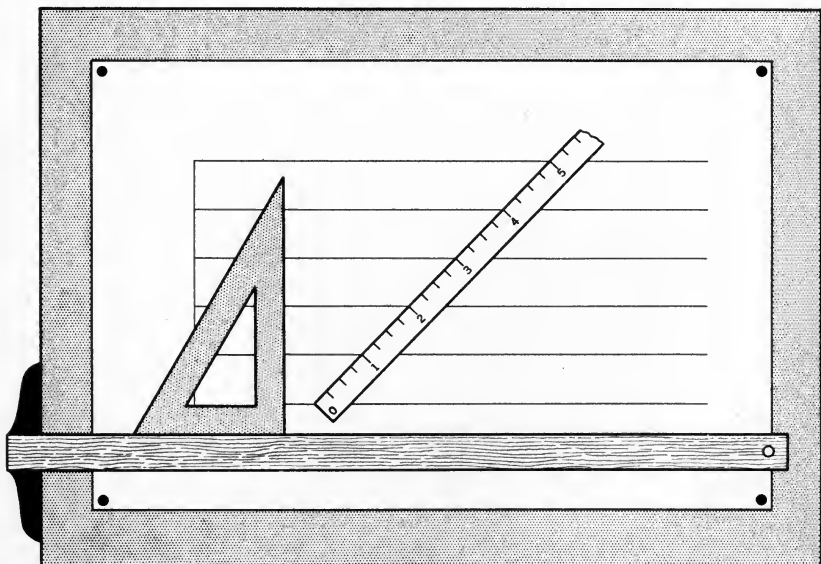


CHART 102. VERTICAL DISTRIBUTION OF BARS.

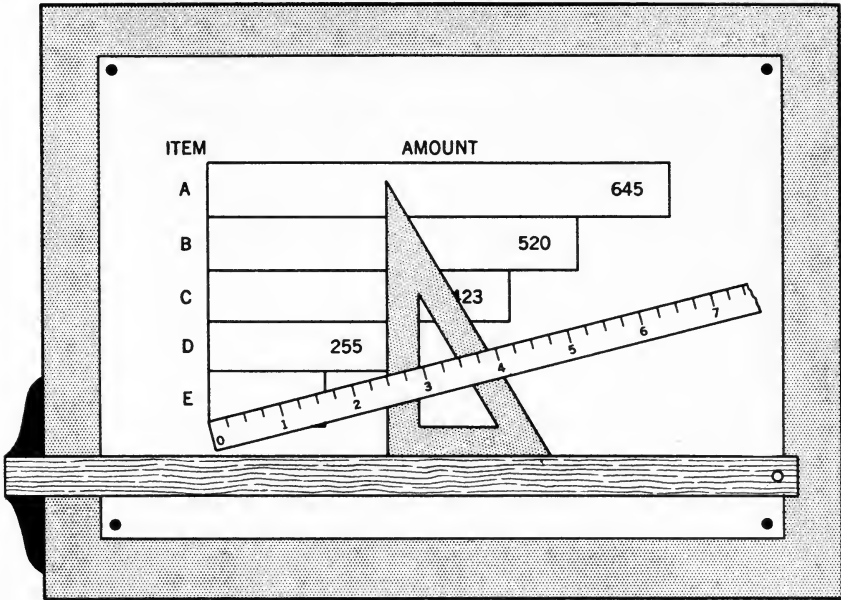


CHART 103. METHOD FOR PLOTTING AMOUNTS.

The method to be followed in the plotting of the various amounts is pictured in Chart 103. The series comprises the following numbers, arranged in descending order:

<i>Bar</i>	<i>Amount</i>
First	645
Second	520
Third	423
Fourth	255
Fifth	146

The longest bar represents 645. The scale is placed at 7, the equivalent of 700, on the right edge of the grid, with zero on the base line of the bars. The chart shows the use of the triangle for plotting the amounts. If a scale is used instead of lettered figures on the bars, it can be laid out by the same method employed for plotting the length of the bars.

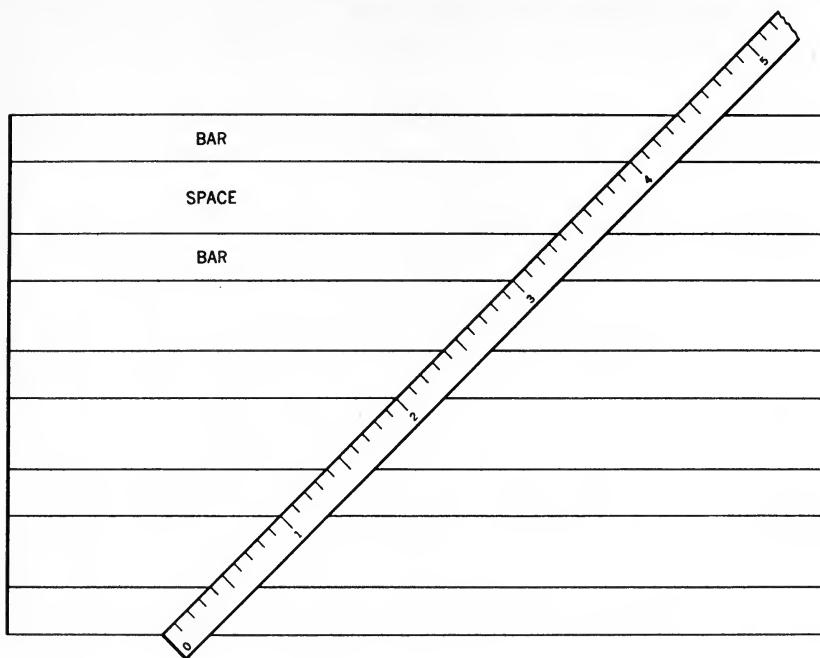


CHART 104. BARS AND SPACING IN SPACED-BAR CHARTS.

### SPACED-BAR LAY-OUT

Chart 104 shows the method for laying out the bars and spaces in a spaced-bar design. The spaces are one-half wider than the bars. There are 5 bars and 4 spaces, which, at 4 graduations for the bars and 6 for the spaces, total 44 graduations. The scale is placed at 44 on the upper line of the first bar, with zero on the lower line of the fifth bar. The method for plotting the amounts is the same as that used in joined-bar charts.

### COLUMN-CHART LAY-OUT

Chart 105 shows a spaced-column lay-out in which the spaces are one half the width of the columns. Each month, with the exception of the last, which is not followed by a space, represents 3 graduations, 2 for the column and 1 for the space, or a total of 35 in all. Joined-column charts are laid out in the same way as joined-bar

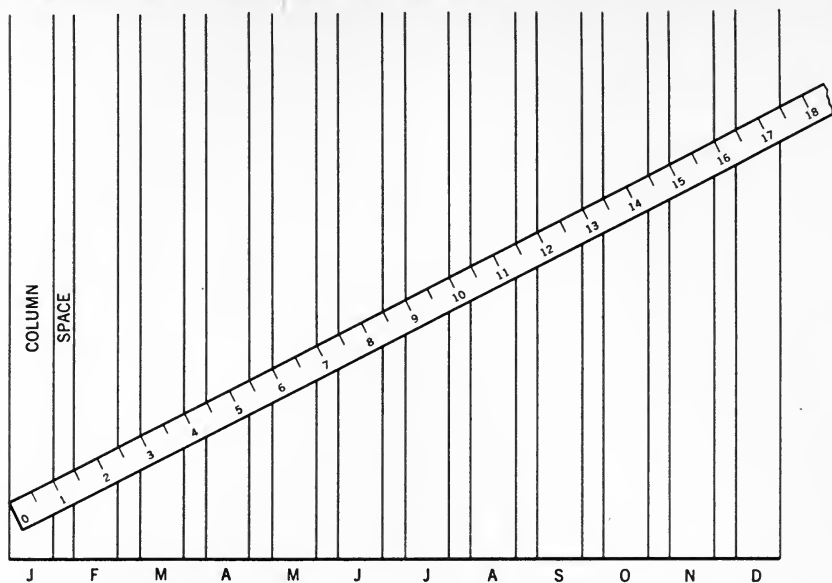


CHART 105. COLUMNS AND SPACING IN SPACED-COLUMN CHARTS.

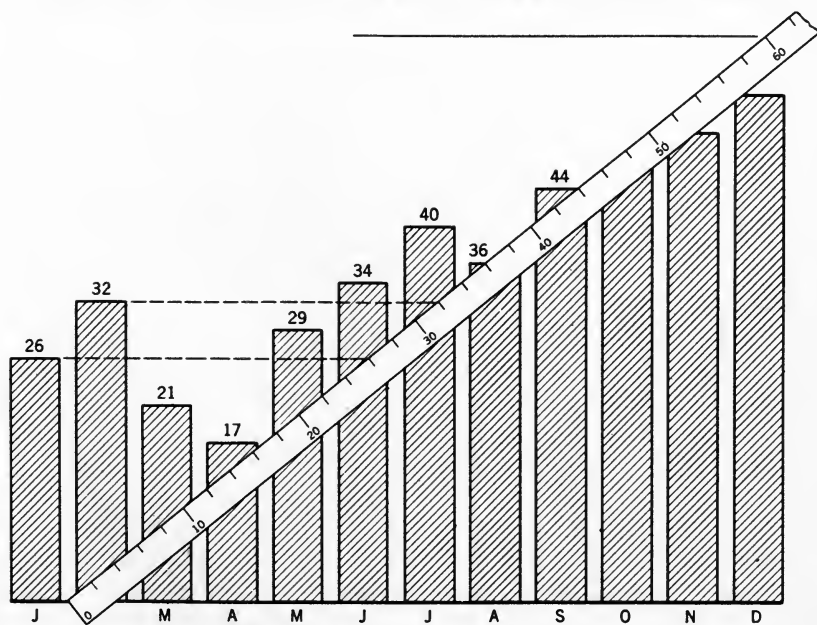


CHART 106. PLOTTING OF AMOUNTS ON COLUMN CHARTS.

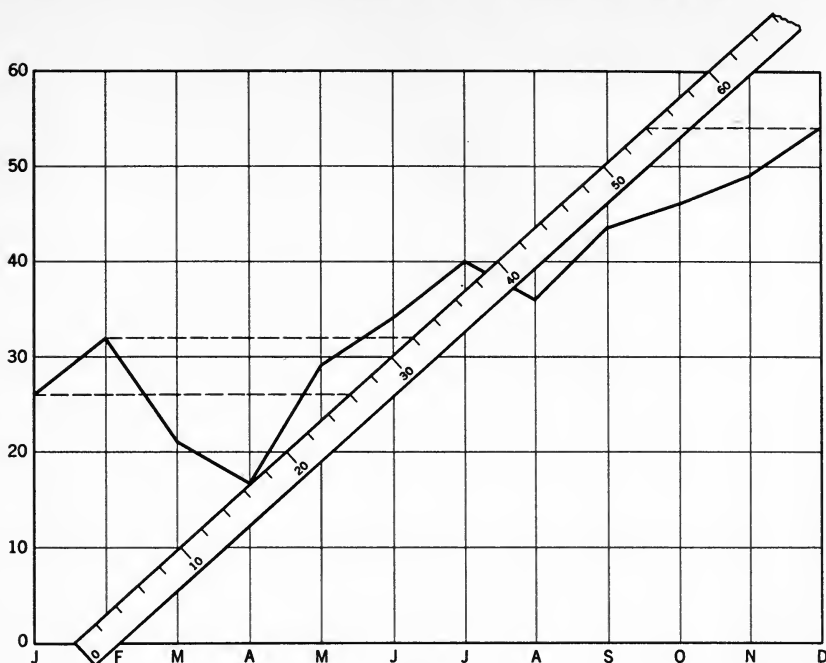


CHART 107. CURVE-CHART LAY-OUT.

charts. The only difference is that the scale is horizontal instead of vertical.

Plotting of the amounts is illustrated in Chart 106, on page 139. The figure for the highest column is 54. The scale is set at 60 on the upper line of the grid to allow room for lettering the figures, if these are placed above the columns. In any case some blank space should be left above the highest column. This is true also in the case of bar charts and curve charts, where some space should be left after the longest bar and above the highest point of the curve, unless it is broken.

### CURVE-CHART LAY-OUT AND PLOTTING

The vertical ruling of the grid in Chart 107 is done in the same way as in Chart 101, page 133, except that, as the plotting is to line, there are 11 instead of 12 spaces. The curve represents the same series of numbers that was used in the spaced-column example and is plotted in the same way.

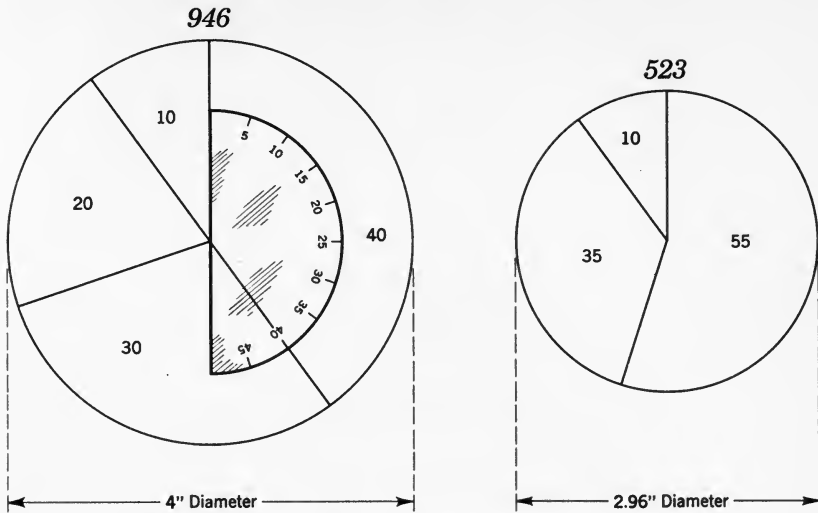


CHART 108. CIRCLE- AND SECTOR-CHART LAY-OUT.

### CIRCLE- AND SECTOR-CHART LAY-OUT

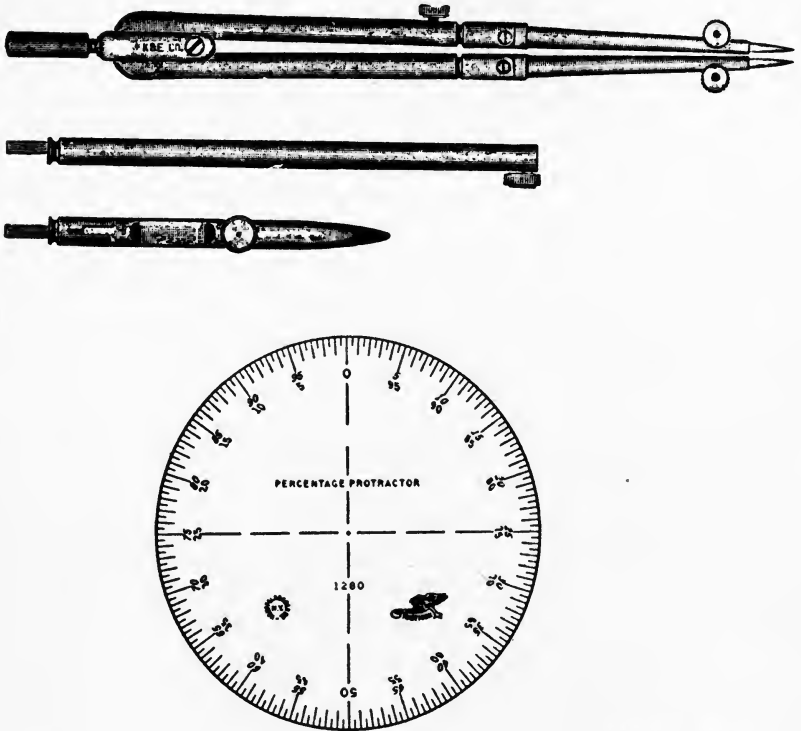
Chart 108 shows a comparison of the numbers 946 and 523 drafted as circles proportional in area. The first circle is subdivided in four, and the second in three percentage sectors.

The first step is to determine the diameters of the circles. Assuming a diameter of 4 inches for the larger circle, the diameter of the smaller one, calculated by the method described in Chapter VII, will be 2.96 inches (square root of the quotient of 523 divided by 946, multiplied by 4 inches). A compass will be needed for drawing the circles, and a protractor for pointing off the sectors. (See Figure 6, page 142.) A cheap compass, obtainable in any drafting-supply store, will serve for pencil sketching. For use with ink a better instrument, with pen attachment and lengthening bar, will be required. Percentage protractors are generally preferred for statistical drafting to those graduated in degrees. A numerical series can be more easily converted to percents than to degrees of a circle.

The protractor is laid over the circle and the percents corresponding to each sector pointed off on the circumference. The order of plotting is by size of sectors, the largest first, the next largest second, and so on. Sectors representing a "Miscellaneous" or "All Other" group of com-

ponents are placed last in the series of sectors. The plotting begins at the center of the upper hemisphere and continues clockwise from right to left.

Familiarity with methods of lay-out and speed in their application are the first requirements in the drafting of statistical charts. The methods illustrated in the preceding examples are simple, but consid-



*Keuffel and Esser Co.*

FIGURE 6. COMPASS AND PROTRACTOR.

erable practice will be needed to get them clearly in mind so they can be applied easily and quickly. The beginner is advised to repeat the examples for the different types a number of times, changing each time the dimensions of the grids, the numerical series, and the distribution of spacing in bar and column designs, so as to become thoroughly familiar with the respective procedures.



## LETTERING

Typewritten lettering should be used unless a lettering guide is available. Hand-lettering on small charts is too slow and usually is less satisfactory than typewriting. The machine must give a firm impression and good alignment. The large open elite type is preferable to pica and larger sizes. Carbon ribbons give clear black copy, but the lettering is apt to smudge if the chart undergoes much handling.

The Vari-Typer machine is used extensively for lettering small charts. It has a number of styles and sizes of interchangeable type. The quality of the work is superior to typewriting, but operation of the machine requires trained personnel.

If the chart is intended for printed reproduction, cut-out letters can be used for the title. These are backed with an adhesive and can be removed and re-used. The titles for Charts 10 and 12 and a number of others reproduced in the preceding chapters were made of cut-out letters.



*Ralph C. Coxhead Corporation*

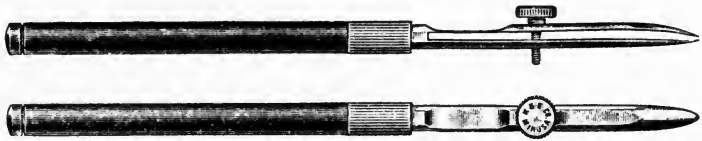
FIGURE 7. THE VARI-TYPER.

## PAPER

Paper for chart purposes should be strong, of uniform thickness, and usable on both sides. It can be either smooth or medium, and single or double thickness. Bond papers of good quality and smooth finish and heavy-weight unruled ledger papers of standard size are extensively used.

## INKING

After the ruling and plotting are completed, the pencil sketch may be lined in India ink with a ruling pen. This instrument is perhaps the most useful and the most used in the draftsman's kit. About four fifths of all the drafting on statistical charts, outside the lettering, is done with the ruling pen. Skill in its use can be acquired only through practice. Some suggestions worth keeping in mind are: that no ink be left on the outside of the pen after filling; that the supply of ink in the pen be kept uniform; that the edge of the pen be kept exactly parallel with the guiding edge; and, of special importance, that the pen be kept thoroughly clean. Dirty pens do dirty work, and ink left on the pen when it is not in use is likely to corrode the metal.

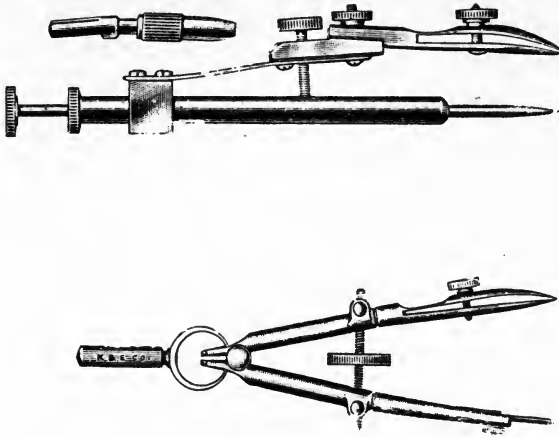


*Keuffel and Esser Co.*

FIGURE 8. RULING PEN.

Various types of ruling pens, such as dotting and railroad pens, used for special purposes, are seldom needed in the drafting of statistical charts. Designs containing a large number of small circles, of which the circle map is an example, are usually ineffective for comparisons of size, but, if such designs are required, a small bow pen and a drop pen for filling in the circles will be needed. For such close work the six-inch compass commonly used for circle charts of display size is too large.

Until such time as the beginner has had sufficient practice in methods of lay-out and plotting to apply them accurately and without hesitation, the drawing should be completed in pencil and carefully checked with the data worksheet before the inking is begun. The pencil sketch serves as a guide for the ruling pen, thus leaving the attention free for the inking process, where a slip or an error is likely to end in a difficult and unsightly erasing job. Mistakes in pencil can be easily corrected, but once they are inked in they are frequently irremediable. In many cases the entire chart may have to be redone.



*Keuffel and Esser Co.*

FIGURE 9. BOW AND DROP PENS.

## ORDER OF OPERATIONS

The following order of operations if faithfully adhered to will save time and help to insure accuracy:

1. Lay out and plot in pencil
2. Check with worksheet of data
3. Ink with ruling pen
4. Clean off with artgum any traces remaining of pencil sketch
5. Lettering
6. Check lettering with worksheet
7. Apply shading or color
8. Inspect and clean

## ■XIV

### DISPLAY CHARTS

**D**ISPLAY charts differ in some respects from the smaller sizes in principles of construction. The latter are usually read at a distance of around two to four feet. The smallest lettering on a display chart must be clearly legible at several times this distance. If the chart is for use in a large conference or hearing, all details should be easily read at not less than twenty feet from the chart.

Because of the purposes for which display charts are used, greater emphasis on simplicity of design and the elimination of surplus wordage is required. Unlike the small chart, which is generally viewed under conditions that give opportunity for study, the display chart, if for use in meetings and conferences, must get its message across in much less time. Titles and stubs should be carefully edited to reduce the amount of lettering. Long titles and subtitles occupy too much space and throw the chart out of balance. As a rule, not more than two aspects of the data can be effectively presented on a single chart. If it is not feasible to cover the subject in one chart without crowding, it should be broken

down into two or more. Three simple charts are better than one complicated one.

## USE OF COLOR

One of the most significant developments in design and drafting technique is the marked increase in the employment of color in all types of statistical charts. Willard Brinton's comment in his *Graphic Presentation*, published in 1939, summarizes the views generally held by specialists in chart design: "It is believed that the evidence is conclusive that to get the maximum results in graphic presentation the question is not 'Can one afford to use color?' but 'Can one afford to omit color?'"

A major contribution to this development has been the adhesive color material introduced a few years ago. Apart from its superiority to colored inks, paints, and washes in ease and speed of application, it has the advantage that the colors can be quickly removed and replaced, if corrections or changes have to be made, without defacing or injuring the surface of the chart.

In addition to its use for filling in surfaces with color or shading, this adhesive material may be employed in the form of tapes or narrow strips in substitution for inked curve patterns in display charts. The tapes come in widths from one-eighth inch to one inch. The half-inch and quarter-inch widths are frequently used for outlining regional subdivisions on maps.

The presentation of colored display charts in conferences or meetings sometimes results in requests for a number of small photostat or printed black-on-white copies. If the colors are in paint or water colors, the charts will have to be done over in black for reproduction. If adhesive colors are used, they can be removed and replaced with black shadings. After the printed or photostat copies are made, these in turn can be taken off and replaced with the original colors. The two operations will ordinarily take, on a single chart, no more than an hour or so, against probably a day's work to make the whole chart over.

## LAY-OUT AND EQUIPMENT

The methods and procedures described in the preceding chapter with relation to lay-out and plotting of small charts apply equally to those of display size. A drafting table, adjustable for height and slant,

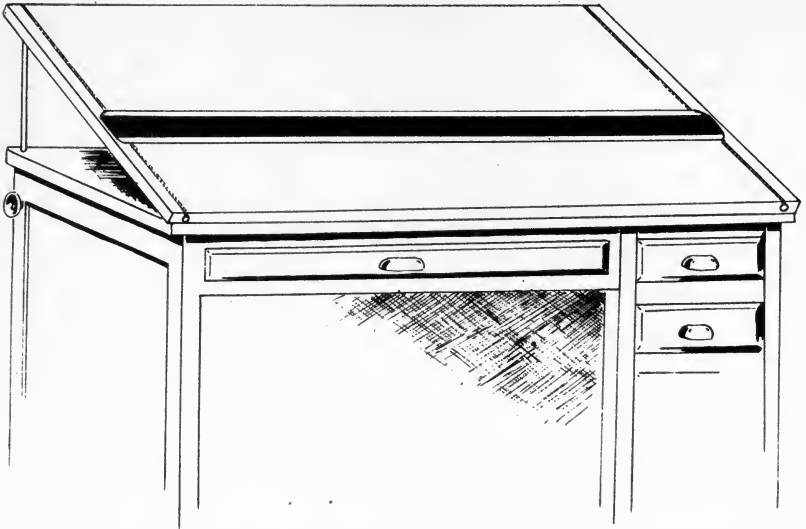


FIGURE 10. DRAFTING TABLE FITTED WITH PARALLEL RULE.

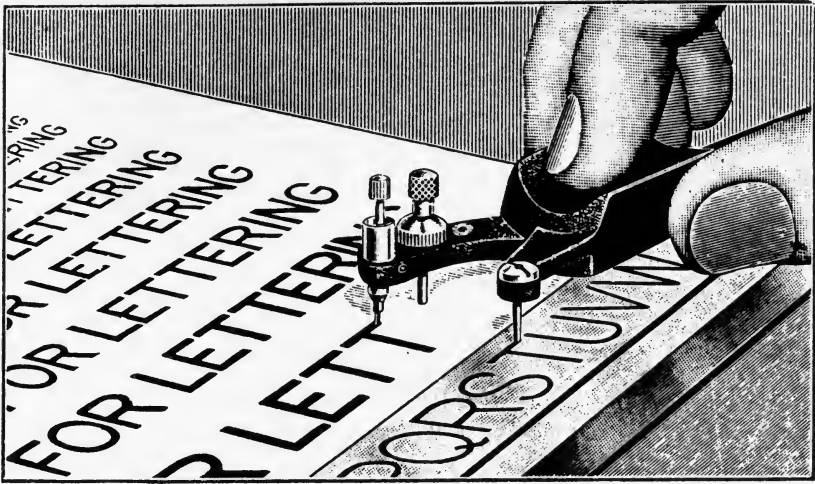
will be needed. A desirable addition is the parallel rule illustrated in Figure 10. This device automatically maintains the rule at right angles to the sides of the table. Other items which will be required are larger triangles, longer scales or tapes, and larger ruling and lettering pens.

Display charts are generally drafted on illustration board from 20-by-30 to 30-by-40 inches in size. The stock should be heavy enough so that it will not curl or bend. Highly glazed surfaces which reflect the light should not be used. Samples of different boards should be tested to see whether they are suitable for drafting. Some are finished with a chalky substance that clogs the pens, and in others the direction of the grain is a source of difficulty in drafting.

## LETTERING

Lettering on display charts is usually done with lettering guides. Figure 11 gives some idea of the design and method of operation of a well-known type. In operation the pen in the forward arm of the scribe is guided by the template grooved with the letters and figures. The height of the lettering ranges from .08 to 2 inches.

If equipment for lettering with guides is lacking, the beginner may have to start with hand-lettering, although if he remains in this type of



*Keuffel and Esser Co.*

FIGURE 11. LEROY LETTERING GUIDE.

work it is likely that he will eventually graduate to the use of guides. For this reason it will be advisable to practice some of the styles of lettering commonly employed on display charts lettered with guides. Early efforts had best be limited to capitals. Small letters are more difficult, and in the majority of display charts only capitals are used. A sample alphabet is shown in Figure 12, page 150.

The relation of width to height and the spacing between letters are the chief problems in hand-lettering. All lettering should be laid out in pencil before inking. Large letters may be outlined in pencil with stencils or cut-out letters and afterward filled in with ink. In this way uniformity is secured, with less chance of the slips and mistakes which are likely to occur if the draftsman depends entirely on his own unaided judgment and skill. Little time or practice should be devoted to ornate and fancy types of lettering. They are sometimes used in statistical charts to emphasize a word or words in the title, but the same effect can be obtained by underlining.

## PAINTS

Poster paints are the best color medium for paper or cloth rolled charts. The products of different manufacturers vary to some extent in adaptability for this purpose, and samples of the various makes should

**A B C D E F G H**  
**I J K L M N O P**  
**Q R S T U V W**  
**X Y Z**

**a b c d e f g h i j k**  
**l m n o p q r s t u**  
**v w x y z**

**0 1 2 3 4 5 6 7**  
**8 9**

FIGURE 12. SAMPLE LETTERING-GUIDE ALPHABET.



be tested to insure that one is chosen which will leave a brilliant, smooth surface free from brush marks. For stiff surfaces, as has been pointed out, the adhesive colors are far superior in appearance and are much easier to apply.

## CRAYONS

Crayons are little used for filling in surfaces on illustration board. They are easier to use than paints on rolled charts but do not afford as striking contrasts. They are applied with light parallel strokes. The color may be deepened by repeating the application. The lines left by the strokes of the crayon may be smoothed by rubbing the surface lightly with a cloth.

## AIRBRUSH COLORING

The airbrush can be employed effectively in tinting large maps, but is seldom used for coloring statistical display charts. All parts of the chart not to be colored must be masked out with paper, and this must be secured with adhesive pressed down firmly on the chart to prevent the color from creeping under the edges. After the color is applied the masking is removed. The whole operation takes much longer than is usually required with adhesive colors or paints. If the chart is in several colors, the process becomes extremely complicated and time-consuming.

## ROLLED CHARTS

Display charts light in weight which can be rolled tightly to occupy a small amount of space (for shipment by mail or express or to be carried as luggage) can be made of tough paper or of cloth similar to that used for window shades. Color must be applied with ink, crayons, paints, or water-colors, as adhesive shadings become detached if charts are rolled.

Rolled charts should be stiffened at top and bottom with light strips of wood ("half-rounds," which can be obtained in any carpenter shop, are about the right weight), as illustrated in Figure 13, page 152, to prevent the chart from buckling or remaining partly unrolled when in use. The strips can be nailed on with short brads. For convenience in hanging, a short piece of cord or tape should be fastened to the upper strip.

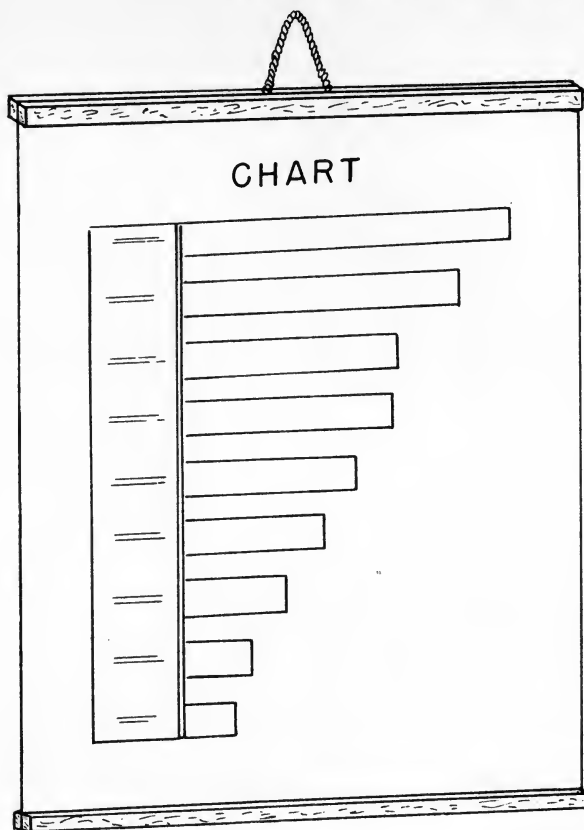


FIGURE 13. METHOD FOR STIFFENING ROLLED CHARTS.

### MOUNTING ON CARDBOARD

Mounting paper charts on cardboard presents no problem where facilities for hot mounting under pressure are available, but these will be found only in large drafting installations. Mounting by hand is usually done with liquid rubber cement. This material will not shrink or warp the paper. It is sufficiently strong if a permanent mount is not required but loses its adhesive qualities with age. The cement is spread uniformly over the back of the chart and the paper pressed down firmly to make close contact with the cardboard. The chart should be smoothed carefully before the cement dries, to prevent wrinkling of the paper.

## ■.XV

### REPRODUCTION PROCESSES

**T**

HE choice among the various methods employed for the reproduction of statistical charts depends mainly on the number of copies required.

#### PHOTOSTAT

If the number of copies needed does not exceed fifty, the photostat process is generally used. In this process the chart is copied photographically on sensitized paper. A copy in white-on-black, called a "negative," is made, from which any number of black-on-white copies, called "positives," can be duplicated. Figure 14 pictures a half "negative" and half "positive" photostatic copy.

Copies made by this process can be obtained quickly and at moderate cost. The standard equipment will make enlargements up to 18-by-24 inches. If larger sizes are required, the prints may be made in sections and joined with adhesive. Charts in color cannot be reproduced by the photostat process.

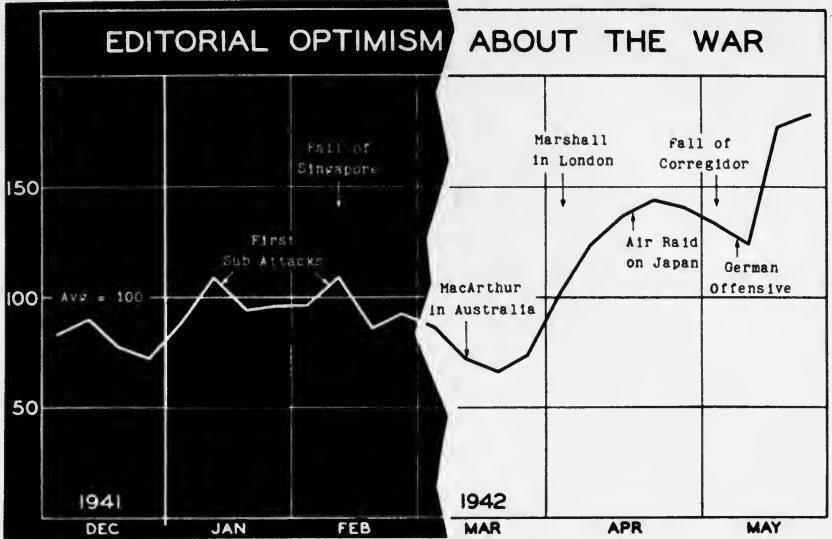


FIGURE 14. COMPARISON OF NEGATIVE AND POSITIVE PHOTOSTAT PRINTS.  
FROM *Manual of Statistics*, WAR DEPARTMENT, SOS.

### PHOTO-OFFSET

In offset printing a sensitized zinc or aluminum plate is made from a photographic negative of the chart. On the press the ink adheres only to those parts of the plate that contain the image of the chart. In the printing process the inked image is transferred to a rubber roller and from this to the paper. The average plate can be used to make up to twenty-five or thirty thousand copies.

As in all work for printed reproduction, special care should be taken in the preparation of the original charts, for the reason that any imperfections, unless discovered on the negative, where they can be touched up, will be reproduced on the plate. Lithographers' artists are skilful in patching up defects on plates, but patching of this kind is expensive in cost and time.

Excellent printing in from one to four colors can be done by this process, but, as each color requires a separate run through the press, color printing is much more expensive than black alone. Some of the best published work in colored statistical charts is printed by photo-offset.

## MULTILITH

In this process the chart is drawn directly on a thin aluminum plate. It saves the time required for the photographic process and eliminates the costly equipment for making photo-offset plates. From six to ten thousand copies can be obtained from a single plate. The image is usually not as clear as in printing done by photo-offset.

## STENCIL AND GELATIN DUPLICATORS

For chart production with mimeograph stencils a special drawing board called the Mimeoscope is used together with various instruments designed for drafting on stencils. In reproduction by gelatin duplicators the original is typed or drawn with a methyl-violet dye and then transferred by contact, in reverse, to a strip of gelatin material from which the printing is done.

These processes are convenient and efficient for duplication of reports, memoranda, releases, and tabulating forms, but are not very suitable for satisfactory chart reproduction. The results obtained with them are not comparable in appearance with those secured with the photostat process and with multilith or photo-offset printing.

## ENLARGEMENTS

Enlargement of small charts for printing is seldom done. Typewritten lettering if enlarged over 50 percent generally looks spotty and ragged. Slight differences in weight of lettering, due to uneven pressure in striking the keys of the typewriter, become prominently visible in the enlargement. Insignificant defects in the drawing that would not be noticeable in the original stand out clearly.

Good enlargements to display size of carefully executed originals can be obtained by photography, but the cost is usually prohibitive. Enlargements for display purposes made with the photostat cost less, but are much inferior in appearance.









## REDUCTIONS

Charts for printed reproduction should be made large enough for a reduction of 20 to 50 percent. The reduction gives the chart a more

finished appearance and eliminates minor irregularities in the drafting. The amount of reduction a chart will stand is governed chiefly by the size of the lettering. Figures 15a and 15b show various types of lettering and weights of ruling reduced one third and one half of the original size. Fine ruling is apt to show breaks or fade out entirely in reductions

LETTER SIZES	
Elite Type	- 12 characters per inch
Pica Type	- 10 characters per
SMALL GOTHIC	- 9 CHARACTER
LARGE GOTHIC	- 9 CHARACTER
.120" TEMPLATE	LETTERING
.140" TEMPLATE	LETTERING
.175" TEMPLATE	LETTERING
.240" TEMPLATE	LETTERING

LINE WEIGHTS	
4 POINT	
3 POINT	
2 1/2 POINT	
2 POINT	
1 1/2 POINT	
1 POINT	
3/4 POINT	
1/2 POINT	

Original Size

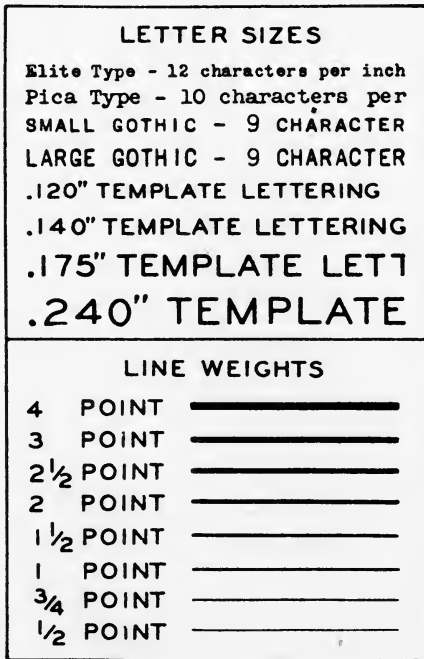
Note: A point, in printer's measure, is approximately 1/12 of a pica, which, in turn is 1/6 of an inch. Therefore, a printer's point is approximately 1/72 inch.

of more than 50 percent. Reductions of elite typewritten lettering should not exceed 30 percent for printing on smooth paper or 20 percent for reproduction in newspapers.

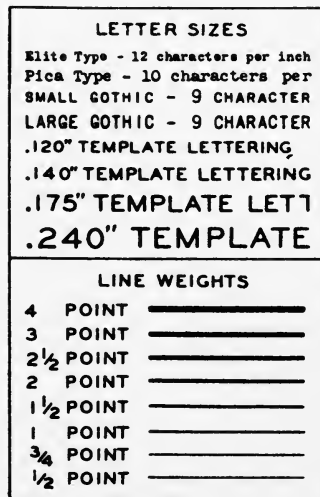
Reduction is calculated in terms of the linear dimensions of the chart, not of its area. A 50 percent reduction of a chart 10 inches wide by 14 inches long means that the width is reduced to 5 inches and the length to 7 inches. The reduction in area, of course, is much greater.

In practice, instructions to the printer for reduction or enlargement are not expressed in fractions or percents. All that is necessary is to indicate on a line drawn parallel with one side of the chart the exact measure to which it is to be reduced or enlarged.

A problem which frequently arises is to fit a chart into a given space in which the proportions of width and length differ from those of the chart. For example, suppose that a chart 8-by-15½ inches is to be re-



Reduced to two thirds of original



Reduced to one half of original

FIGURE 15A (OPPOSITE PAGE) AND FIGURE 15B (ABOVE). REDUCTION OF LETTERING AND RULING. FROM *Time Series Charts, A Manual of Design and Construction*.

ESSENTIAL ITEMS

Mask, Gas, Training	3,053,190	Same
Mine, Land, Chemical	1,109,107	Size

ESSENTIAL ITEMS

Mask, Gas, Training	3,053,190	10%
Mine, Land, Chemical	1,109,107	Reduction

ESSENTIAL ITEMS

Mask, Gas, Training	3,053,190	20%
Mine, Land, Chemical	1,109,107	Reduction

ESSENTIAL ITEMS

Mask, Gas, Training	3,053,190	30%
Mine, Land, Chemical	1,109,107	Reduction

ESSENTIAL ITEMS

Mask, Gas, Training	3,053,190	40%
Mine, Land, Chemical	1,109,107	Reduction

ESSENTIAL ITEMS

Mask, Gas, Training	3,053,190	50%
Mine, Land, Chemical	1,109,107	Reduction

FIGURE 16. REDUCTION OF ELITE TYPE. FROM *Manual of Statistics*,  
WAR DEPARTMENT, SOS.



duced for printing to fit a space 4-by-7 inches in size. The reduction in the width dimension, from 8 to 4, is 50 percent, but 50 percent of  $15\frac{1}{2}$  is  $7\frac{1}{4}$ , which exceeds the height of the printing space. The reduction must, therefore, be calculated from the longer dimension, that is, from  $15\frac{1}{2}$  to 7, which amounts to approximately 55 percent. Applying this ratio to both dimensions of the chart gives the size of the printing image, 3.6 by 7 inches.

A slide rule is a great convenience for solving quickly and accurately problems of this kind. If the two chart dimensions are set opposite each other on the rule, the conversion to fit a smaller or larger space can be determined without computation.

Figure 16 shows reductions of elite type ranging from 10 to 50 percent of the original size.

## ■XVI

### CLASSIFICATION OF CHARTS BY USE

**T**HE details of the designing, planning, and drafting of a chart are necessarily subordinated to the purpose for which it is to be used. The size of the audience, the physical conditions of the locale where the chart is to be shown, and the method of presentation are all factors which enter into the problem. Classified by use, the majority of statistical charts fall within one of the following seven categories:

1. For publication in newspapers, weekly and monthly magazines, or printed reports
2. For general inter-office distribution
3. A single copy for desk use
4. For use in conferences, board meetings, and hearings
5. For permanent or temporary exhibits
6. As graphic illustrations to accompany public addresses
7. For the daily, weekly, or monthly recording of current operations

## CHARTS FOR PUBLICATION

Statistical charts appear frequently in the reports, bulletins, and other published material issued by governmental departments and agencies and in trade journals and other periodicals which specialize in studies and articles relating to commercial, industrial, or general economic subjects. They are rarely used by the widely circulated popular weeklies and monthlies. Occasionally special articles in Sunday newspaper editions are illustrated with charts. Some newspapers run line or column charts picturing the movements of stock and bond prices. With these exceptions statistical charts find little favor in the daily press. The average newspaper reader will skip chart illustrations unless they are strikingly pictorial or relate to a subject in which he is especially interested. The chart has to compete with a variety of other pictorial forms which present information in such a way that it can be readily assimilated without mental effort. A statistical chart, no matter how clear and simple in design, does demand a little close attention if its message is to be understood.

Bar and column designs are generally preferred to the curve types. Sector charts, if they do not contain very small sectors and are not overloaded with lettering, are favored for their pictorial quality. Simplicity in design and lettering is, of course, essential.

Charts for weekly and monthly magazines require more care in preparation than for reproduction in newsprint. Defects that would not be noticeable in a newspaper stand out clearly on the smooth-finish paper on which magazines are printed. The slight irregularities that nearly always occur in typed lettering show up prominently. The grid ruling and curves, if curve designs are employed, should be lighter than on charts for publication in newspapers.

The lettering should be done with a lettering guide or typed. Free-hand lettering on small charts takes too much time and is usually less satisfactory than typewriting. Typed lettering must be clean and neat and free from marks of erasures. If the lettering is stripped on the chart, the work can be speeded by having the lettering and drafting done separately at the same time.

The drafting and lettering on charts for printed reproduction can be done piecemeal. The title, scales, and labels may be lettered on separate pieces of paper and stripped on the chart with rubber cement. In this way if a mistake occurs it can be stripped over with corrected

copy. Any part of the lettering can be changed as often as may be required. The finished chart sometimes looks like patchwork, but if the stripping is done carefully, no sign of it will appear in the printed copy. The edges of the patches sometimes show a faint dark line, but this is easily cleared up by painting with white ink. Chart 109, in which the title, subtitle, and curve labels were stripped on after the drawing was finished, was plated without painting out the edges of the stripping.

**WAGE-EARNERS AND PRODUCTION, MANUFACTURING INDUSTRIES  
INDEXES: 1899 TO 1939**

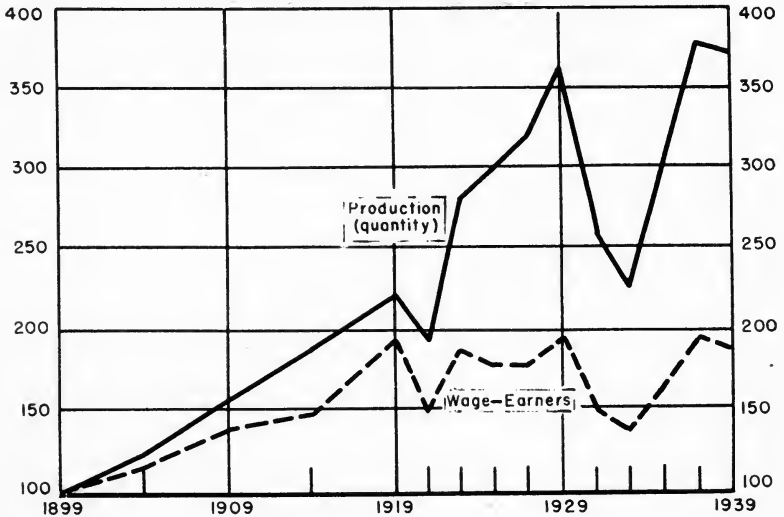


CHART 109. EXAMPLE OF STRIPPED TITLE AND CURVE LABELS.

One solution of the lettering problem, illustrated in Chart 110, is the substitution of type lettering set by the printer. If this method is adopted, the title and labels need not appear on the drawing. An additional rough sketch is made for the printer to indicate the location and wording of the title and labels to be pasted on the chart before the printing plate is made. Charts lettered in this way generally present a better appearance than if lettered with guides, and have the advantage that less time and work in the drafting process is required.

The use of colors, with the exception of red, which comes out black, is inadvisable unless provision is made for color printing. Blues and greens come out fainter than red. Reproduction of light tints is usually

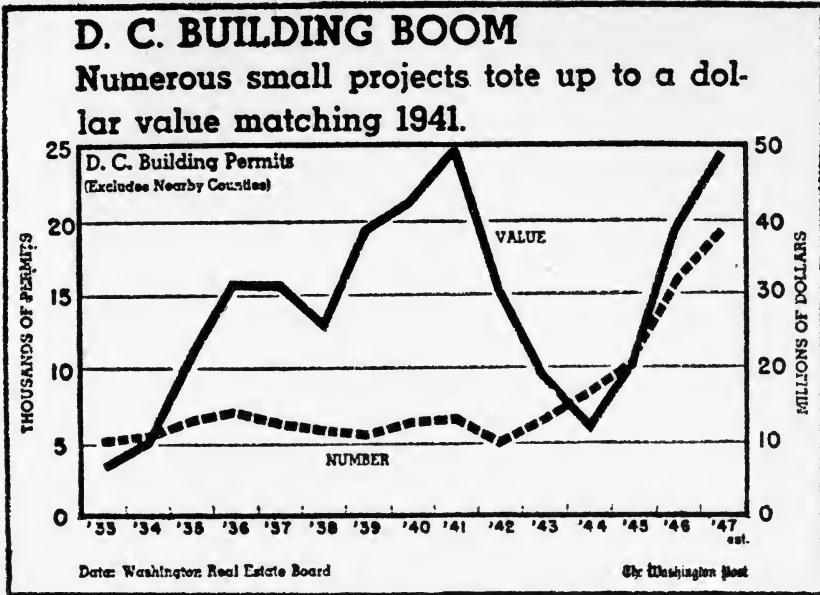


CHART 110.

too weak for good printing. If the chart is to be printed in color, the original, drawn and lettered in black, is accompanied by a rough sketch in color to indicate to the printer what portions of the chart are in color and what colors to use.

### CHARTS FOR INTER-OFFICE DISTRIBUTION

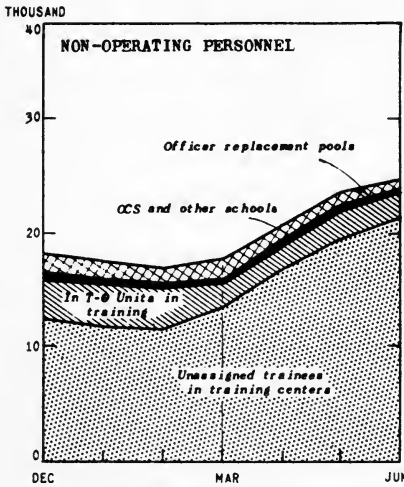
Statistical charts are frequently utilized in large offices for circulating information of general interest among heads of departments and supervisory or administrative personnel. If the number of copies required does not exceed fifty, they are generally reproduced by the photostat process. The methods used in preparing the charts are the same as for printed reproduction. Charts for this purpose are often more technical in design and nomenclature than would be practicable or advisable for general publication.

If charts for this purpose form part of a typewritten memorandum for photostat reproduction, their width should not exceed that of the accompanying text. Otherwise, the reduction necessary to bring the chart to the required width will also reduce the width of the text.

CHARTS FOR DESK USE

On small charts for desk use, where only a single copy is required, stripping cannot be employed. All the lettering must be done on the sheet containing the drawing. If possible, the title should be in larger lettering than the stub and labels, and done either with a a lettering

QMC MILITARY PERSONNEL



QMC non-operating personnel has increased since March - second quarter average strength was one-third larger than first quarter (17,089 and 22,996, respectively). Unassigned trainees increased from 67 to 85 percent of total in "pipeline" between 1 January and 30 June, while personnel in T/O unit training declined from 21 to 10 percent of the total. Officers in pools declined from 1,882 to 800 in same period - from 9 to 3 percent of total. Percent in schools remained practically the same.

Practically no change in June in the percent of operating personnel physically qualified for overseas service. Percent of physically qualified officer operating personnel without overseas service declined from 87 to 85 percent of total qualified in June. Corresponding percentage for enlisted personnel increased from 60 to 64 percent of total in June.

MALE OPERATING PERSONNEL

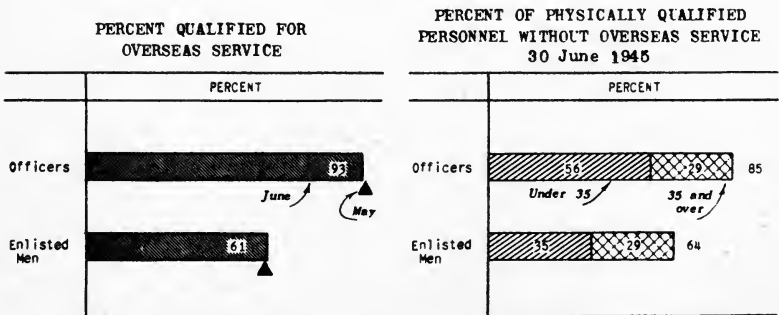


CHART 111. FROM STATISTICAL REPORTS TO THE QUARTERMASTER GENERAL.

guide or typed. Free use of color will aid in setting off contrasting elements and contribute to the interest and attractiveness of the chart.

The lettering on Chart 111, including the title, was all done on the Vari-Typer. The variety of styles and sizes of interchangeable type provided by this machine is especially advantageous for lettering small charts. This example was selected from a series of daily reports to the Quartermaster General. The accompanying text comment and summarization of the data was featured in all the reports.

The objective was to place at the disposition of the Quartermaster General as quickly as possible the statistical background relating to questions of administration and policy requiring his attention and action. Through contacts with the chief executive officers the statistical department was kept in close touch with current developments. The selection of subjects for the charts was made on the basis of their immediate interest and importance.

The drafting was done on sheets of standard size, punched for filing in loose-leaf binders. Colored shadings were used extensively, but were selected from the patterns most suitable for photostat reproduction, in case a number of copies were needed.

Text summaries are a valuable addition to any chart, but, because of the prohibitive amount of space they would occupy in the large lettering used on display charts, their use is generally limited to charts of small size.

Charts of this type fill a real need. Chart and exhibit rooms serve very well to show to visitors, but it can hardly be expected that a busy executive will depend on them to any great extent for the class of current information he needs to have immediately available in a form that facilitates quick reference and of a size convenient for desk use.

## **CHARTS FOR CONFERENCES, BOARD MEETINGS, AND HEARINGS**

The selection of design and size of display charts for conferences, meetings of boards or committees, and other small gatherings is determined mainly by the number of people likely to be present. For an ordinary departmental conference of executive heads, display charts around 20-by-30 inches in size will be large enough. If the number taking part in the conference exceeds fifteen or twenty, both lettering and drawing should be larger.

If the conference includes representatives of interests widely diverse in character, careful editing of the titles and labels is necessary to make

them clearly descriptive in terms familiar to everyone. Labels should be placed close to the components and categories. Attempts to show different aspects of the data in a single chart are usually ineffective. Unless the chart automatically tells its story it will have to be explained, and charts that require verbal explanation are generally failures. Redundant lettering, unessential ruling, and ornamental borders and curlicues serve only to divert attention from the main purpose of the chart.

The lettering should be done, if possible, with lettering guides. Hand-lettering of display size generally lacks finish and uniform spacing. Irregularities in lettering are the first details to catch the eye, and the impression of carelessness or poor workmanship they create detracts seriously from the effectiveness of the chart.

The time between the calling of a conference and the date it is to be held is sometimes too short for making up the required number of charts in display size. A method that may be employed in such emergencies consists in drafting the charts on small sheets, with stripped typed lettering, for duplication by photostat. Enough copies of the originals are run off to provide each person attending the meeting with a full set of the charts planned for presentation.

To obtain the best results with charts for use in conferences or hearings it is essential that the method of presentation be carefully planned and adapted to the order of business likely to be followed during the meeting. It frequently happens in business conferences that no formal agenda is prepared and the order in which the various subjects will come up for discussion cannot be determined in advance. The best plan in such cases is to distribute the charts separately about the room, so they are immediately available when they are reached in the course of the discussions.

If the agenda is limited to one general subject, the procedure may be similar to that followed in lectures. A speaker, sometimes the chairman of the conference or a member of the statistical staff that designed the charts, takes charge of the presentation. The charts, placed on an easel or a table, are shown and discussed one at a time.

Various details that must be taken into account have to do with the physical conditions of the room in which the meeting is held. They usually offer little difficulty if it takes place in an office or board room equipped with facilities for the placement and handling of the charts. But if it is scheduled for a locale where such essentials as adequate lighting and the necessary furniture and equipment for displaying the charts are lacking, these must be provided before the meeting begins.



Any last-minute improvisations are very likely to prove unsatisfactory.

Nothing so tries the patience of an audience as confusion or delays in the order and method of the presentation. The position and height of the chart stand and adequate lighting are of special importance. Some inconspicuous procedure for disposing of the charts after they are shown is needed. Charts not exceeding 20-by-30 inches in size usually can be laid face down on the table in front of those not yet shown. Charts of larger sizes should be turned over to an assistant for disposal. The speaker should stand at the right, not in front, of the charts, so he will not obstruct the vision of people seated at the side of the room. He can use a pointer two or three feet long to call attention to features of the chart of special significance, without at any time impeding a full view of the chart from all parts of the room.

A brief reference to the experience of the War Department Statistics Branch in the course of the series of meetings with the Senate and House Military Committees during the last war, referred to in Chapter I, may serve to illustrate the type of problems met with in the use of charts in conferences. Many of the meetings were held in the offices of the War Department, where all necessary equipment and facilities were available. Often, however, for the greater convenience of the Committee members, they took place in committee rooms in the Capitol or in the Senate and House Offices, where a number of the requirements for successful chart presentation were lacking. Also, as the rooms were in frequent use for other purposes, the time for remedying such deficiencies was limited.

In the meetings with the Senate Committee where the attendance seldom exceeded ten, little difficulty was encountered in securing a table or desk large enough and high enough to display the charts full-length to all present. The provision of supplemental lighting was usually unnecessary. As none of the members of the Committee were more than twenty feet from the charts, the labels and titles were clearly legible and reference to them could be omitted in the speaker's verbal introduction to each chart.

The attendance in the meetings with the House Committee generally ranged from thirty to forty. This meant that if the charts were placed on an ordinary desk or table only the upper part of them would be visible to those seated beyond the fourth or fifth row of chairs. The stand for the charts had to be built up by one means or another—sometimes by piling books on the table or adding a pair of filing-case units to secure sufficient height. Usually the illumination from the

overhead lighting was inadequate. This was remedied by placing a footlight below the charts. As the labels of curves and segments could not be easily read from the rear of the room, the speaker included in his introductory remarks a complete description of the graphic features of each chart.

Questions from the audience were another serious problem. The speaker had to be fairly well informed concerning the subject of each chart and have at hand in convenient form such additional data as might possibly be requested by members of the Committees. A frequent request, if the charts represented percentages or index numbers, was for their translation into their basic equivalents, or in the case of curve charts, the high, low, and end points of the curves. Such questions were taken care of by lettering the figures in light pencil above or below these points or on the margins of the charts, where, although not visible to the audience, they were instantly available in answering questions of this kind. Requests for more extensive data were referred to an assistant provided with tables and other source material pertaining to the charts.

A few experiments were made with pictorial additions to the charts—sometimes characterized the “kindergarten” method—consisting in drawings of the objects represented by the curves, bars, and other conventional graphic types. For example, if the chart pictured the production rate of airplane bombs, a drawing of a bomb accompanied the lettering in the stub in bar charts or above the curve in curve charts. It was finally decided that the limited value of such aids to visualization did not justify the time and labor expended on them.

## CHART EXHIBITS

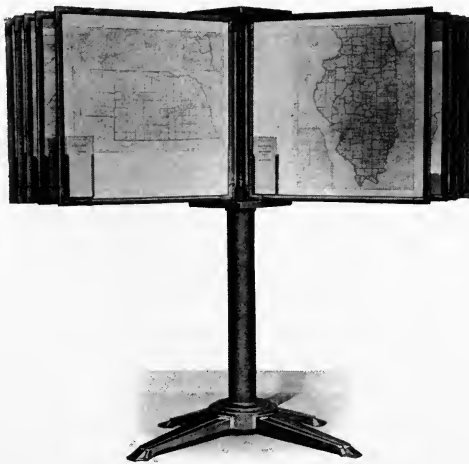
In large offices a room is sometimes set aside to be used exclusively for a permanent chart exhibit. In other cases the exhibit is located in a room used for conferences and board meetings.

The commonest defect in chart exhibits is lack of flexibility. The exhibit rooms are filled up with subjects which appear to be of outstanding interest at the moment. Within a short time many of the charts will be out of date unless provision is made for keeping the exhibit in line with the new statistical data received from day to day. As many as possible of the charts should be designed with space left for adding new data. If the time scale in curve and column charts is in months, blank space for at least three additional months should be

left at the right of the drawing. Otherwise, the drafting room will be confronted each month with the task of making over most of the live charts in the exhibit.

The major problem in the maintenance of a chart exhibit is how to keep it alive. Every facility for making frequent changes should be provided. The method employed for fastening the charts in place on the walls or display fixtures should permit their easy removal without tearing or defacing the paper or cardboard. Stapling devices are not adapted for use on charts that must be returned to the drafting room periodically to be brought up to date, or that are likely to be needed in conferences or for exhibit in another room or building. Within a short time the margins on which the stapling is done become defaced to such a degree that the chart has to be made over. Map tacks, which leave little trace on the chart margins, are commonly used for this purpose.

The type of fixture which is shown in Figure 17 is very convenient for exhibits of small- or medium-sized charts. It occupies little space and is portable. The use of wall space is preferable for charts of display size.



*Multiplex Display Fixture Company*

FIGURE 17. PORTABLE FIXTURE FOR EXHIBIT OF SMALL CHARTS.

Conferences requiring the use of charts are frequently held in rooms where hanging the charts on hooks or tacks is impracticable because of possible injury to the wood paneling or the wall finish. In such cases

light easels are the best solution, although they have the disadvantage that only one chart at a time can be shown.

One of the most important requirements for the display of statistical charts in exhibits is adequate lighting. It must be strong enough to bring out clearly contrasts in color and shading and permit easy reading of the lettering. Overhead central lighting is usually unsatisfactory. Whenever possible, hooded lights should be placed immediately above the charts.

Figure 18 shows a wall cross-section of a permanent chart exhibit installed by a Federal agency in Washington. Good lighting is secured with a series of fluorescent lights extending the length of the wall. These are enclosed in a lighting box open at the bottom. The space between the lighting box and the shelf below is large enough for a chart 40 to 42 inches in height. This space is backed with plywood, with an outside layer of heavy cardboard. The slanting shelf below the charts provides space for reports, tables, or other matter relating to the subjects presented in the exhibit.

## CHARTS FOR PUBLIC ADDRESSES

The chief problem in the preparation of charts for use with addresses or discussions before large gatherings is the matter of size. The lettering on a 30-by-40 inch illustration-board chart, unless it is very large, will not be clearly legible at a distance beyond thirty to forty feet. Larger sizes of illustration board are difficult to transport and awkward to handle.

If the address is given from the seating level of the room, the utilization of illustration-board charts is impracticable. Only those of the audience seated near the speaker can obtain a full-length view of the charts. If they are shown from a raised platform, the stand for the charts should be high enough to leave a space of several feet between the lower margins and the floor.

The charts should be shown from a central position, one at a time. Distributing them separately at the front of the stage or platform, an arrangement sometimes adopted, saves some handling, but divides the attention of the audience, which should be held to the chart under discussion by the speaker.

Strong lighting should be provided if cardboard charts are used, otherwise only those of the audience seated near the speaker will be able to distinguish details in the charts. Footlights, sometimes used for

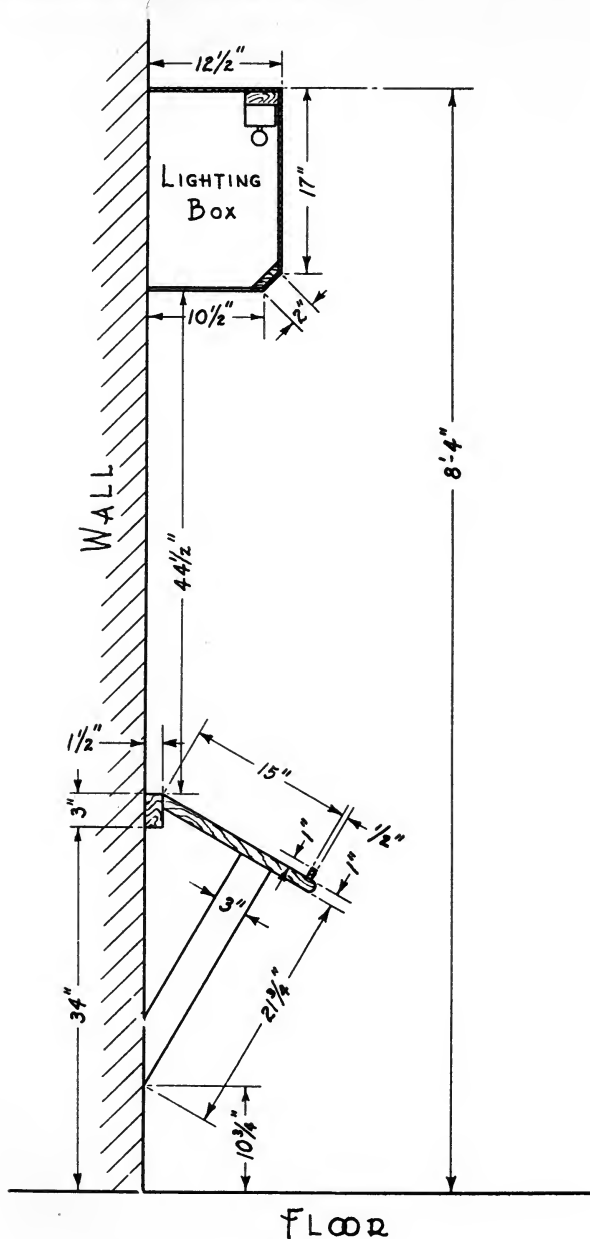
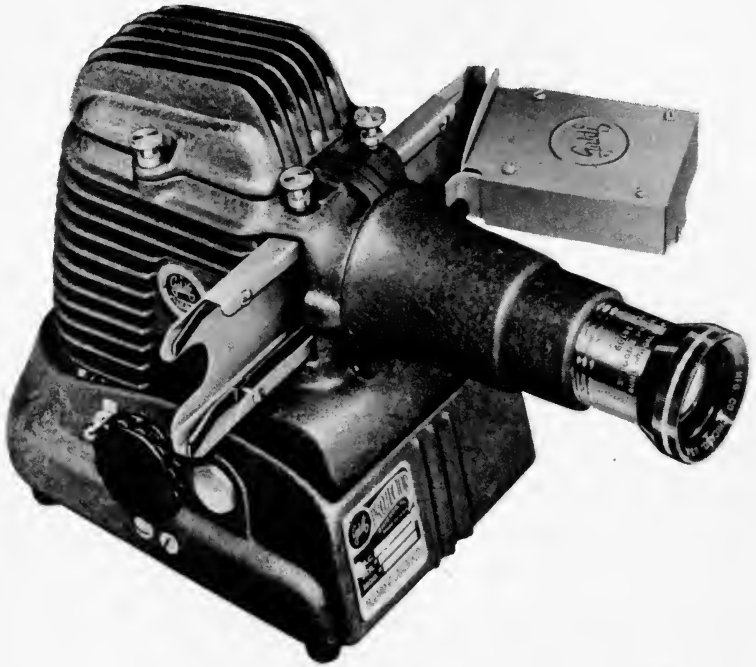


FIGURE 18. WALL CROSS-SECTION OF A CHART EXHIBIT.

this purpose, are better than nothing, although the lighting should be from above rather than from below the chart.

Lantern-slide projection gives the best results if the audience is too large for the use of illustration-board charts. The charts are first drafted in a size convenient for lettering and then reduced photographically to that of the slides. With a good projector a clear magnification up to ten feet square or over can be secured.



*Goldie Mfg. Co.*

FIGURE 19. LANTERN-SLIDE PROJECTOR.

While the best results in lantern-slide projection will be obtained only if the room where the charts are shown is in complete darkness, this is often difficult or impossible in large public halls and auditoriums. The disadvantages of semidarkness can be overcome to a considerable extent if a projector with a high light output is used and the position of the screen with relation to the room lights adjusted so that no light except that from the projector falls directly upon it. The room lights should be controlled, if possible, from the projector position.

This method solves the problem of size, but involves a few minor complications, among them the position of the speaker. He cannot stand in front of the screen, and at either side will not be seen clearly in the semidarkness required for satisfactory screen projection. This difficulty is usually met by placing in front of the speaker a small table or desk equipped with a hooded desk light.

The microphone, commonly employed for the delivery of addresses to large audiences, limits to some extent the speaker's freedom of movement. Unless he is accustomed to the use of this instrument, he is likely in the course of his address to turn his head toward the screen to call attention to some especially significant feature of the chart. This will be instantly reflected in a noticeable difference in the tone and volume of his voice.

The projector, with the slides arranged in their appropriate order, should be in charge of an assistant who can be trusted not to mix up the chart sequence nor put the slides into the projector upside down. A system of visual signals between the speaker and his assistant should be worked out and practiced until there is no chance of slips in the timing.

Charts to be shown with a public address should be extremely simple in design. Colors, shading, and curve patterns designating components and categories should be chosen with an eye to strong contrasts. It is essential that the meaning and purpose of the chart be obvious at a glance. If they are not, the attention of the audience is divided between deciphering the chart and listening to what the speaker has to say about it.

## CHARTS FOR RECORDING CURRENT OPERATIONS

Charts of this type are little more than accounting devices in graphic form. They are used extensively in all classes of industrial and commercial activities. They generally consist of a series of dates at the top of the chart and a list of items at the left. The ruling is vertical for the time scale and horizontal for the items. The entries corresponding to each time unit are noted as numbers or symbols or with adhesive tape in color or shading. If the chart is laid out on cardboard, map tacks of different colors or shapes may be utilized for the same purpose.

Ruled loose-leaf sheets are commonly employed for charts representing a continuous daily record. If the entries are at longer intervals,

the chart is usually drafted in wall-chart size. A curve or column display chart, if space is left at the right of the drawing for future entries, serves the same purpose.

A type sometimes designated "Progress Chart," similar in design, is employed to record progress on a project, study, or investigation with a definite time limit. Usually the time scale is in months, the last month in the series representing the date set for completion. The entries are in percents, showing the proportion of the project finished to the end of each time unit.



## ■XVII

### STATISTICAL PROCEDURES

**T**HE foregoing chapters have dealt chiefly with the various stages of design, drafting, and production. This chapter will take up in some detail the procedures employed in the preparation of the statistical material before the chart reaches the drafting stage.

In large enterprises or organizations this is a matter with which the draftsman need not concern himself. The initial idea of the chart generally originates with someone exercising managerial or administrative functions. It then passes to the statistical staff, which carries out the necessary research and the collection and analysis of the data. It usually reaches the draftsman in the form of a table suitably arranged for drafting and generally accompanied by a rough freehand sketch outlining the design selected.

There are many small enterprises, however, where the draftsman may be called upon to take over partly or entirely the work of collection and analysis of the data and the preparation of the tables for the charts, as well as their reproduction in typed or printed form. In this case he

will need some knowledge of statistical procedures. A large number of persons are engaged in such work, but only a small proportion call themselves statisticians, and fewer still have had special training in statistics. The fact is that the methods employed in the preparation of data for the majority of charts are simple and easily learned. Some of the most important of these are outlined in the following pages. A brief study of a good text on statistics will give the student all the additional refinements in statistical technique he will ever be called upon to use. *Elementary Statistics*, by Dr. F. H. Harper, may be especially recommended for simplicity and clarity of treatment in terms understandable to anyone with a high-school education.

The knowledge of mathematics needed for this phase of the work varies with the nature of the problem. Only rarely will more than a thorough grounding in arithmetic be required. This is true even of the higher flights of statistical analysis, once they are divested of technical terms and mathematical symbols. After the various steps are broken down into everyday English, it will be found that they demand only a working knowledge of eighth-grade arithmetic.

## ROUNDING

Much time will be saved in preparing statistical data for charts or tables by rounding large numbers to three or at the most four digits. Plotting to the fourth digit in any but very large display charts is impracticable. In tables small numbers save space and are easier to read and understand than large ones. Rounding focuses attention on the more significant digits and reduces the work of calculating the conversion of basic figures to relative numbers.

In rounding, a digit less than five is dropped. A digit greater than five adds one to the next digit to the left. If the digit to be discarded is an even five, the next digit, if an even number, is unchanged, but if odd, it is raised.

Care must be used in rounding series of numbers varying widely in magnitude to avoid undue distortion of the smaller items. For example, the series 150,700, 72,300, and 5,500, if rounded to thousands, becomes 151, 72, and 6. The change in the first two numbers through rounding amounts to less than one half of 1 percent, but the third number is increased by over 9 percent. It is best in such cases to add one decimal place in all the rounded numbers.

Frequently a column of rounded numbers will not add to the

rounded total. The difference is usually slight, but a footnote should be added explaining that, because of rounding, the total does not agree with the sum of the items. If the figures are percents, it is customary to increase or decrease by one the right-hand digit of one or more of the larger percents to bring the total to 100.

AVERAGES

Averages are employed to summarize statistical data. They are computed in various ways. The terms designating the two methods most frequently used are "simple," or "unweighted," and "weighted" averages. The simple average is merely the quotient obtained by dividing the total of a series of values by the number of components. Table IV illustrates the procedure.

TABLE IV

SIMPLE AVERAGE	
<i>Components</i>	<i>Values</i>
A	220
B	135
C	365
	<hr style="width: 100%;"/>
Total	720
Average	240

If the series contains one or more extreme values, the average may differ so far from any of the individual values or any grouping of them as to be of no real significance. Table V is an example.

TABLE V

AVERAGE OF A WIDE RANGE OF VALUES	
<i>Components</i>	<i>Values</i>
A	75
B	306
C	34
D	26
E	550
F	65
G	29
	<hr style="width: 100%;"/>
Total	7      1,085
Average	155

The figure obtained by dividing the sum of the values by the number of components is nearly three-and-one-half times the average of the five smaller values and is 64 percent below the average of the two larger ones. In cases of such wide differences in the range of values, the median, the middle item when the values are arranged according to size, is sometimes used. This arrangement, using the same data, is shown in Table VI.

TABLE VI  
ARRANGEMENT OF VALUES TO DETERMINE THE MEDIAN

550
306
75
65 Median
34
29
26

The median, 65, is more representative of the five lower values than the average, but neither is of much use as a summarization of the whole series. The median is seldom employed in commercial and industrial tables, chiefly because few people are familiar with the term. The same objection applies in lesser degree to "mean" and "arithmetic mean," which are sometimes used for "average."

### WEIGHTED AVERAGE

If both components and values vary in size, the weighted average should be used. Table VII shows the weighted-average cost per unit of a product manufactured in three separate establishments.

TABLE VII

WEIGHTED AVERAGE

<i>Establishment</i>	<i>Number of Units Produced</i>	<i>Total Cost</i>
A	400	\$ 4,800
B	1,100	11,900
C	700	8,600
Total	<u>2,200</u>	<u>\$25,300</u>

Weighted-average cost per unit \$11.50

Weighted averages derived from series in which there are extreme differences in the size of components or values are likely, as in simple averages, to be of little significance for practical use.

Averages and percents should not be averaged. The procedure for obtaining a true average of a number of averages or percents is the same as that for the weighted average. The basic values and component figures from which the individual averages or percents are derived are totaled. The true average is the quotient of the value total divided by the component total.

A type of error common in both simple and weighted averages is the inclusion of components which have no bearing on or merely distort the summarization. Errors of this kind are frequent in per capita estimates covering the total population. A recently published rate of per capita consumption of liquor in the United States was calculated by dividing the total consumption by the total population, without taking into account that the population group fourteen years of age and under, numbering nearly thirty-three million, consumes no liquor.

## FREQUENCY DISTRIBUTIONS

Frequency distributions are distributions of amounts by categories. Table VIII, representing a theoretical distribution of the wage-earners in an industrial establishment by rates of pay per hour, is an example of a simple frequency distribution.

TABLE VIII

SIMPLE FREQUENCY DISTRIBUTION	
<i>Rates of Pay</i> <i>(Cents Per Hour)</i>	<i>Number of Wage-earners Re-</i> <i>ceiving Specified Rates</i>
70	12
75	21
80	63
85	75
90	84
95	80
100	74
105	60
110	51
115	36
120 and over	22

Table IX shows a distribution of wage-earners by weekly earnings, estimated from the data in Table VIII. The number of different individual amounts in an average weekly payroll is too large to show each separately in a chart or statistical table of reasonable size. For this reason, the data are grouped in class intervals.

TABLE IX

CLASS-INTERVAL DISTRIBUTION	
<i>Class Interval</i> ( <i>Dollars Per Week</i> )	<i>Number of</i> <i>Wage-earners</i>
25-29	31
30-34	140
35-39	235
40-44	114
45 and over	58

The class intervals in this table are in groups of five, each interval comprising the items from the first to the last number, including those exceeding the last, but less than the first number of the following class interval. For example, a wage-earner whose pay check amounted to over \$44, but less than \$45, was classed in the 40-44 interval.

The class intervals should be approximately equal in size. Frequently a series is made up chiefly of items which fall within the range of relatively small class intervals but ends with several of much greater spread. In Table X the range in each of the first four class intervals is 100, while in the fifth it is 500, and in the sixth, 1,000. Presented in a table, a distribution of this kind may be understood, but it is difficult to make a chart of it that will show a clear picture of the relation between the amounts in the small and large class intervals.

TABLE X

DIFFERENCES IN RANGE OF CLASS INTERVALS	
<i>Class Interval</i>	<i>Amount</i>
101-200	125
201-300	224
301-400	654
401-500	185
501-1,000	110
1,001-2,000	56

## INDEX NUMBERS

Index numbers are frequently used in the analysis and presentation of statistical data. Published index-number series compiled by governmental statistical agencies alone cover an extensive range of economic and industrial activities. Many tables published in economic periodicals include only index numbers, omitting the basic data from which the indexes are derived.

The term index number has a technical sound, but it is only another name for percent. A certain figure or figures in a series is selected as the base, with an assumed value of 100. All the figures in the series are then converted to percents of this base. For example, the series 160, 80, 120, 200, if the base selected is the first number, becomes as index numbers 100, 50, 75, 125. Each of the numbers is divided by the base.

The designation "index number" is frequently omitted in tables and charts. The base figure, followed by 100—for example, "1929 = 100," "1941-45 = 100"—is lettered in the body of the chart or over the upper ruling of the grid. In typewritten tables it is either typed below the title or over the first ruling of the table. In printed tables it is often set in heavier type.

The examples which follow illustrate some of the advantages of this method for use in statistical analysis and particularly its value for comparisons of two or more series of unlike basic units or of extreme difference in size. As the examples are interrelated, the same time series, 1929 to 1937, is used in all of them. This period covers the great depression of 1929-33 and the succeeding recovery movement during which various important indicators reached or exceeded the 1929 levels. The data represent important factors in the manufacturing industry; the charts present the same data in graphic form.

The first example shows the use of index numbers for comparing two series which, because of the difference in the nature of the basic units, are not comparable in their original form. The series represent two factors of primary importance, the total number of workers employed and the total amount of time worked. The data in Table XI are estimates of average employment and average hours worked per week in the manufacturing industries. The estimates were published by the Bureau of Labor Statistics of the U.S. Department of Labor. The employment data include both wage and salary employees, but the changes over the period may be taken as representative of the employment of wage-

earners, as the salaried employees constitute only an insignificant proportion of the over-all totals.

TABLE XI

EMPLOYMENT AND HOURS WORKED PER WEEK, MANUFACTURING INDUSTRY: 1929 TO 1937									
Year	1929	1930	1931	1932	1933	1934	1935	1936	1937
Employment (Thousands)	10,534	9,401	8,021	6,797	7,258	8,346	8,907	9,653	10,606
Hours worked per week	44.2	42.1	40.5	38.3	38.1	34.6	36.6	39.2	38.6

The two series are drafted separately in Chart 112. Double-scale charts are sometimes used for comparisons of this kind. Whether combined in a single chart with two scales or charted separately, however, the curves, because of the difference in the scales, do not afford a true comparison of the relative changes over the period and offer but little advantage over the tabular presentation.

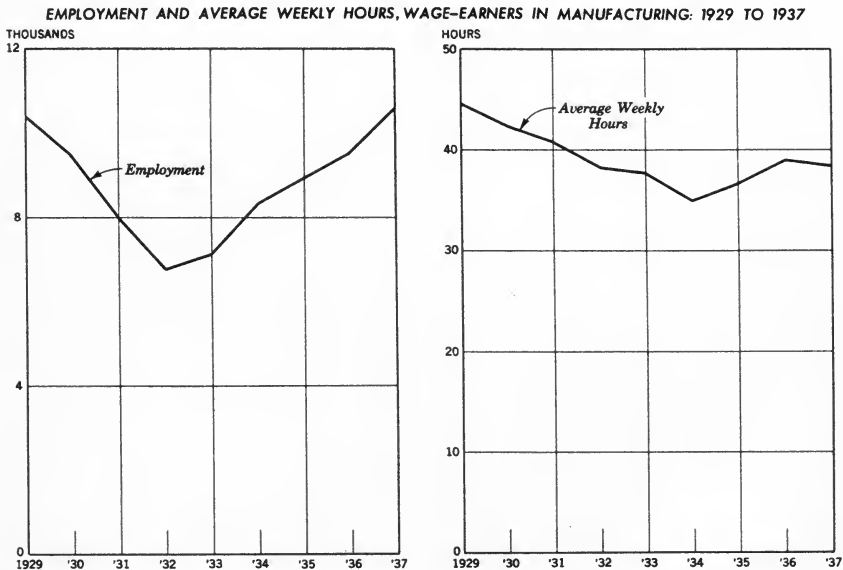


CHART 112.

Both series, converted to index numbers based on 1929 as 100, with a third index, total hours worked, derived from the first two, are shown in Table XII and Chart 113.



TABLE XII

EMPLOYMENT, HOURS WORKED PER WEEK, AND TOTAL HOURS WORKED:  
1929 TO 1937

INDEX NUMBERS, 1929 = 100.

Year	1929	1930	1931	1932	1933	1934	1935	1936	1937
Employment	100	89	76	64	69	79	84	92	101
Hours worked per week	100	95	92	87	86	79	83	89	87
Total hours worked (Hours worked per week multiplied by employment)	100	84	70	56	59	62	70	82	88

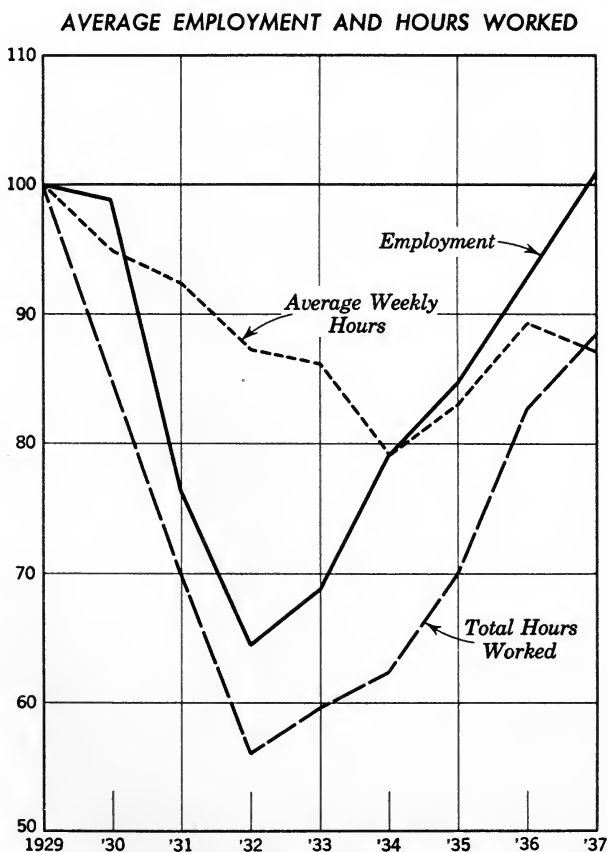


CHART 113.

Either of two methods may be employed to obtain the third series, total hours worked: (1) Multiply average hours worked by number employed and convert the products to index numbers; or (2) multiply the index of hours by the index of employment and divide the products by 100. The latter method is simpler and shorter, and the index numbers, after rounding, will be the same. Index numbers from 100 to 1,000 are rounded to three digits, and if less than 100, to two digits. Slightly closer accuracy can be secured by adding one decimal place, but this is offset by loss in simplicity and clarity of presentation. There is no point in straining for microscopic accuracy in relative series which, in reality, can be only approximately exact, particularly if the data represent estimates or averages combined from many sources.

Conversion of the basic data to index numbers makes it possible to present them graphically in a form that facilitates exact comparison and interpretation.

The volume of industrial production is one of the primary indicators of changes in economic conditions. The first line in Table XIII represents the index for all manufacturing for the years 1929 to 1937 based on the average for the period 1935-39. These data were compiled by the Federal Reserve Board. The second line is the same index converted to a series based on 1929. The conversion is effected by dividing each of the numbers in the Federal Reserve Board index by its 1929 index number, 110.

TABLE XIII

PRODUCTION, WHOLESALE PRICES, AND VALUE OF PRODUCTION:  
1929 TO 1937

Year	1929	1930	1931	1932	1933	1934	1935	1936	1937
Industrial production (1935-39 = 100)	110	90	75	57	68	74	87	104	113
Industrial production (1929 = 100)	100	82	68	52	62	67	79	94	103
Wholesale prices (Manufacturing)	100	93	82	74	75	83	87	87	92
Value of production (Price index multiplied by production index)	100	76	55	39	46	61	69	91	95

The first two lines illustrate the procedure for converting series of index numbers from one base to another. The wholesale-price index is compiled by the U.S. Department of Labor. The fourth line, value of

production, is calculated by the short-cut method described in the preceding example. The three series, production, price, and value, are compared graphically in Chart 114.

Special care should be exercised to obviate misinterpretation or misuse of derived indexes through the employment of designations that imply a relationship which may be, in fact, non-existent. The indexes "Output Per Worker" and "Per Hour," derived by dividing the index of production by the indexes of employment or man-hours, are examples. Changes in these indexes are sometimes assumed to indicate that corresponding changes have taken place in the productiveness or efficiency

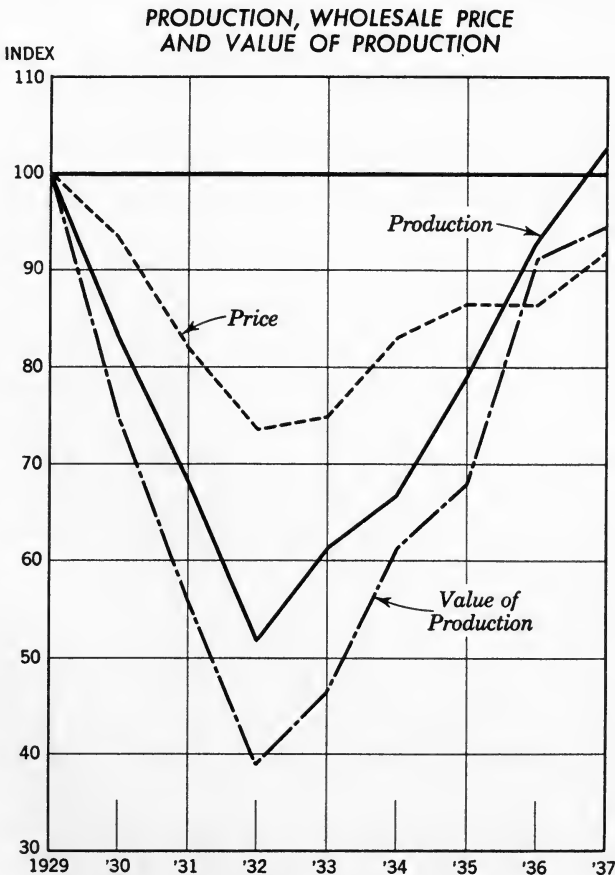


CHART 114.

of labor, although this interpretation has no basis in fact. The course of these indexes through the period 1929 to 1937 illustrates this point. Both the basic and the derived indexes are shown in Table XIV.

TABLE XIV

OUTPUT PER MAN AND PER HOUR, MANUFACTURING: 1929 TO 1937									
Year	1929	1930	1931	1932	1933	1934	1935	1936	1937
<i>Basic Indexes</i>									
Employment	100	89	76	64	69	79	84	92	101
Total hours worked	100	84	70	56	59	62	70	82	88
Output (Production index)	100	82	68	52	62	67	79	94	103
<i>Derived Indexes</i>									
Output per man (Output index divided by employment index)	100	92	89	81	90	85	94	102	102
Output per hour (Output index divided by total-hours index)	100	98	97	93	105	108	113	115	117

The basic indexes, employment and total hours worked, differ fundamentally in that the hourly unit is constant while the employment unit ranges from part-time work during the depression years to full-time in the recovery. An employee working three days a week is not, for the purpose of the comparison shown by the derived indexes, the same "man" as one working five or six days a week.

The curves in Chart 115 are not indicative of either decline or increase in the average contribution of labor. It is highly unlikely that efficiency per man or per hour decreased during the depression. In fact, if the general tendency in the reduction in working forces that took place, to retain as far as possible the highly skilled workers, is taken into account, it is probable that the average productive capacity of labor rose rather than fell during that period. The curves reflect in the earlier years the general slowing-down of the whole productive process, due to lack of demand and disorganized markets. In the rise that followed, improved equipment and economies in production methods developed from the experience gained during the depression contributed heavily to the gain in rate of production. These factors alone accounted to a considerable extent for the increase in ratios of output per man and per hour.

The foregoing examples, covering a few significant factors in a typical economic problem, illustrate some applications of the index method in statistical research and analysis. The numerous economic indexes published by public and private statistical agencies can often be employed in background studies for comparison with developments on a

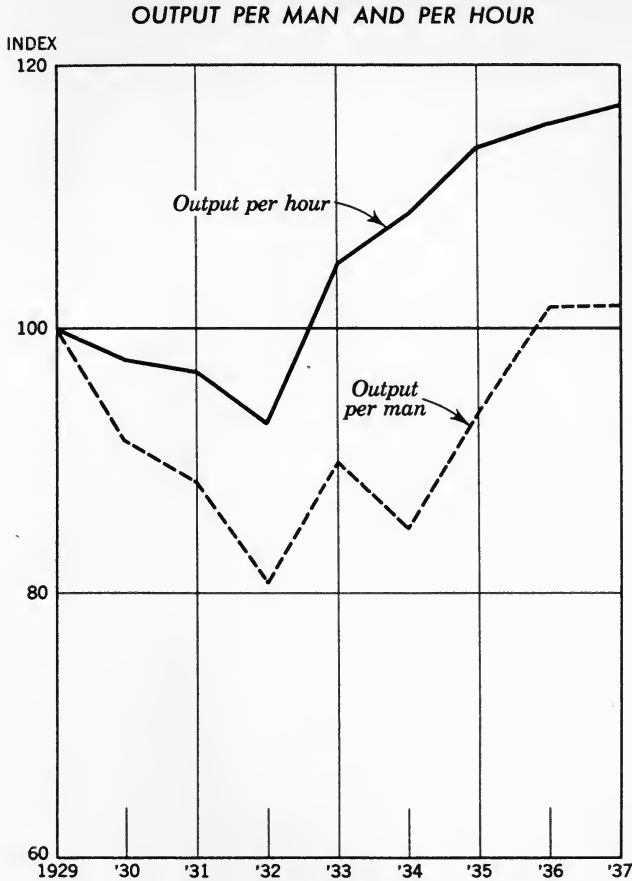


CHART 115.

smaller scale in individual enterprises. As the indexes are immediately available, studies of this general nature can be made with a minimum expenditure of time and effort. All the basic indexes used in the index-number examples were taken from a single volume, the Statistical Abstract of the United States, published by the U.S. Department of Commerce. The tables were done in one day by one person, including computation of the derived indexes.

If the calculations are made without the aid of computing machines, the closest possible rounding consistent with a fair degree of accuracy should be employed to shorten and simplify the work. Even with ma-

chines the use of large figures is usually unnecessary. Investment in a good slide rule will pay handsome dividends in economy of time and tedious computation. Anyone can learn to use a slide rule with an hour or so of practice. For computing percentages or other ratios which do not run beyond three digits, it is faster than a machine. All of the derived series in the index-number tables were computed with a twenty-inch slide rule. A smaller size may be used for determining the proportions of charts and for multiplication or division to two digits, but for close work to three digits a longer rule is required.

Rough sketching is an invaluable aid in statistical analysis. Relationships whose significance would become apparent only after careful study of the same data in a table stand out instantly in a sketch. For this purpose pencil sketches on printed graph paper will serve quite as well as inked charts plotted exactly to scale.

## ■XVIII

### PLANNING, TABULATION, AND PRESENTATION OF TABLES

**T**HE first requisite in planning a table is a clear understanding of what the table is for and how it is to be used. Once the objectives are determined and the sources outlined, the succeeding steps are:

1. Lay-out of tabulating sheet
2. Tabulation, followed by check to sources
3. Addition of columns and computation of derived figures, if any, followed by check
4. Lay-out of stubs, columns, and column heads for typing
5. Typing, followed by check to tabulating sheet

#### TABULATING SHEETS

Careful design of the lay-out for the tabulating sheet will obviate complexity and confusion and save time, labor, and mistakes. It should be arranged so that, as far as possible, numbers to be compared are in

ACQUISITION, DISPOSAL, AND INVENTORY OF SURPLUS PROPERTY THROUGH MAR. 31, 1946, BY DISPOSAL AGENCY

(Millions of dollars)

Disposal agency and class of product	Net acquisitions	Disposals				Confirmed inventory, end of month		
		Total	Miscellaneous disposals a/	Property sold		Total	Property on lease	Available for disposal
				Reported cost	Sold for			
ALL DOMESTIC AGENCIES.....	15,458	2,499	277	2,222	1,025	12,959	579	12,380
War Assets Administration, total.....	14,943	2,344	268	2,076	942	12,599	579	12,020
Aircraft and parts and components....	6,903	579	152	427	70	6,325	52	6,273
Airports.....	6	3	3	0	0	2	0	2
Consumer goods.....	1,952	775	40	734	366	1,178	0	1,178
Plants and industrial real property....	3,570	392	4	387	231	3,178	519	2,659
Capital and producer goods.....	b/ 2,512	596	68	528	276	1,917	8	1,909
U. S. Maritime Commission:								
Shipyards.....	20	19	0	19	2	1	0	1
Other marine property.....	103	48	6	42	20	55	0	55
Farm Credit Administration:								
Farm and forest land.....	90	4	1	3	2	87	0	87
Production and Marketing Administration:								
Food and agricultural products.....	82	45	*	45	45	38	0	38

War Assets Administration

TABLE XV.



the same column. Comparison of numbers is easier when they appear one above the other rather than side by side. Units should be aligned vertically with units, and decimals with decimals. In tabulations containing both basic and derived figures a blank column should be left at the right of each basic column for recording the derived figures. In the final typed table the basic columns should go side by side at the left of the table and the derived columns side by side at the right. The reader compares derived figures with each other, not with the basic figures.

The series of numbers and stub entries should be broken down into groups for convenience in tabulation, copying, and reading. In some tables, of which Table XV is an example, the arrangement in groups is determined by the nature of the data. Otherwise the usual practice is to leave a blank line after each five items. Monthly figures can be arranged in quarterly or semiannual groups.

Ledger-ruled paper is often used for tabulating purposes, but the columns are usually too wide, with the result that the table occupies more space than is necessary, is awkward to handle, and must be folded two or three times to get it to a size convenient for filing. For general use a specially prepared form about 11-by-17 inches in size, ruled in columns one-half inch wide, with quarter-inch horizontal ruling, provides sufficient space for all but extremely wide tables and when folded once will fit in a standard filing cabinet.

## UNITS OF VALUE

When the unit of value is the same for all the columns, it is customary to place it under the title (see Table XV). If it applies to some of the columns, but not to all, it may be lettered in a box head, as shown in Table XVI, on page 192; and, if it applies to a single column only, it may be shown at the foot of the column head.

## TITLES

The title should be a concise but fairly complete description of the subject-matter. The facts the table shows should be emphasized by naming them at the beginning of the title. Such forms as "Table Showing," "Number of," and "Distribution of" in table titles and column headings should not be used unless they are essential to a clear description of the data.

In the typed copy, titles should be centered above the table. If they

STORAGE OF MAJOR GROUPS OF ASF ITEMS  
31 July 1944

Technical Service and Major Group	Estimated Value in Thousands of Dollars						Percent of Total				
	Total In Storage	Under Repair	Await- ing Final Assem- bly	Ready for Issue			Un- obli- gated	Un- obli- gated	Is- sue to Army	Opera- tional Re- serve	Int. Aid and Navy
				Unobli- gated	Issue to Army	Opera- tional Reserve					
TOTAL . . . . .	1,234,567	890,123	45,678	9,012,345	678,901	234,567	89,012	34.5	67.8	90.1	2.3
ORDNANCE DEPARTMENT . . . . .	4,567,890	123,456	78,901	2,345,678	901,234	456,789	12,345	67.8	90.1	23.4	5.6
Small Arms . . . . .	789,012	34,567	8,901	23,456	78,901	23,456	78,901	23.4	56.7	89.0	1.2
Artillery . . . . .	345,678	90,123	4,567	890,123	42,678	90,123	4,567	89.0	12.3	49.6	7.8
Tanks . . . . .	901,234	56,789	1,234	56,789	12,345	67,890	1,234	56.7	89.0	12.3	4.5
Self-Propelled Weapons . . . . .	678,901	23,456	7,890	123,456	78,901	23,456	7,890	12.3	45.6	78.9	1.2
Combat Cars and Carriers . . . . .	34,567	89,123	4,567	890,123	42,678	90,123	4,567	89.0	12.3	45.6	7.8
Trucks . . . . .	123,456	78,901	2,345	678,901	23,456	23,456	2,345	67.8	90.1	23.4	5.6
Other Vehicles . . . . .	789,012	34,567	8,901	234,567	89,012	34,567	8,901	23.4	56.7	89.0	1.2
Small Arms Ammunition . . . . .	345,678	90,123	4,567	890,123	42,678	90,123	4,567	89.0	12.3	45.6	7.8
Ammunition (Excl. Small Arms)	901,234	56,789	1,234	567,890	12,345	67,890	1,234	56.7	89.0	12.3	4.5

TABLE XVI. FROM Standards of Presentation, ARMY SERVICE FORCES.

run into more than one line the second line also should be centered and, if possible, be shorter than the first. Abbreviations should not be used in titles and subtitles.

## STUBS

The items in the stub should be edited to as uniform a maximum length as is possible without employment of unfamiliar abbreviations. Long stub items should be written in two or more lines. In tables where the list of items is broken down into groups the usual practice is to letter the title of the group at the left of the stub column and indent the subordinate items two or three spaces. This arrangement is shown in Table XV. If the subordinate items are longer than the group title, the arrangement may be reversed, as in Table XVI.

The order of items in the stub should follow a logical sequence. This may be quantitative, progressive, chronological, or alphabetical. Ascending or descending order of rank in the attribute in which the items are compared facilitates easy reading and interpretation. Any miscellaneous or combined group, such as "All other," should appear at the end of the list rather than in order of its size. The total may be the first or the last line of the table.

## TABULATION

The data should be recorded in black pencil. The No. 2 or 2½ is best for this purpose. A pen should not be used, as frequent erasures are unavoidable. An erasing shield will help to prevent smudgy erasing.

Much time will be saved in tabulation by working in twos. One person reads off the figures from the original source, the other records them on the tabulating sheet. The data for a single table may be drawn from a number of documents, reports, schedules, or other sources, which differ in shape, size, and arrangement. One person working alone on such a tabulation will take three or four times as long as two working together and will make more mistakes. The same method will save time in "reading back" to sources. Errors are more easily noted when read aloud.

Verification by reading back, however, is not an absolute guarantee of accuracy. The work is monotonous, and, if it is continued for some time, the attention may wander because of boredom or fatigue. Where

tape adding machines are used, the tapes, if properly labeled, can often be used to save time and work in verification. Some tables permit the use of a method that reduces materially the probability of errors. The lines as well as the columns are totaled. If the entries and the additions have been made correctly, the sum of the line totals will exactly coincide with the sum of the column totals.

## COLUMN WIDTHS

In typed tables the width of the columns should be as uniform as the size of the figures and the number of the columns will permit. If crowded for space, the minimum width necessary for individual columns can be determined by counting the digits and punctuation marks in the largest figure of each column and adding two blank spaces for ruling. Long column heads should be typed in several lines to fit the space required by the figures below them. The last three columns in Table XVI are examples. The practice of basing the width of columns on the space needed for long column heads written in one or two lines often results in columns that are far wider than is necessary for the data and a table that is too wide for typing on a machine of standard size.

## CAPITALIZATION

Titles should be capitalized throughout. In typed tables spaced capitals underlined are often used for short titles. Only the initial letter of the first word in subtitles is capitalized, with the exception of words normally written with initial capitals. The same rule applies to stub titles and column headings.

## PUNCTUATION

The title should not end with a period. If it consists of two sentences or independent phrases, a period follows the first but is omitted after the second. Periods are not used in column headings or stub items except where required for abbreviations. Commas should be used to separate thousands from hundreds and millions from thousands. Leaders, a line of spaced periods between stub titles and the first vertical ruling, are usually included in typed tables. Ditto marks should not be used.

If the data represent money, the dollar sign should be typed before each number in the first line, and repeated before the total if this is placed at the bottom of the table. It may be omitted if the data are rounded and the rounded unit is indicated below the title or in a column head.

## SYMBOLS

All spaces to the right of each stub item must be filled in. The symbols used to indicate that the data for a particular item are lacking vary widely. The zero, the single dash, and the double dash are often used for this purpose and are quite as often misunderstood. The data may be lacking for various reasons. The collection of information concerning a particular item may have been discontinued, or the information may not be pertinent or necessary for the purpose of the table, or the data may not have been received when the tabulation was made. A footnote defining or explaining the omission is preferable to arbitrary symbols whose meaning is often not clearly understood.

The footnote symbol most commonly used in typed tables is a combination of an underlined letter and an oblique, a/. It occupies only two spaces but requires backspacing for the underline. Another, less frequently employed, is a combination of letter and parentheses, (b). The use of the asterisk and double asterisk is usually limited to tables with not more than two footnotes.

## RULING

Methods in use for ruling statistical tables differ to some extent in minor details, but the following rules are generally applicable. The ruling is done in India ink with a ruling pen. A light double rule or a single heavy rule is drawn from margin to margin above the stub and column heads. The horizontal separations of the box and column heads are in single light rules. Single light vertical rules are drawn between columns. The sides of the table should be left open, without ruling. Totals and grand totals should be separated from other numbers by heavier single rules, vertical if the totals are at the right, horizontal if they are at the bottom of the table. Averages should be set off in the same manner.



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