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COMPUTER ANALYSIS AND EVALUATION OF STOCK TRADING TACTICS

by

ROBERT LAURENCE BABER

SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

1959

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Chairman, Departmental Committee on Graduate Students

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ROBERT LAURENCE BABER

Submitted to the Department of Electrical Engineering on May 25, 1959, in partial fulfillment of the requirements for the degree of Master of Science.

ABSTRACT

In this thesis, a theory of the stock market is presented, together with a scheme for buying and selling stocks based upon the predictions given by the theory. This trading scheme is tested by a program written for the IBM type 705 Electronic Data Processing Machine which simulates a person using this scheme. Results from the trader simulation program are presented and conclusions as to the potential for profit-making by the scheme are drawn. Suggestions for possible modifications and revisions to the simulation program are given.

A program that produces graphs of prices and volumes of stock transactions has been written and is briefly described. Numerical market data is used as input to the program. A sample of the output graphs is shown.

Thesis Supervisor: Dr. Frank M. Verzuh
Title: Assistant Director of the Computation Center

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to Dr. Frank M. Verzuh for the great deal of time and effort he has expended in supervising this thesis.

I thank my mother for her great amount of help in gathering a large part of the market data.

I would also like to express my gratitude to the International Business Machines Corporation for the use of facilities while I was employed in their laboratories, and particularly to Mr. Paul W. Case and Mr. Herb H. Graff for their assistance in obtaining machine time.

The assistance of Merrill, Lynch, Pierce, Fenner and Smith, Inc., in collecting data and obtaining machine time is greatly appreciated.

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CHAPTER I

THE FUNDAMENTAL VS. THE TECHNICAL APPROACH TO STOCK ANALYSIS

Successful trading of corporate securities for profit depends upon selecting the right issue and selecting the right time for buying and selling it. A great deal of effort has been expended in studying the stock market with this objective. These studies, which have been carried out by numerous people ever since the market originated, can be divided into two categories according to the approach to the problem.

One approach is the so-called "fundamental" one. A trader using this method will examine all available data in arriving at his decision of what to buy or sell and when to buy or sell it. He is interested in the data contained in the reports and the financial statements of the company whose stock he is considering, their earnings records, their history of dividends, the abilities of the management and directors of the company, and any other factors that might in any way affect the market price of the stock. He may concern himself primarily with only a few of the more important factors or he may try to take as many as possible into account, but he is always concerned with what the stock represents -- part of a company.

The person using the technical approach, on the other hand, concerns himself with the history of prices and volumes of stock trading transactions only. He takes the attitude that determining which of the fundamental factors are pertinent and determining their order of importance are difficult tasks in which errors are likely to be made. Sufficient data on some factors that may be important may not be available. The psychology of the other investors and traders in securities will have a collective effect upon the market prices. Factors of

which he is completely unaware may be of importance.

He also argues that the real value of a stock is what it can be bought or sold for, which is accurately given by data on recent transactions in that stock. This real value may have little or no relationship to the value of the stock given on the books of the company or to any other financial data pertaining to that company. Comparing market prices and financial data of many companies will show that this argument is correct more often than not.

The "technical" trader, therefore, concludes that it is impossible for him to get an accurate picture of all factors (taken in their proper perspective) that influence the market prices. Market data (prices and volumes of actual transactions) is the best and most reliable indication of the total effect of all these "fundamental" factors weighted according to their true importance. He concerns himself solely with the market action of the securities and not with what these securities represent.

Technical analysis fo stocks involves recording market data (usually in graphical form) and analyzing this data. Various patterns and trends are studied to determine their meanings, implications, and possible predictions of future price movements. The goal of this analysis is the selection of a set of meaningful patterns that can be interpreted as signals marking good times to buy and sell.

This thesis describes and evaluates one of these technical theories. Its origin, the Dow Theory, is covered in Chapter II. Chapter III deals with the extension of the ideas behind the Dow Theory into a more detailed theory applicable to individual stocks. The various patterns covered by the theory are described in this chapter. Chapter IV gives a description of pattern recognition as performed by a computer program that simulates a person following the technical theory.

Restrictions that patterns must meet are specified and parameters that affect pattern recognition are defined. Chapter V explains the operation of the computer programs, describing the inputs to and the outputs from each program. Chapter VI presents and discusses the results of several runs of the trader simulation program. Suggestions for revisions and future work in this area are made in Chapter VII.

CHAPTER II

THE DOW THEORY

The Dow Theory is the forerunner of stock market studies of the technical type. It is concerned not with any individual stock, but with averages of a number os stocks (the Dow-Jones averages). Its primary aim is to signal a reversal from a "Bull" market (one in which the main trend of prices is upward) to a "Bear" market (one in which the trend is downward) and vice versa.

The movements in the averages are separated into three categories: the primary trends, the secondary trends, and the minor trends. The primary trends are the large over-all up and down movements. They normally last for about a year or more and result in a change in the averages of 20% or more. The market is a bear market when the primary trend is down and is a bull market when the primary trend is up. Signalling a change in the primary trend as accurately and as promptly as possible is the aim of the Dow Theory.

The secondary trends are interruptions in the price movement in the primary direction. They normally last from three weeks to three months or so and retrace about one-third to two-thirds of the last movement in the primary direction. In a bull market, the secondary downward trends are sometimes called "corrections". The upward secondary trends in a bear market are called "rallies" or "recoveries".

The minor trends are price variations that are smaller than the secondary trends and are of shorter duration. The Dow Theory attaches no importance to these minor trends; they are merely parts of the secondary trends.

The Dow Theory uses both the Dow-Jones Industrial average and the Rail average. Each is examined for the signal indicating a change in primary trend. The direction of the primary trend is assumed to be unchanged until both averages signal the change.

Figure II-1 illustrates the configuration that signals the change from a bull to a bear market. The chart is a daily plot of the market average (at the close of each day's trading). The section to the left of point "a" is an upward movement of secondary trend extent and duration, bringing the average to a new high in the bull market (point "a"). The graph from point "a" to point "b" is a secondary decline, and the plot from "b" to "c" is the next secondary recovery. If during this secondary recovery the average had increased above its value at point "a", the bull market would have been "confirmed" and the primary trend would have still been upward. If, as in fig. II-1, a secondary decline begins before the average rises above its value at "a" and then drops below its previous local minimum value (point "b"), the new bear market is signalled, and the primary trend is then down. The following restrictions must be met in order for the pattern to signal the change in trend: sections "a" to "b", "b" to "c", and "c" to "d" must each be true secondary trends in extent and duration, and point "c" must be below point "a". The bear market is signalled at point "d" (not at point "c"), when the average drops below its value at "b".

Figure II-2 shows the configuration signalling a change from a bear to a bull market. The entire pattern is figure II-1 turned upside down. The analogous restrictions must be met, i.e., the several sections of the graph must be secondary trends rather than minor ones, and point "g" must be above point "e". When the average rises above point "f", the new bull market is signalled. This occurs at point "h" on fig. II-2. If, in the section to the right of point "f", the average had continued down below point "e" instead of stopping above it, the primary trend would have been confirmed and would still be a downward one.

Confusing patterns sometimes arise in the charts of the averages, but the preceding rules can always be applied exactly. For instance, if in fig. II-2 point "g" were below "e", the pattern would not signal a change in primary trend, even though

the graph rises above point "f" at "h". If one average signals a change of trend but the other does not, the primary trend is considered to be unchanged (at least until some other development occurs).

The sales volume plots are used in conjunction with the price graphs for supporting indications only. No conclusions are drawn from the volume graphs and they are not an integral part of a pattern signalling a change in primary trend. Generally, volume tends to increase as prices move in the direction of the primary trend. This volume rule is thought of as a generalization, not as a definite statement of fact. In questionable cases, the volume indications may be of help until the price movements show definite indications of either a continuing primary trend or a reversal of that trend. The behavior of the volume section of the chart may be bullish (volume increasing when price increases) when the primary trend is down. If the accompanying pattern in the price chart is such that a reversal signal could be developing, this volume behavior would alert the chartist to watch for a completion of a reversal signal. The volume indication itself would be no reversal signal, but it would point out what to watch for. Similiar bearish volume patterns occuring when a bull market has been in effect for some time would alert the chartist to watch for a bear market signal.

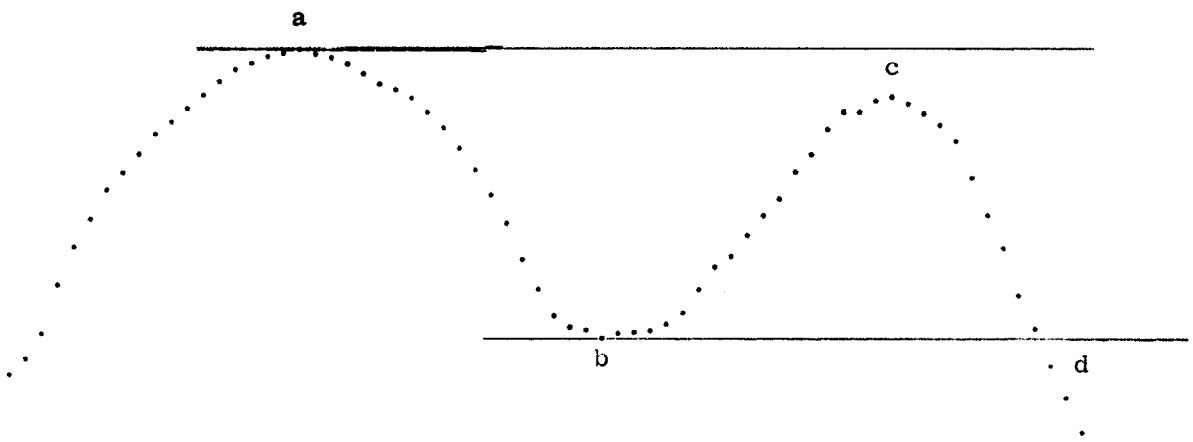


Fig. II-1

Beginning of a Bear Market Signal

(Minor trends not shown for simplicity)

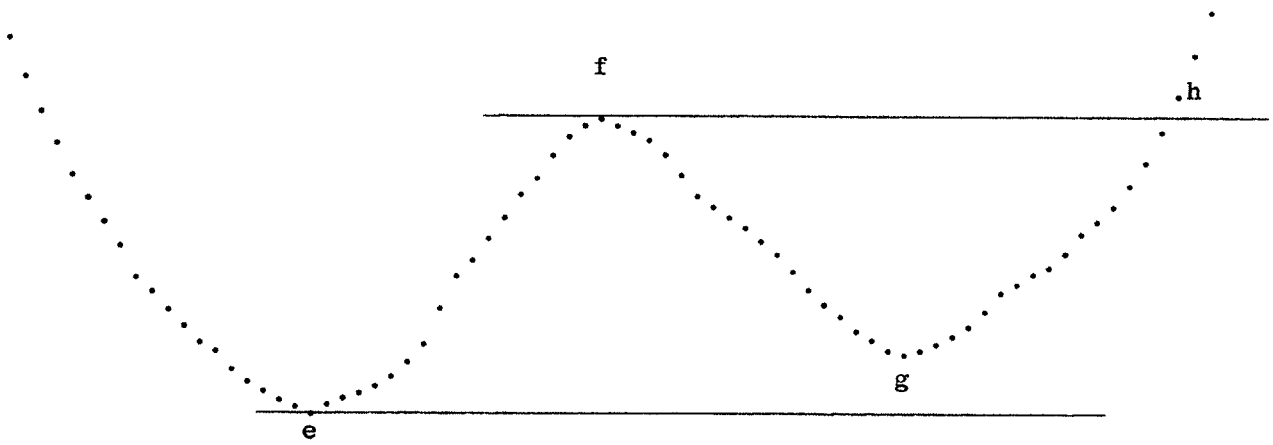


Fig. II-2

Beginning of a Bull Market Signal

CHAPTER III

A TECHNICAL THEORY APPLICABLE TO INDIVIDUAL STOCKS

Stocks generally move upward and downward together. If a trader bought a number of stocks when the Dow Theory indicated the start of a bull market and sold them when it signalled the beginning of a bear market, he would most likely profit from the transactions more or less regardless what stocks he picked. However, the facts that some stocks move upward and downward more than others and that some begin their primary trends before or after the averages do opens the possibility of obtaining considerably greater profit than would result from watching the averages only. To try to take advantage of this possibility, technical analysis methods have been devised that study the price and volume movements in the charts of individual stocks.

Numerous different schemes are in use. Many involve preparing some form of graph of prices and/or volume as a function of time and recognizing certain patterns that appear in these graphs. Some involve a statistical study of the trends in the prices. The technical theory that is the subject of this thesis is basically that described in the book "Technical Analysis of Stock Trends" by Robert D. Edwards and John Magee.

In any analysis using graphs, the question of what type of price scale to use is one of the first that must be considered. An arithmetic scale is often used because the market data printed in the papers is in dollar figures, including the day-to-day changes in price. Many investors and traders are as concerned by these actual dollar changes in price as they are by percentage changes. For persons with this outlook, the arithmetic scale is probably more meaningful than any other because of its

simplicity. However, for the trader who is concerned with percentage changes in price rather than with the dollar amounts involved, a semi-log scale is much more meaningful. A price change of 1 in a stock selling for 10 is of the same significance as a change of 10 in a stock selling for 100; each represents the same profit or loss for the same dollar investment in each stock. It is the amount of percentage change in the price of the stock that determines how much profit or loss is incurred, not the dollar change of value. It is for these latter reasons that the semi-log plot is the type studied in the technical theory used in this thesis. Logarithms of the prices are used instead of the prices themselves for the purpose of recognizing patterns. The charts produced by the computer programs are semi-log plots.

Figures III-1 through III-3 show the major patterns described in "Technical Analysis of Stock Trends". The "head-and-shoulders" pattern in fig. III-1 is a reversal pattern, indicating a change in trend. Fig. III-1 shows a head and shoulders top pattern indicating a change from an upward trend to a downward one. An upside-down version of fig. III-1 (a head and shoulders bottom) occurs and signals a change from a downward trend to an upward one. The line connecting points "b" and "d" is termed the neckline and is always nearly horizontal. Variations of this pattern occur which have extra "heads" (large peaks, section "b" to "d") or extra "shoulders" (smaller peaks). The breakout below the neckline at point "f" gives the reversal signal. The duration of the pattern is variable, being normally between 1 month and 1 year.

The head and shoulders top pattern gives an indication of the minimum price decline to be expected following it. Fig. III-1 shows this measurement (distance "h" in the figure). The price may be expected to decline below the neckline at the date of breakout by a distance greater than the distance from the neckline to the top of the head (point "c"). The same measuring implications apply to the head and shoulders bottom.

Figure III-2 shows triangle patterns. They are less positive in their indications (more fallible) than the head and shoulders. They can either signal a reversal of trend or a continuation of it, depending upon the direction in which prices break out from the pattern. The ensuing price trend will be in the same direction in which the breakout occurs. The ascending triangle has a horizontal upper trendline (line "a" to "c") and a lower trendline (line "b" to "d") that slopes upward to the right. The breakout occurs upward and the following price trend will be upward. The descending triangle is the opposite of the ascending triangle; the lower trendline is horizontal, the upper trendline is sloping downward to the right, and the breakout will be downward. The symmetrical triangle has a downward sloping upper trendline and an upward sloping lower trendline. Breakout can be either upward or downward. The direction of breakout indicates whether the following price movement will be up or down.

A measuring implication, similiar to that of the head and shoulders pattern, is contained in the triangles. The measuring distance ("h" in fig. III-2) is the distance between the second peak in the triangle (point "b") and the opposite trendline. The price may be expected to move at least this distance above (or below, as the case may be) the point on the trendline (through which breakout occurs) on the date of the breakout.

The triangle pattern does not necessarily have two points determining each trendline. Several extra turns of the price movement may be contained in the pattern. Each trendline is drawn between the two points that will cause the entire pattern to be enclosed by the two lines. Usually any other peaks inside the pattern will lie on or close to one of the trendlines so drawn.

It happens fairly often that after breaking out from a triangle, the price will return to near the price level of the apex of the triangle(the point where the two trendlines

meet and cross) and then continue in the direction of the breakout.

Triangles in which the breakout occurs close to the apex are generally not very meaningful and sometimes give erroneous signals. If breakout occurs farther to the right of point "a" than about 2/3 to 3/4 of the distance between point "a" and the apex the pattern should not be considered too reliable.

Fig. III-3 shows patterns called rectangles in "Technical Analysis of Stock Trends". They, like triangles, can either signal a reversal of trend or confirm the continuation of the trend in effect prior to the pattern. The breakout direction indicates the direction of the following trend. Both trendlines are horizontal (or very nearly so). There may be more than two peaks on either or both of the trendlines.

Numerous other smaller patterns are described in "Technical Analysis of Stock Trends". Many of these are patterns that signal continuation of the main trend. They are small in both price movement and time duration (no longer than a few weeks). Some of them bear resemblance to the triangles and rectangles.

The computer program, instead of recognizing the head and shoulders, triangles, rectangles, and other smaller patterns individually, categorizes patterns into nine types according to the slopes of the upper and lower trendlines. (Each trendline is constructed between the two most recent local maximum or minimum points). A "response" table, fig. III-4, shows for each pattern type-breakout direction combination whether the trader should buy, sell, or do neither.

Symmetrical triangles will be recognized as a type 9 pattern; ascending triangles, type 7; descending triangles, type 3; rectangles, type 1. The last half of the head and shoulders top will be recognized as a type 3 pattern; the last half of a head and shoulders bottom, as a type 7.

"Technical Analysis of Stock Trends" contains a section devoted to trading tactics. The responses shown in fig. III-4 and used in the program written for this thesis are derived

from the recommendations contained in this section of the book. These recommendations are based on the trend indications given by the patterns already described and by other considerations dealt with in the book.

"Stop loss" orders are used in the trading scheme in the computer program. These orders, commonly called stop orders, are used to minimize losses and to establish or fix a certain minimum profit in some transactions. A stop order to sell a stock is an order to the broker to sell it at the current market price if the market price drops below a stated price called the stop level. For example, a stop order to sell 100 shares of Acme Corp. at 40 might be placed when the stock was selling at 41. If any transactions of Acme stock were made at the exchange at a price below 40, the broker would then handle the order as an ordinary sell order. The order might be executed either above or below 40, depending upon what price the broker could obtain. Stop orders to buy to cover a short position are handled in an analogous manner. If the price of the stock rises above the stated stop level, the broker treats the order as an ordinary order to buy to cover, to be executed at the best price the broker can obtain. Whenever an interest in a stock is held (either "long" or "short"), a stop order for that stock is maintained by the program. When the stock is originally purchased (or sold short) the stop order is recorded. The stop level is computed to be 7% below the last local minimum price (7% above the last local maximum price for a short interest). When a new local minimum (or maximum) occurs in the price movement of that stock, a new stop level is computed as described above. The old stop level is replaced by the newly figured one if so doing raises the stop level for a sell order or lowers it for an order to buy to cover a short. Using stop orders in this manner sets an upper limit on the possible loss and safeguards profits.

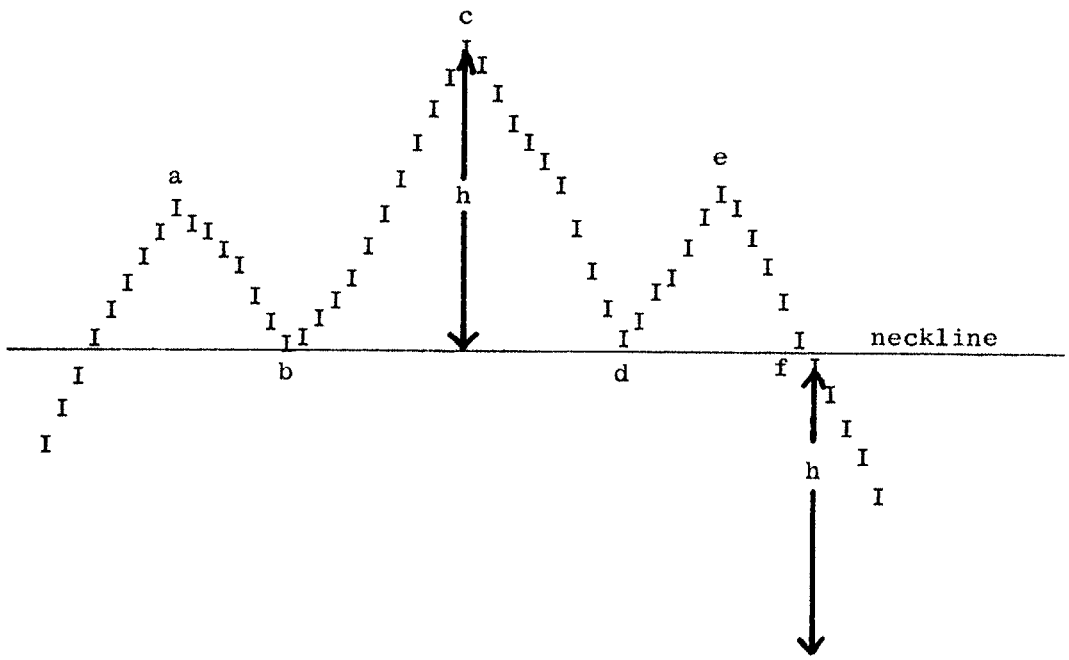
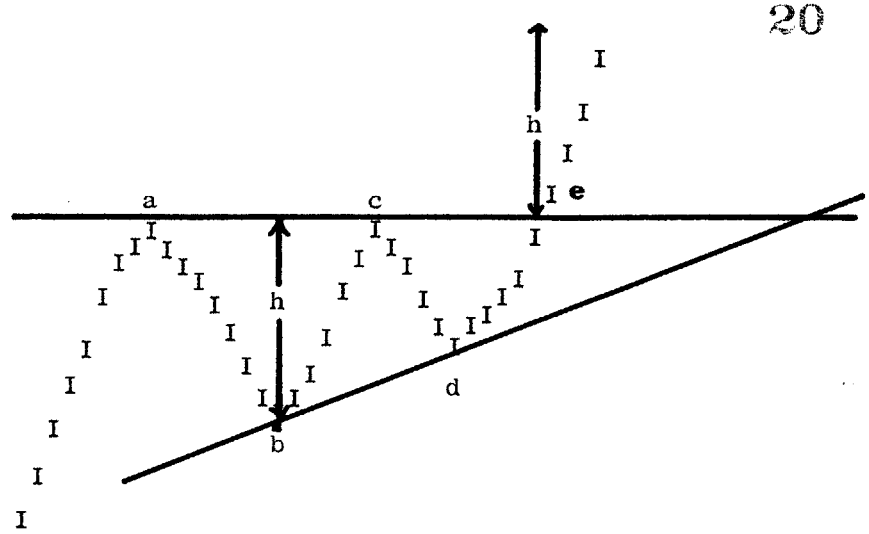


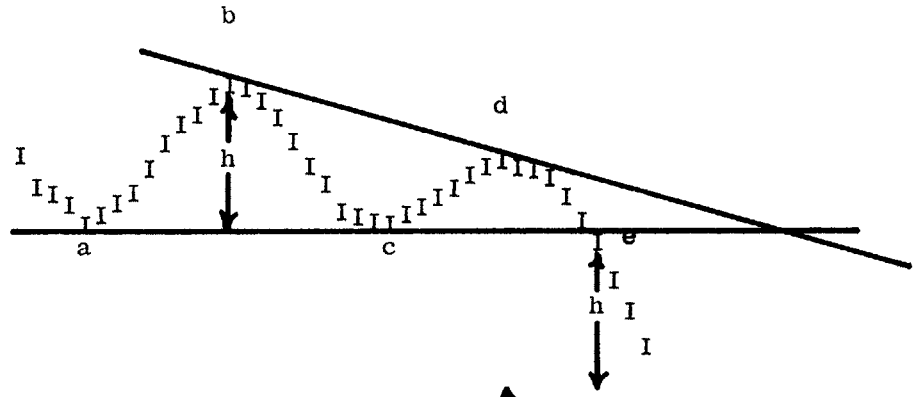
Fig. III-1

Head-and-Shoulders Top Pattern

a) Ascending triangle



b) Descending triangle



c) Symmetrical triangle

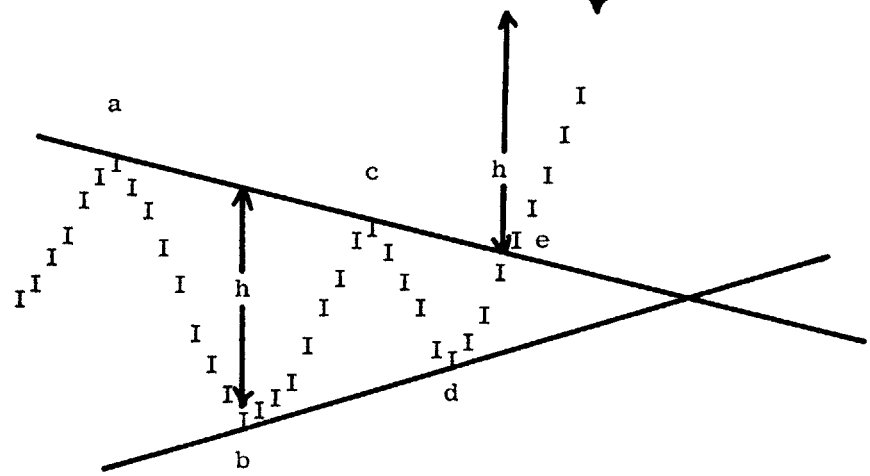
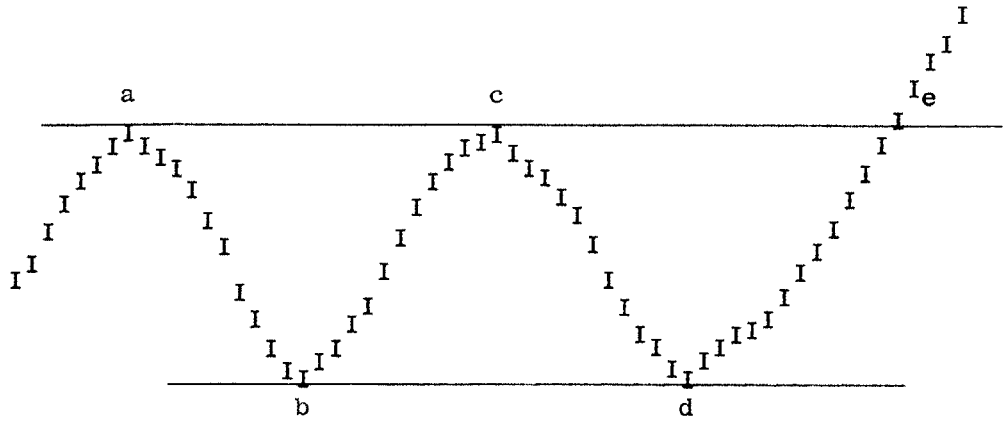


Fig. III-2

Triangle Patterns



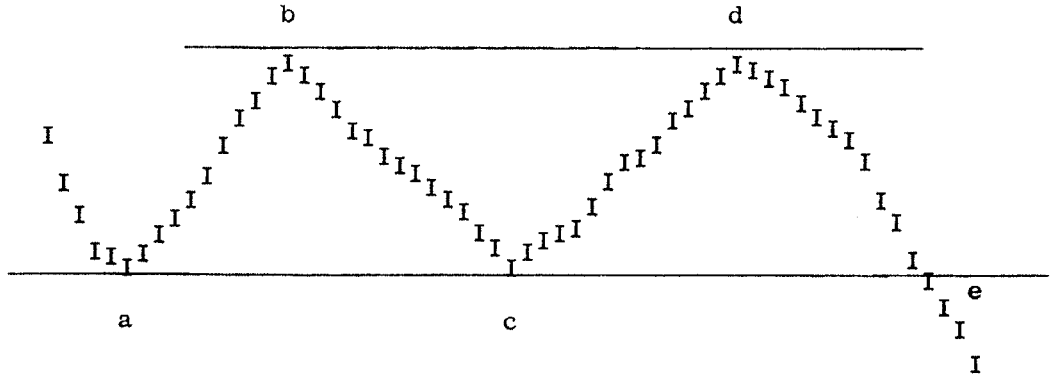


Fig. III-3

Rectangle Patterns

Pattern Type	Trendline Configuration	Breakout Direction	Response
1		up down	buy sell
2		up down	nothing nothing
3		up down	nothing sell
4		up down	nothing nothing
5		up down	nothing nothing
6		up down	nothing sell
7		up down	buy nothing
8		up down	buy nothing
9		up down	buy sell

Fig. III-4

Trading Response Table

CHAPTER IV

PATTERN RECOGNITION

Patterns are recognized and classified into nine different types by the program according to the trendline combination, as described in chapter III. The program is written to give the responses (buy, sell, or do neither) shown in table III-4. These responses can be varied by making slight modifications to the program.

A minimum size restriction is placed upon the pattern. The "minimum pattern height" is a parameter that can be varied from one program run to the next. The size of a pattern is computed when one is encountered and this size is compared to the minimum size parameter. If the pattern does not exceed this size, that pattern is ignored, and no buy or sell order will be recorded or executed, regardless of what type of pattern it was. The pattern size is calculated as the distance between the upper and lower trendlines on the breakout date when the graph is drawn on semi-log graph paper. (The number that is computed by the program is the difference between the logs of the trendline values on the breakout date.) This pattern size restriction eliminates trading on small patterns and also eliminates trading on triangle patterns when the breakout occurs close to the apex of the triangle.

A breakout from a pattern is recognized when the market price rises 3% or more above the upper trendline on that date (upward breakout) or when the price drops 3% or more below the lower trendline (downward breakout). An additional restriction is placed upon upward breakouts: the price rise must be accompanied by a significant increase in volume over an average of daily volumes that were traded within the pattern.

Another variable parameter is used in the determination of local maximum and minimum points in the price plot. Newly

detected possible maximum or minimum points are considered tentative. If, after "N" days after this tentative point ("N" is a parameter called the day distance), a point higher than the tentative high (or lower that the tentative low) has not been found, it is then considered to be a definite high point (or low point) and the next tentative point is searched for. If a higher high (or a lower low) is found within "N" days, that new point is considered to be the tentative high and the previous one is ignored. The low and high points determined by this method are the ones used to compute trendlines for pattern classification purposes. Large values of the day distance will result in longer patterns being considered and the shorter ones being ignored. This would correspond to a trader interested in long-term investments. A smaller value of the day distance will cause the program to recognize patterns in the smaller, shorter price fluctuations. This corresponds to a trader who is interested primarily in shorter-term profits of a more speculative nature.

CHAPTER V

FUNCTION AND OPERATION OF PROGRAMS

Figure V-1 is a block diagram of the system of programs written to perform the simulation of a trader using the technical scheme described in chapters III and IV. Three separate programs are used, all of which are written for the IBM type 705 computer. The first program, labelled STK DA in fig. V-1, is a clerical program; it computes logarithms of the prices and re-arranges the format of the market data. The output from STK DA is used as input to the other two programs. The program abbreviated STKCHT prepares charts of any of the stocks on the master data tape. The trader simulation is performed by the third program, STKTRD. The output from STKTRD is a list of all transactions made together with statements of stocks owned, their value, etc.

The "data cards" (fig. V-1) contain market data in the same form as it appears in daily newspapers. One card is punched for each stock for each day. Program STKDA checks this data for completeness, proper sequence, and consistency (the closing price must not be above the high and must not be below the low, etc.) It computes logarithms of the prices and writes this data onto the master tape. The first record written onto this tape contains a table of the names of all the stocks included in the data. Each following record on the master data tape contains all data for all stocks for one day.

The input to STKCHT consists of the master data tape and "request" cards. These cards tell the program which stocks to chart. STKCHT determines what scales (volume and price) to use for each graph by examining the data to be charted before preparing the graph. Several months are plotted on each chart page. A sufficient number of pages are made to chart the entire period contained in the data.

The program STKTRD simulates a person buying and selling stocks using the technical schemes outlined in chapters III and IV. Each day's data is examined to determine if a breakout from a significant pattern has occurred. If such a breakout occurs, an order to buy or sell is recorded and executed at the next day's closing price. Accounts of cash and stocks are kept and are up-dated upon the execution of each order. A list of all such transactions is prepared. The output also includes statements of cash and securities owned, giving amounts and values. The input cards to STKTRD initialize the inventory of cash and stocks before trading is commenced. These cards are also used to set the various parameters, to provide information necessary for adjustment of inventories when splits, stock distributions, etc. occur, and to request statements of assets at particular dates. The response to each type of price pattern can be varied by making minor modifications to the program.

Figures V-2 through V-5 show sample printed listings of the various data generated in the operation of the system of programs. Fig. V-2 shows a partial listing of the data cards used for the initial input to the system. Fig. V-3 is a chart page that was prepared by the program STKCHT. Fig. V-4 is a sample page of transaction reports, output from STKTRD. Fig. V-5 is a statement of assets, also part of the output from STKTRD.

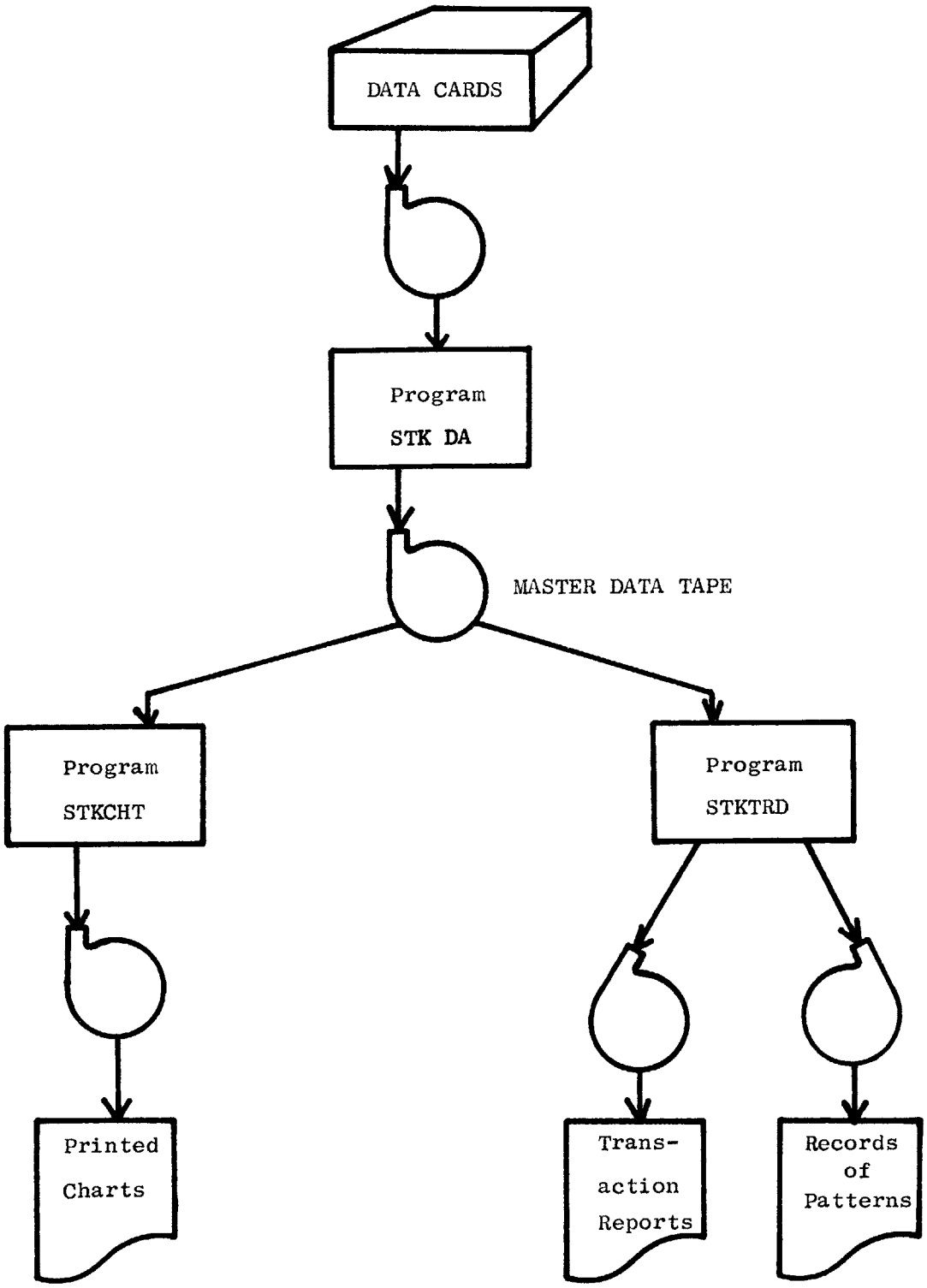


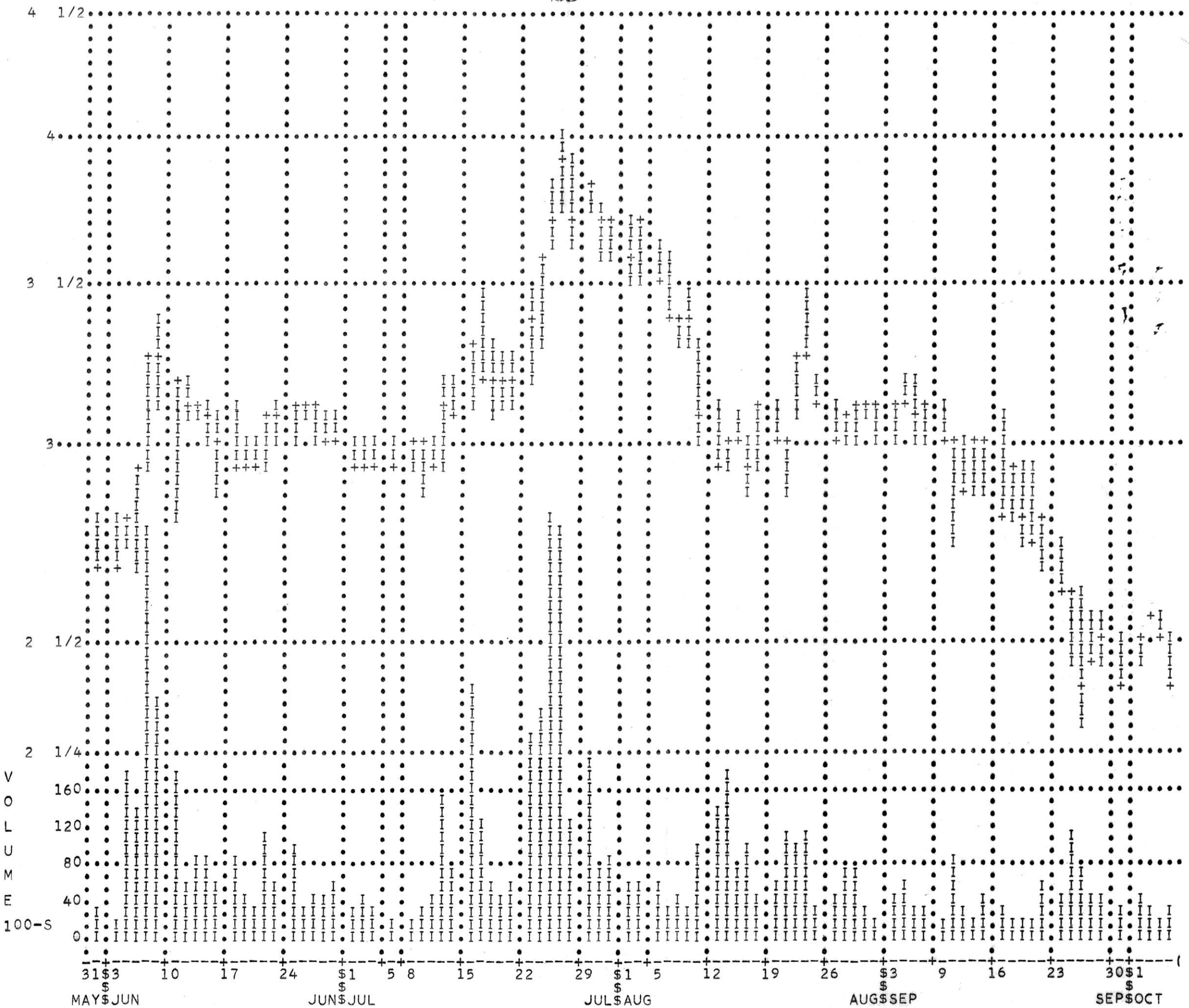
Fig. V-1

Block Diagram of the System of Programs

005-1/4	005-1/4	005-1/4	00000300	MAY	31	57	AUDIO DEVELOPMENT	A
2-13/16	2-11/16	2-11/16	00003100	MAY	31	57	BANFF OIL	A
030-0/8	029-5/8	029-5/8	00000600	MAY	31	57	DINERS CLUB, INC.	A
047-1/2	046-1/2	046-1/2	00002900	MAY	31	57	MESABI IRON	A
028-5/8	027-5/8	027-3/4	00001300	MAY	31	57	MOLYBDENUM	A
018-5/8	018-1/8	018-1/2	00013500	MAY	31	57	AMERICAN AIRLINES	N
007-1/8	006-7/8	006-7/8	00003300	MAY	31	57	AMERICAN MOTORS	N
047-1/2	047-1/8	047-1/2	00002100	MAY	31	57	BURROUGHS	N
028-7/8	028-1/2	028-5/8	00001700	MAY	31	57	MINERAL AND CHEMICAL CORP.	N
054-3/8	053-1/2	053-5/8	00004600	MAY	31	57	REPUBLIC STEEL	N
005-1/4	005-1/4	005-1/4	00000200	JUN	03	57	AUDIO DEVELOPMENT	A
2-13/16	2-11/16	2-11/16	00001800	JUN	03	57	BANFF OIL	A
029-3/8	029-0/8	029-0/8	00000300	JUN	03	57	DINERS CLUB, INC.	A
046-7/8	045-3/4	045-3/4	00000700	JUN	03	57	MESABI IRON	A
027-3/4	027-5/8	027-5/8	00000300	JUN	03	57	MOLYBDENUM	A
018-7/8	018-1/2	018-5/8	00005000	JUN	03	57	AMERICAN AIRLINES	N
007-1/8	006-7/8	006-7/8	00008500	JUN	03	57	AMERICAN MOTORS	N
047-1/2	046-3/4	047-1/8	00002700	JUN	03	57	BURROUGHS	N
028-7/8	028-1/4	028-3/8	00002500	JUN	03	57	MINERAL AND CHEMICAL CORP.	N
053-5/8	053-1/4	053-3/8	00003900	JUN	03	57	REPUBLIC STEEL	N
- /	- /	- /	00000000	JUN	04	57	AUDIO DEVELOPMENT	A
2-13/16	2-03/04	2-13/16	00017000	JUN	04	57	BANFF OIL	A
029-1/2	029-1/4	029-1/4	00000800	JUN	04	57	DINERS CLUB, INC.	A
045-1/2	045-3/8	045-1/2	00000600	JUN	04	57	MESABI IRON	A
027-5/8	026-5/8	026-5/8	00001200	JUN	04	57	MOLYBDENUM	A
018-7/8	018-5/8	018-3/4	00005600	JUN	04	57	AMERICAN AIRLINES	N
007-0/8	006-7/8	007-0/8	00002700	JUN	04	57	AMERICAN MOTORS	N
047-5/8	046-7/8	047-5/8	00001500	JUN	04	57	BURROUGHS	N
028-1/2	028-0/8	028-0/8	00003000	JUN	04	57	MINERAL AND CHEMICAL CORP.	N
053-7/8	053-1/2	053-5/8	00003500	JUN	04	57	REPUBLIC STEEL	N
005-1/4	005-1/8	005-1/8	00000200	JUN	05	57	AUDIO DEVELOPMENT	A
2-15/16	2-11/16	2-15/16	00013800	JUN	05	57	BANFF OIL	A
029-5/8	029-1/4	029-1/4	00000300	JUN	05	57	DINERS CLUB, INC.	A
045-0/8	045-0/8	045-0/8	00000100	JUN	05	57	MESABI IRON	A
027-1/4	027-1/4	027-1/4	00000100	JUN	05	57	MOLYBDENUM	A
018-3/4	018-1/2	018-5/8	00004500	JUN	05	57	AMERICAN AIRLINES	N
007-3/8	007-0/8	007-3/8	00018700	JUN	05	57	AMERICAN MOTORS	N
047-1/2	047-0/8	047-1/2	00002400	JUN	05	57	BURROUGHS	N
028-3/8	027-3/4	028-0/8	00003100	JUN	05	57	MINERAL AND CHEMICAL CORP.	N
053-7/8	053-1/2	053-1/2	00003500	JUN	05	57	REPUBLIC STEEL	N

Fig. V-2

Partial Listing of Data Cards


4 1/2
4
3 1/2
3
2 1/2
2 1/4
VOLUME
160
120
80
40
0
100-S
31 3 10 17 24 1 5 8 15 22 29 1 5 12 19 26 3 9 16 23 30 1
MAY JUN JUN JUL JUL AUG AUG SEP SEP OCT
1957

ISSUE			EXCH	DESCRIPTION	# SHARES	DATE	TOT. AMT.	CHARGES	NET AMOUNT
MOLYBDENUM	050025	29.0000 MP	ASE	PURCHASE	1100	JUL. 5,1957	$31,900.00	$ 368.50	$32,268.50-
AMERICAN MOTORS	070031	7.6250 MP	NYSE	SHORT SALE	600	JUL.15,1957	$ 4,575.00	$ 93.75	$ 4,481.25
MOLYBDENUM	050042	30.1250 MP	ASE	SALE	1100	JUL.30,1957	$33,137.50	$ 374.69	$32,762.81
MOLYBDENUM	050043	29.3750 MP	ASE	SHORT SALE	100	JUL.31,1957	$ 2,937.50	$ 33.69	$ 2,903.81
AMERICAN AIRLINES	060049	18.5000 MP	NYSE	SHORT SALE	1200	AUG. 8,1957	$22,200.00	$ 318.00	$21,882.00
AUDIO DEVELOPMENT	010050	9.1250 MP	ASE	PURCHASE	200	AUG. 9,1957	$ 1,825.00	$ 34.25	$ 1,859.25-
MESABI IRON	040052	36.5000 MM	ASE	SHORT SALE	300	AUG.13,1957	$10,950.00	$ 111.75	$10,838.25
MESABI IRON	040067	40.8750	ASE	*PURCHASE TO COVER SHORT	300	SEP. 4,1957	$12,262.50	$ 118.31	$12,380.81-
MESABI IRON	040068	41.3750 MP	ASE	PURCHASE	600	SEP. 5,1957	$24,825.00	$ 238.13	$25,063.13-
AMERICAN MOTORS	070068	7.5000 MP	NYSE	*PURCHASE TO COVER SHORT	600	SEP. 5,1957	$ 4,500.00	$ 93.00	$ 4,593.00-
BANFF OIL	020072	2.8750 MP	ASE	SHORT SALE	800	SEP.11,1957	$ 2,300.00	$ 78.00	$ 2,222.00
AUDIO DEVELOPMENT	010081	9.8750 MP	ASE	SALE	200	SEP.24,1957	$ 1,975.00	$ 35.75	$ 1,939.25
DINERS CLUB, INC.	030081	39.0000 MZ	ASE	SHORT SALE	100	SEP.24,1957	$ 3,900.00	$ 38.50	$ 3,861.50
AUDIO DEVELOPMENT	010082	9.6250 MP	ASE	SHORT SALE	300	SEP.25,1957	$ 2,887.50	$ 52.88	$ 2,834.62

Fig. V-4

A Transaction Report

STATEMENT OF ASSETS -- JUN 30, 1958.

CASH			$ 122,403.01
BANFF OIL	ASE	1300	$ 2,600.00
DINERS CLUB, INC.	ASE	800-	$ 22,900.00-
MOLYBDENUM	ASE	800	$ 25,000.00
AMERICAN MOTORS	NYSE	2000-	$ 25,750.00-
TOTAL			$ 101,353.01

MINIMUM CASH WAS $ 17,905.40 ON JAN 24 58.

Fig. V-5

A Statement of Assets

CHAPTER VI

ANALYSIS OF RESULTS

Figs. VI-1 through VI-6 are graphs of the value of cash and stocks versus time for several program runs of STKTRD. The day distance parameter is given on each fig. and applies to all plots on that page. The numbers written near the various plots are minimum pattern height parameters expressed in logarithms of prices. In fig. VI-1, two runs with different values for the minimum pattern height gave results that were nearly equal. When plotted, they appear identical. The same situation occurred in fig. VI-5. In these cases both values of the minimum pattern height are shown. Fig. VI-1 also contains an approximate plot of the Dow-Jones Industrial average for comparison purposes. Fig. VI-7 shows the amount of profit, the number of profitable transactions, and the total number of transactions caused by each pattern type. Four different runs are analyzed in this manner. The period covered is from May 31, 1957 to June 30, 1958.

The graphs show that the smaller the day distance, the larger the profit made over the period from May 31, 1957 through March 4, 1959. The two smallest values of day distance (5 and 7) also show the largest loss in the first part of the above period. The total value of cash and stocks for these runs was sensitive to the market changes, that is, the value went up and down with the averages. However, the percentage loss was less and the percentage profit was greater than the Dow-Jones Industrial average for both of these values of day distance.

With values of 10 and 12 for the day distance, a more consistent rise in worth of assets was obtained. Greater profits were made when the average was rising than when it was

dropping. Greater profits were made when the market was declining than when it was moving upward comparatively slowly. This is particularly noticeable with the day distance equal to 12, when a decline in worth was experienced during the period in which the market moved more slowly.

The results of the run with a day distance of 16 are more erratic than with any of the smaller day distances. Profits were made over the entire period, but they were not so great as with day distances of 10 and 12. Also, greater losses were incurred during the period.

The run with the day distance equal to 20 resulted in a large and nearly consistent loss. The last quarter of 1958 showed a profit, however, when the averages were continuing a fairly rapid climb started almost a year before. It was during this period that each program run made the greatest profit.

Fig. VI-7 shows how profitable each pattern type was in the runs listed. The period covered by this table is from May 31, 1957 to June 30, 1958, during which time the market first declined, and then started a bull market. On June 30, 1958, the average was still below its May 1957 value. Patterns not indicated in fig. VI-7 were not encountered.

In each case, the symmetrical triangle with upward breakout accounted for the greatest profit. The ascending triangle accounted for the greatest loss. Descending triangles generally resulted in profit, although several individual transactions caused losses. Symmetrical triangles with a downward breakout almost always lost. Rectangles with downward breakouts also generally lost. Patterns with both trendlines sloping downward were encountered and short sales were made if a downward breakout occurred. This was the second most profitable pattern in each case shown in fig. VI-7. Its reverse, a pattern with both trendlines sloping upward with an upward breakout, generally resulted in loss.

The results of trading runs by STKTRD indicate that a technical trading scheme of this nature can be very profitable. The scheme used by STKTRD appears somewhat crude when some of the refinements that could be added are considered. The trading methods discussed in "Technical Analysis of Stock Trends" are considerably more elaborate than those used by STKTRD. Numerous smaller patterns are considered and are discussed in detail. A more elaborate trading scheme such as that covered in the above book should be even more profitable.

There are several considerations that would be important in practice that, for the sake of simplicity, were not included in STKTRD. One is the matter of income taxes, for which no provision was made. Another is "switching" stocks (selling one stock in order to obtain cash to buy another that appears more promising). STKTRD sells a stock only when the price movement of that stock contains a pattern or other indication that is considered to be a sell signal. There are certain restrictions that are placed upon selling short. These restrictions were not built into STKTRD.

Fig. VI-1

DAY DISTANCE = 5

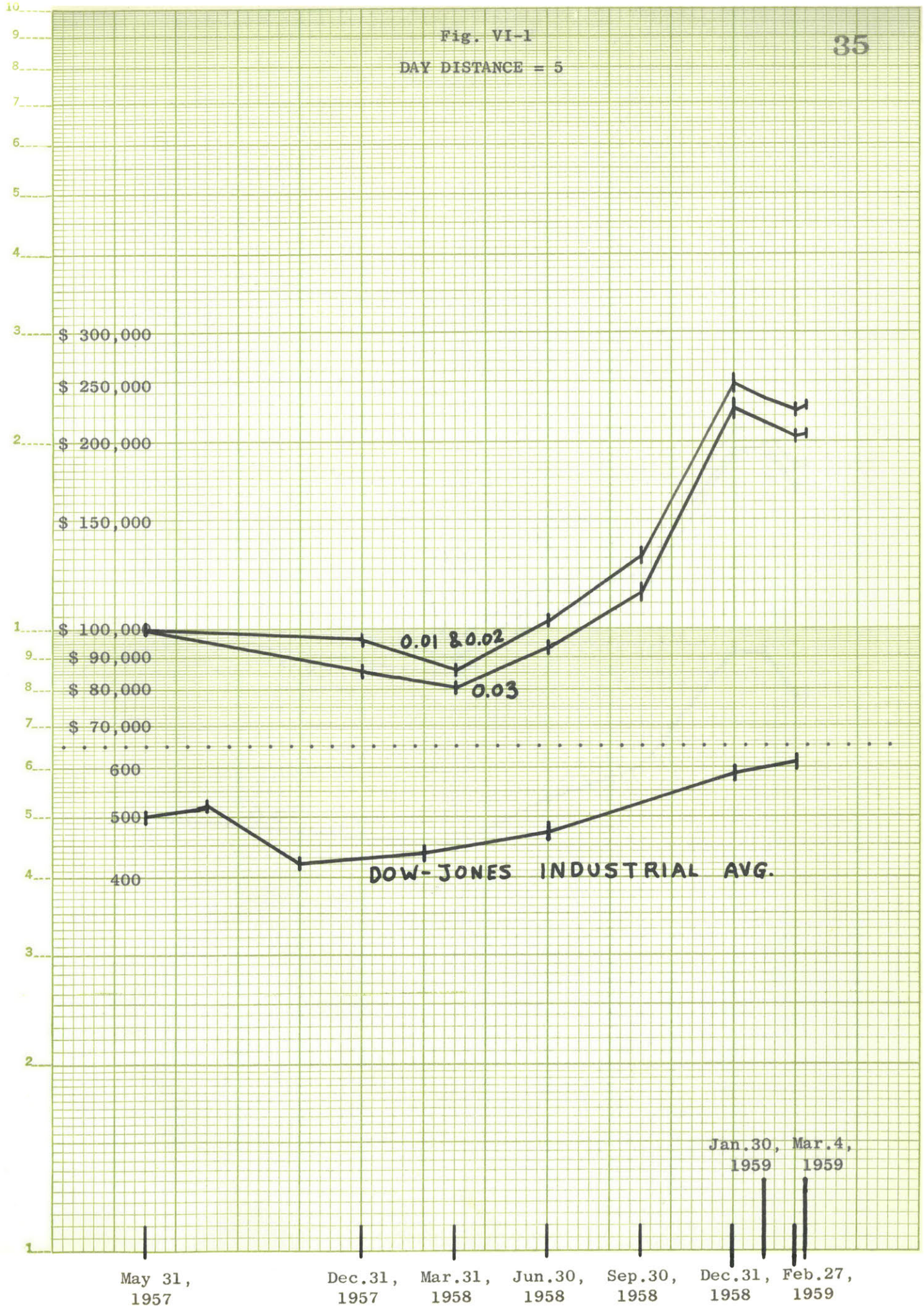


Fig. VI-2

DAY DISTANCE = 7

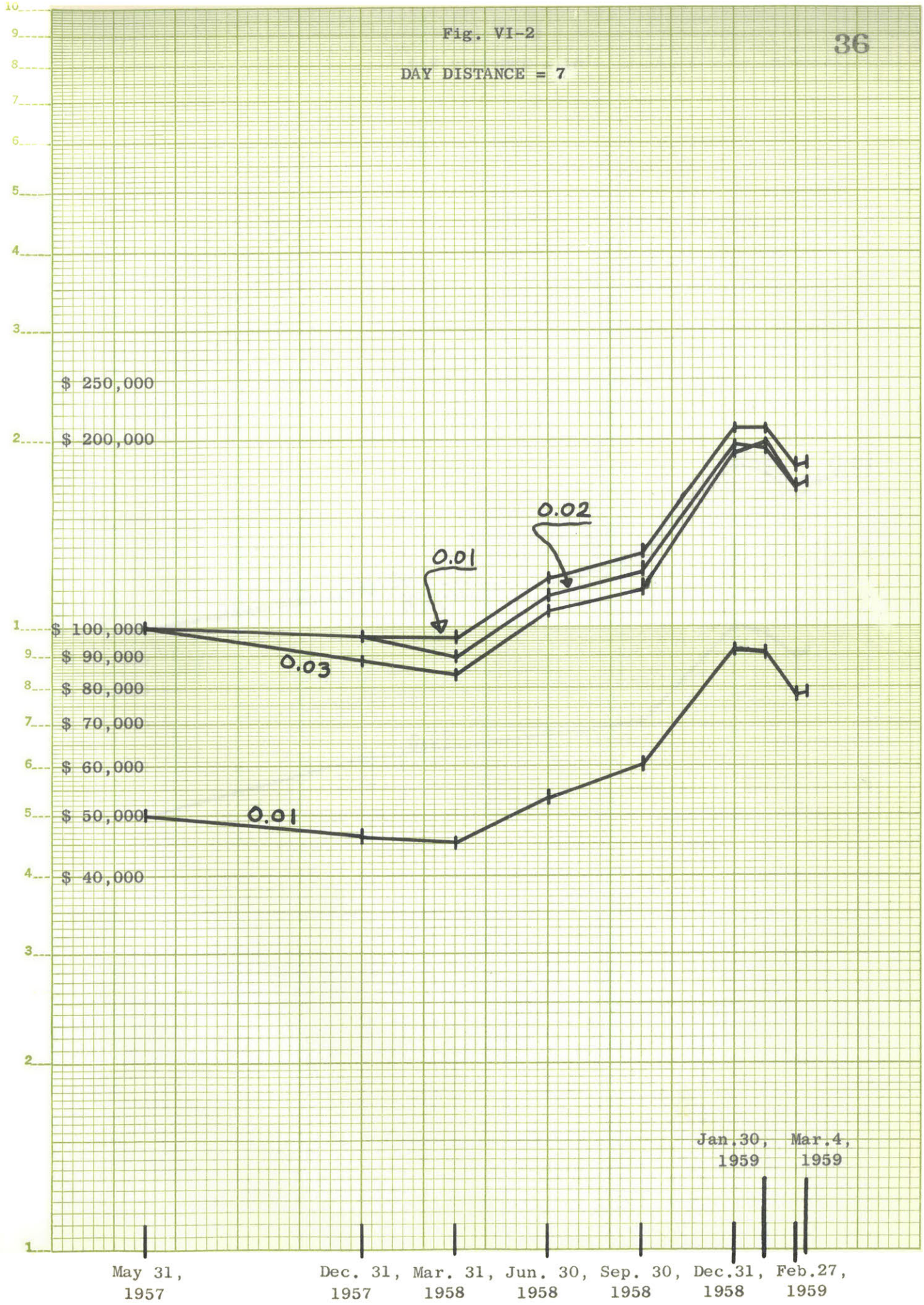


Fig. VI-3

DAY DISTANCE = 10

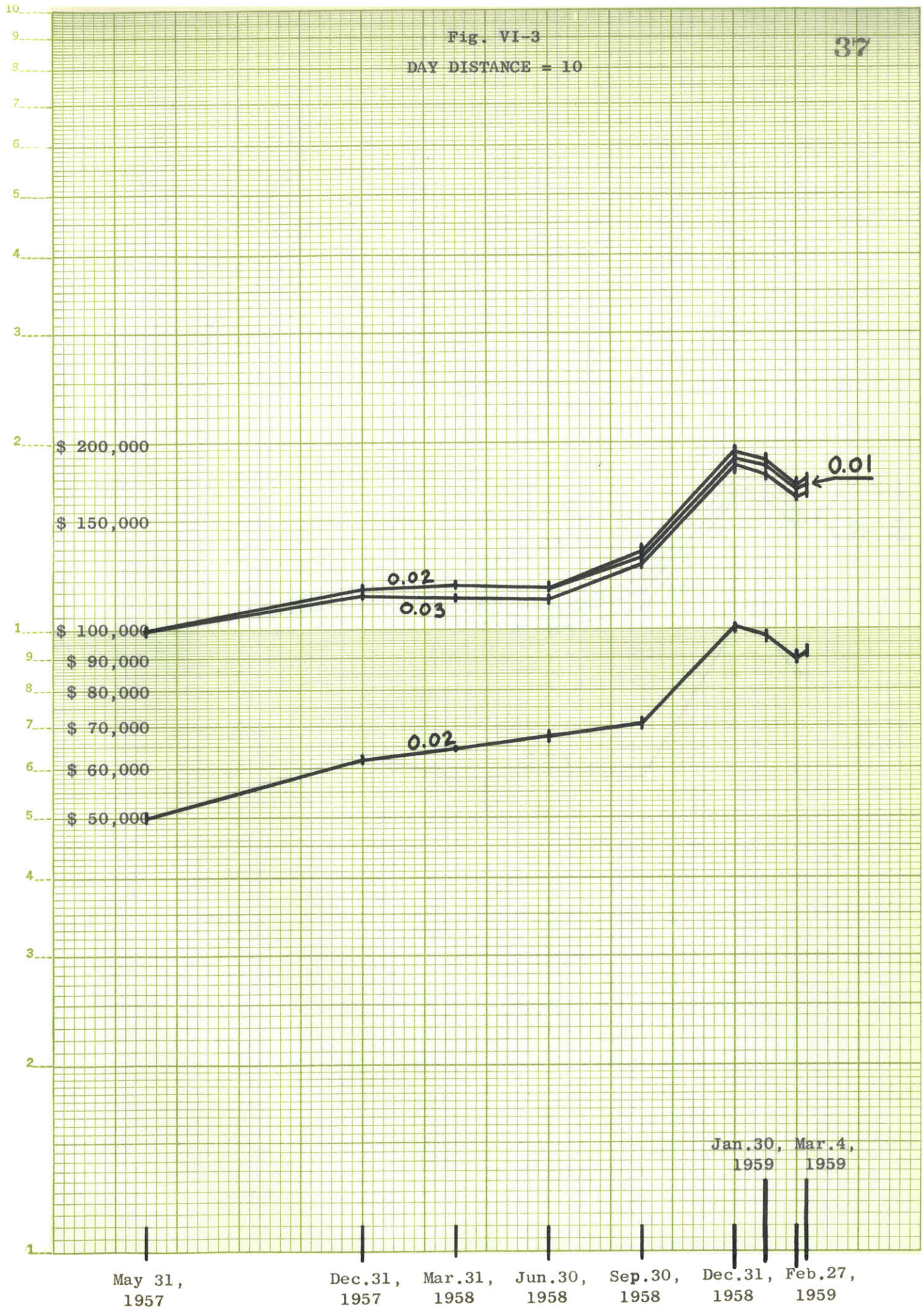


Fig. VI-4

DAY DISTANCE = 12

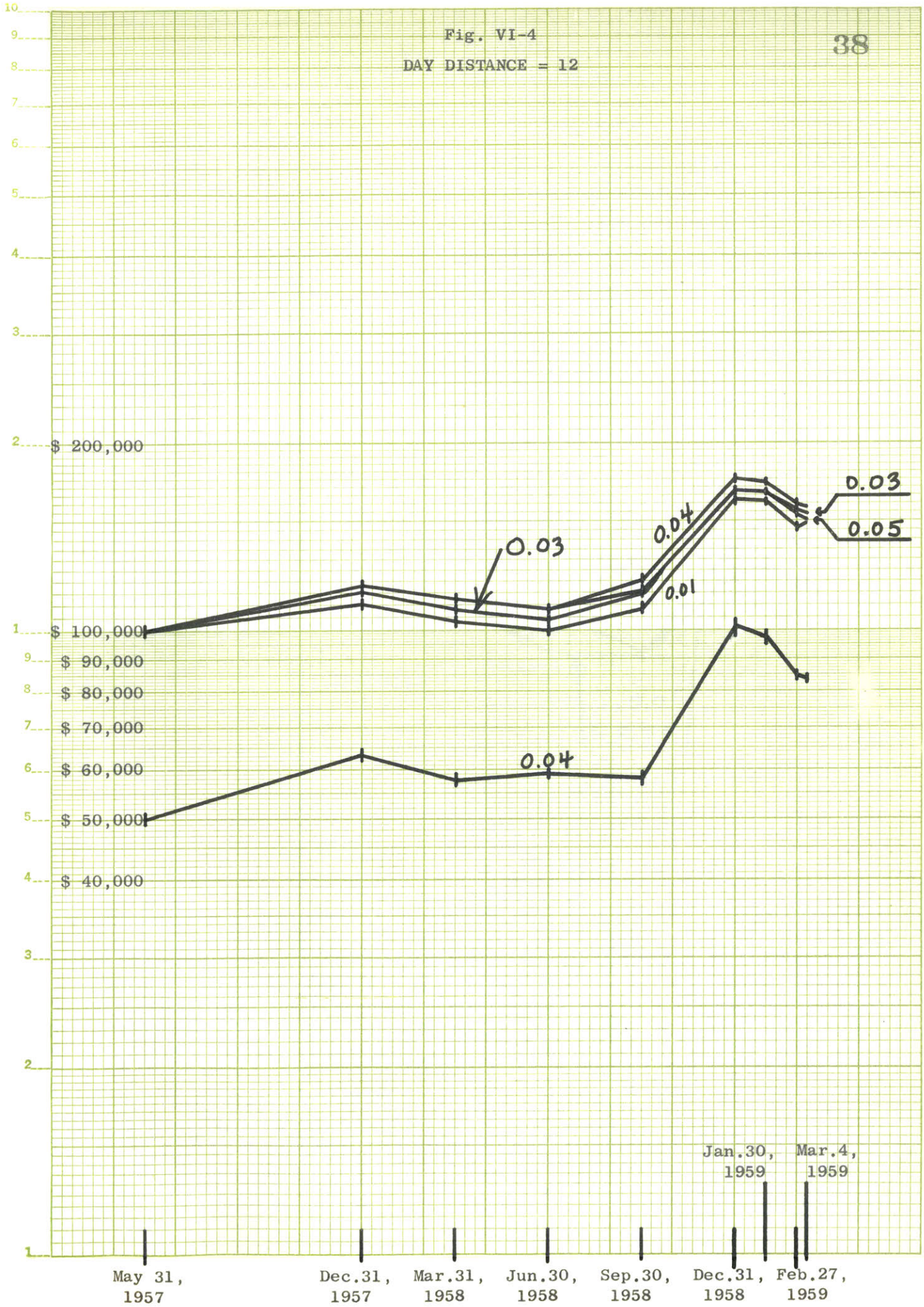


Fig. VI-5

DAY DISTANCE = 16

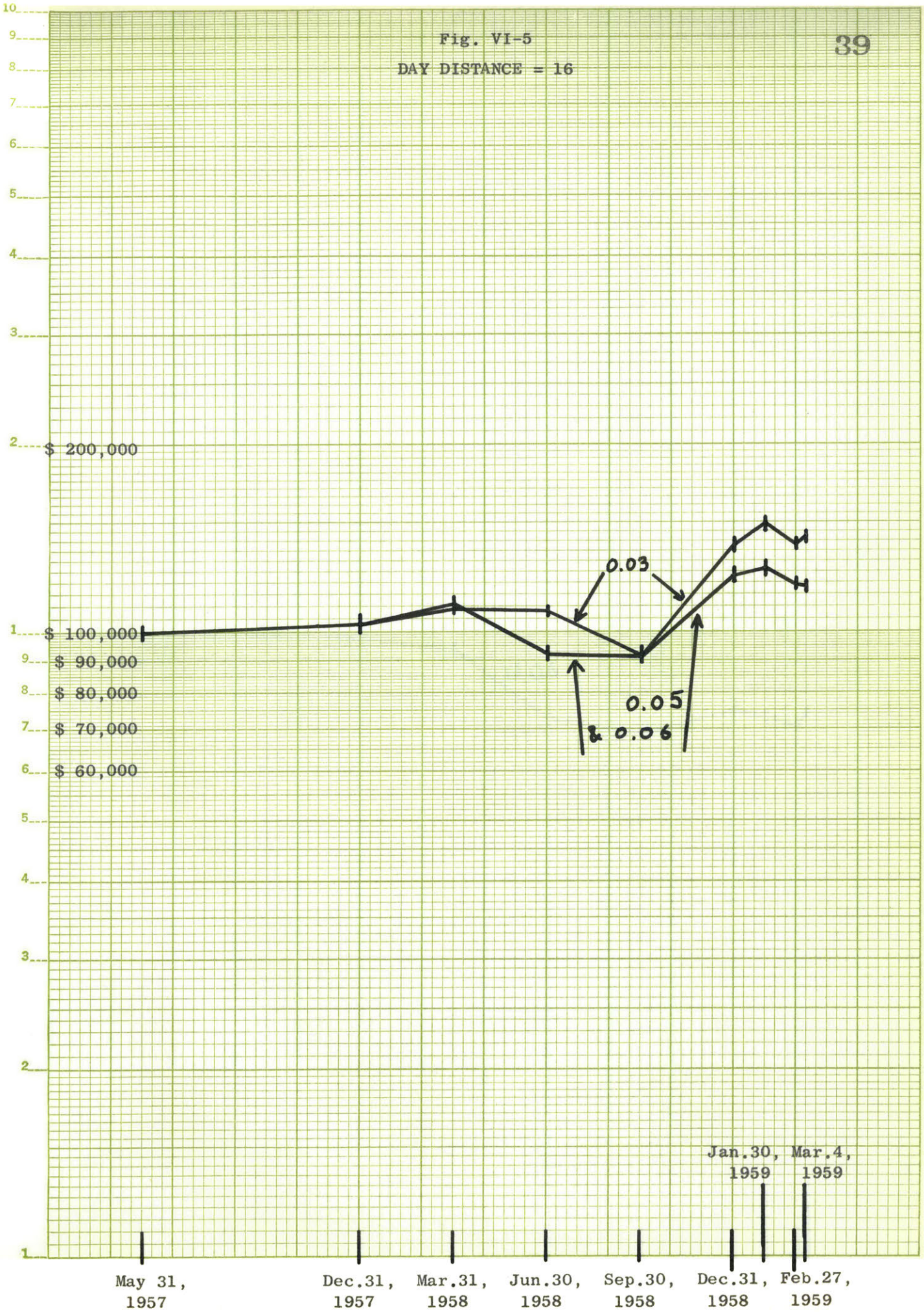
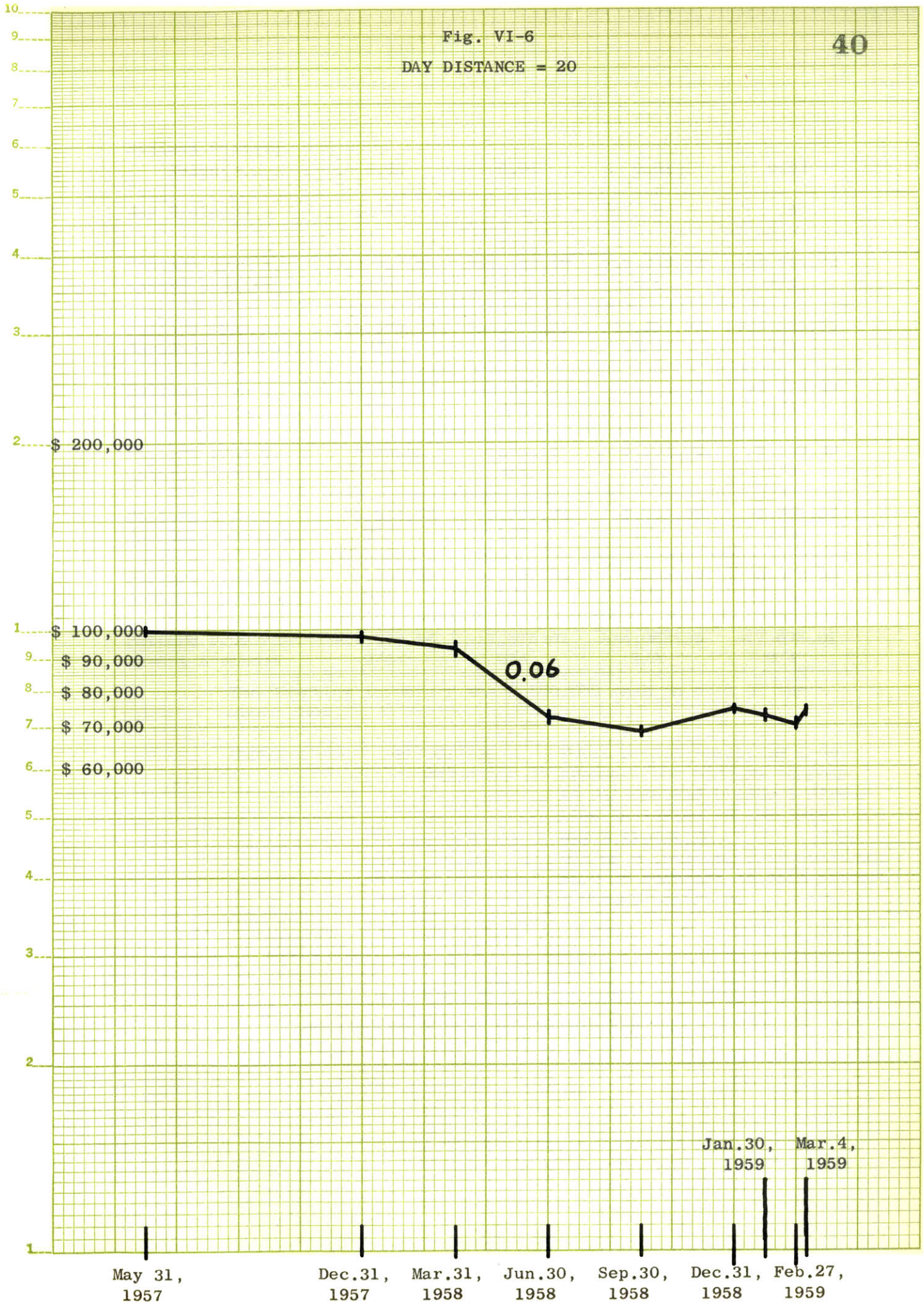


Fig. VI-6

DAY DISTANCE = 20



Minimum Pattern Height	0.01	0.01	0.01	0.02
Day Distance	7	8	9	8
Pattern type 9, upward breakout	+17,817.35 3/5	+25,492.49 3/3	+13,648.00 1/1	+24,742.62 2/3
Pattern type 6, downward breakout	+15,520.94 2/4	+14,271.31 3/5	+2,857.37 3/5	+12,619.56 3/5
Pattern type 3, downward breakout	+2,922.73 2/3	+2,922.73 2/3	+1,815.73 2/4	+2,479.98 2/4
Pattern type 8, upward breakout	-569.51 1/4	+186.74 2/4	-5,104.02 1/5	-2,550.38 1/3
Pattern type 9, downward breakout	-1,377.58 2/7	-3,769.84 1/8	-2,665.09 1/7	-1,991.57 1/4
Pattern type 1, downward breakout	-1,902.50 0/2	-1,027.06 1/3	-2,205.50 0/2	-2,372.06 1/4
Pattern type 7, upward breakout	-12,476.14 0/4	-17,675.01 0/4	-14,082.38 1/5	-17,675.01 0/4

The starting inventory was $ 100,000 cash in each of the above runs.

Explanation: +17,817.35
3/5

Total profit resulting from transactions made in response to pattern and breakout direction indicated to the left was $ 17,817.35.
Out of a total of 5 transactions made in response to this pattern, 3 were profitable.

Fig. VI-7

Analysis of Profit by Pattern Type

CHAPTER VII

SUGGESTIONS FOR FUTURE WORK

Revisions that could be incorporated into STKTRD would include correcting the limitations discussed in Chapter VI: switching stocks, taking income taxes into account, including the restrictions on selling short, and refining the trading scheme. An analysis of the same type as contained in fig. VI-7 should be made for all runs over the entire period. Such an analysis could be divided into several time periods to see if certain patterns were always unprofitable or if how profitable they were varied with the market conditions. The results of such an analysis might suggest some further refinements to the trading scheme.

Some of the considerations covered in "Technical Analysis of Stock Trends" that might be included are:

1) "Progressive" stop orders. When rapid increases in price occur, place new stop orders each day with the stop level 1/8 point under that day's closing market price.
2) Recognizing "gaps". If one day's low is higher than the previous day's high, the difference is called a "gap". These gaps have a significance comparable to small patterns.
3) Reclassify pattern types 6 and 8 (fig. III-4) to distinguish between parallel, converging, and diverging trendlines. These patterns with parallel or converging trendlines are of some significance in the theory in "Technical Analysis of Stock Trends".

4) Using breakouts from some patterns as "prepare to buy (or sell)" signals. If, after the initial breakout occurs, the price moves back toward the pattern, advantage can be taken of this move to make the purchase (or sale) at a more favorable price.

5) If a new buy signal is given and stock is already owned, STKTRD does not buy more. This could be changed to correspond more closely with actual situations in which the trader might wish to make an additional purchase.

Analyzing results from considerably more program runs, covering a larger number of stocks over a longer period of time, would make the conclusions much more meaningful. Ten stocks were used in the runs made. Twenty-one months of data on each stock were used, covering the period from May 31, 1957 through March 4, 1959.

A more mechanized way of obtaining data would facilitate making additional runs. The data used here was copied from newspapers and other printed sources and then punched onto IBM cards. This is a very time-consuming task. If such data were stored in a machine-readable form, the amount of time required to gather the data would be considerably reduced.

APPENDIX A

GLOSSARY

The following is a partial list of terms used in this thesis together with a definition or explanation. Names of the various patterns are not included.

APEX. The apex of a triangle pattern is the point at which the two trendlines defining the pattern meet. (See Chapter III.)

BREAKOUT. A breakout from a pattern occurs when the market price moves out of a pattern by rising a significant distance above the upper trendline or below the lower trendline. (See Chapter IV.)

BUY TO COVER A SHORT. When a person buys to cover, he purchases stock to replace that which he "borrowed" and sold short. (See the definitions of short sale and interest below.)

INTEREST. A person has an interest in a stock if he either owns some shares or has sold short and has not replaced the stock he sold short. The term short interest refers to the case where he has sold stock short and has not yet replaced that stock by buying to cover. The term long interest is used to contrast with short interest and refers to the situation in which a trader has purchased stock and still owns it.

LOCAL MAXIMUM POINT. A local maximum point on a market price graph is a point that is higher than any other point within several days.

LOCAL MINIMUM POINT. A local minimum point is a point that is lower than any other point within several days.

POSITION. This term is very similiar to the term defined above, interest. A person is said to be in a short position when he has a short interest in a stock. The term long position is not used very often, but when it is used it refers to the situation in which a person has a long interest in a stock.

SHORT SALE. When a trader sells a stock short, he sells stock that he does not own. In effect, he borrows the stock and then sells it. He must, at some later time, replace the stock he has borrowed by purchasing some stock. This later purchase is called buying to cover a short, or more simply, buying to cover.

STOP ORDERS. A stop order is an order to buy or sell stock at the best obtainable price *if* the market price rises above or drops below a specified price called the stop level. There are different kinds of stop orders, distinguished by the restriction on the price movement required to satisfy the conditions of the order. (See Chapter III.)

TRENDLINE. A trendline is a line drawn on a price graph between two local minimum points (lower trendline) or between two local maximum points (upper trendline). (See Chapter III.)

VOLUME. The number of shares traded is called the volume. For example, if 1500 shares of Acme Corp. stock were traded in a day, that day's volume of Acme stock would be 1500 shares. The term volume may refer to the number of shares of one stock traded, or to the number of shares traded on an exchange.

BIBLIOGRAPHY

1. Avakian, R., The Effect of Retained Earnings, Changes in Dividends, and Changes in Earnings on Stock Prices, S.B. Thesis, M.I.T., Industrial Management, 1954.
2. Bastis, T.E., and Fues, J.N., The Relationship of the Price-Dividend Ratio to Capital Appreciation of Securities Listed on the New York Stock Exchange, S.B. Thesis, M.I.T., Industrial Management, 1954.
3. Edwards, Robert D., and Magee, John, Technical Analysis of Stock Trends, John Magee, Springfield, Mass., 1957.
4. Gould, Burnham S., Jr., A Statistical Study of Utility Stock Prices, S.M. Thesis, M.I.T., 1956.
5. Hamilton, W.P., Stock Market Barometer, Harper, New York, 1922.
6. IBM Corp., Manual of Operation, Type 705 EDPM.
7. IBM Corp., Manual of Operation, 705 Autocoder System.
8. O'Daly, Bernard, A Theory of Common-Stock Investment Applied to Measure Inflation in the Stock Market and to Evaluate the Behavior of Investors, S.M. Thesis, M.I.T., Industrial Management, 1955.
9. Rhea, Robert, The Dow Theory, Barron's, New York, 1932.
10. Russell, Richard, "Reading the Charts", Barron's, vol.39, no. 20, May 18, 1959, p.5.
11. Wanger, Ralph L., An Algebraic Model for Investment Analysis of Common Stocks, S.B. Thesis, M.I.T., Industrial Management, 1955.
12. Barron's, weekly publication, Boston, Mass.
13. The Wall Street Journal, daily newspaper, New York.