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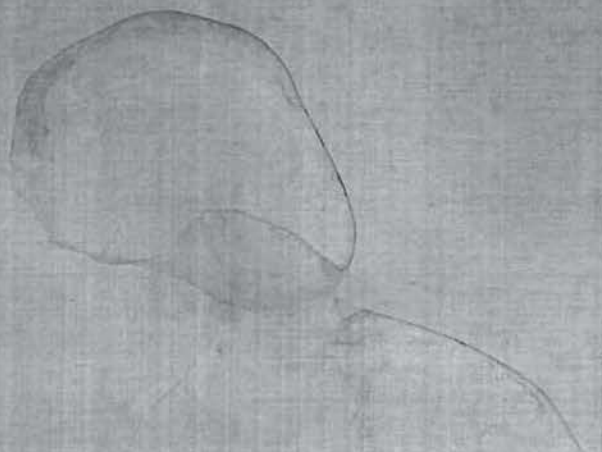
INDUSTRIAL ENGINEERING STUDY OF HAZARDS ASSOCIATED WITH UNDERGROUND COAL MINE PRODUCTION

VOLUME II

THEODORE BARRY AND ASSOCIATES

USBM CONTRACT REPORT S0110601

DECEMBER 10, 1971



DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON, D. C.

USBM SO110601

INDUSTRIAL ENGINEERING STUDY OF HAZARDS ASSOCIATED WITH UNDERGROUND COAL MINE PRODUCTION

VOLUME II
DATA AND CHARTS

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TABLE OF CONTENTS

CHAPTER 1: AN OVERVIEW OF BITUMINOUS COAL MINING IN THE UNITED STATES

		Page
I.	INTRODUCTION	1
II.	UNITED STATES COAL RESERVES	2
III.	MINING PRACTICE IN THE UNITED STATES	3

CHAPTER 2: MULTIFLOW PROCESS CHARTS

I.	CONVENTIONAL MINING OPERATIONS	12
	A. The Conventional Mining Style	12
	B. Undercutting Operation	19
	C. Face Drilling Operation	31
	D. Shooting	41
	E. Loading	56
	F. Roof Bolting	81
II.	CONTINUOUS MINING OPERATIONS	112
III.	AUGER MINING OPERATIONS	142
	A. Auger Mining Style	142
	B. Auger Basic Operations	155

CHAPTER 3: TYPICAL WORK CYCLE TIMES

I.	DESCRIPTION OF WORK CYCLE DATA	161
II.	MINE CATEGORIES	162
III.	WORK ELEMENT ABBREVIATIONS AND DEFINITIONS	163
IV.	HAZARDOUS EXPOSURE	166
	EXHIBITS	167

CHAPTER 4: STANDARD TIME DATA 201

CHAPTER 1

AN OVERVIEW OF BITUMINOUS COAL MINING IN THE UNITED STATES

I. INTRODUCTION

Presented in this volume are the basic mining techniques and production operations associated with underground bituminous coal mining.

Chapter 2, "Multiflow Process Charts", presents, in sketch form, a description of the various operations characteristic of conventional and continuous mining. In order to focus attention upon the major components and operations in each work cycle, certain items are not shown in the sketches, e.g., machine electrical cables, brattice, and rib posts. The elapsed time shown for each sketch is considered representative for the various work elements summarized by the sketch. More detailed work element times can be found in Chapter 3, "Typical Work Cycle Times", and Chapter 4. "Standard Time Data".

The charts and illustrations of Chapter 2 are presented in such a manner that the reader will be introduced to:

First	-	The style of mining employed and its basic operations.
Second	-	The mining cycle involved.
Third	-	The equipment and crew work cycles and their work elements.

Chapter 3, "Typical Work Cycle Times", presents representative work element times for the various categories of seam height, production tonnage, and mining style which comprise the industry. Work elements commonly subject to hazardous exposure are noted for each cycle along with a percentage estimate of the total cycle time subject to such exposure. Total elapsed times for work cycles, even within the same category, varied widely, depending upon conditions. Consequently, a range of observed cycle times is presented in each case to give the reader a better understanding of the significance of this variance.

The work element times presented in this section represent the distillation of over ten thousand elapsed work element times recorded by TB & A consultants in over fifty mines throughout the country. The raw time data which form the basis for the average times shown in Chapter 3 may prove useful in future research efforts conducted by the USBM. These raw time data sheets will be delivered to the Technical Project Officer with his copy of the final report.

The means and standard deviations for all observed work elements are presented in Chapter 4. These work elements are not arranged in chronological work sequence order. They are intended as a reference for that person interested in a particular work element time associated with a certain mining process or operation.

Theodore Barry and Associates recognizes that this report will be read by officials and managers at various decision-making levels who are not knowledgeable in mining operations. Although the entire report has been developed and presented in a manner designed to be meaningful to this kind of reader, we realize that the use of certain terminology, phraseology, and assumptions throughout the report may confuse the lay reader. Therefore, the following sections are devoted to a brief overview and general discussion of basic bituminous mining operations in the United States.

II. UNITED STATES COAL RESERVES

The United States possesses about one-third of the world's known coal supply. Most of the coal deposits in this country are classified as bituminous. Bituminous coal is widely used to generate electricity, as well as for other industrial purposes such as steel making and metal forging. Although approximately 30 billion tons of bituminous coal have already been mined in the United States, huge reserves, estimated to last 2,000 years at the present rate of extraction, still remain. The importance of coal in our future energy reservoir can be seen from the estimates of the total recoverable fuel reserves in the United States given below:

Coal	80%
Shale Oil	8%
Natural Gas and Liquids	6%
Petroleum	3%
Uranium Oxide	3%
Total	100%

Due to the relatively limited supply of oil, natural gas and uranium, coal will remain the nation's most important fuel source for the foreseeable future.

The great importance of coal to the United States' total energy resources helps put the underground safety problem in proper perspective. Every conceivable effort certainly must be made to develop an underground environment which allows the American miner to work with a degree of safety and comfort

comparable to his counterparts in other major industries. Yet, while it may theoretically be possible to prevent every fatality and accident associated with underground mining, such a program could easily require so large a capital investment that U. S. coal would literally be eliminated from the low-cost energy market. Neither the nation's economy nor its security could afford such an occurrence. Consequently, the economic impact upon the industry and the nation as a whole of proposed changes in federal rules and regulations must be carefully considered.

III. MINING PRACTICE IN THE UNITED STATES

The three most common underground mining styles used today in the United States are:

- Conventional Mining
- Continuous Mining
- Continuous Auger Mining

In most available statistical data, continuous auger mining is hidden within the continuous mining classification. Significant distinctions should be made, however, especially when man-machine relationships, space relationships, and safety are being considered. Therefore, continuous auger mining is treated as a separate category in this study. This classification should not be confused with the highwall auger mining used in conjunction with above-ground strip mining.

This study does not include longwall mining, which is used extensively in Europe but very little in the United States.

A. Activities Common to All Underground Mining

The activities described below are common to all underground coal mining.

1. Driving Openings

The driving of initial openings into the coal bed is accomplished in one of three ways. The decision on which method to use usually depends upon the depth of the coal bed beneath the surface.

a. Drift Openings

In mines where the coal bed outcrops to the surface, the operator will drive an entry directly into the hillside.

b. Slope Entry

In mines where the coal bed is located less than 600 feet below the surface, the operator will normally drive an opening down on an angle or slope until the coal bed is reached.

c. Shaft Entries

In mines where the coal bed is located more than 600 feet below the surface, the operator will drive a shaft straight down to the coal bed.

2. Development

Once the coal bed is reached, coal is extracted by driving entries (called "rooms") and crosscuts (perpendicular to the entries). This is done in such a way as to create huge blocks of coal (called "pillars") which are left untouched to support the roof and prevent massive roof falls.

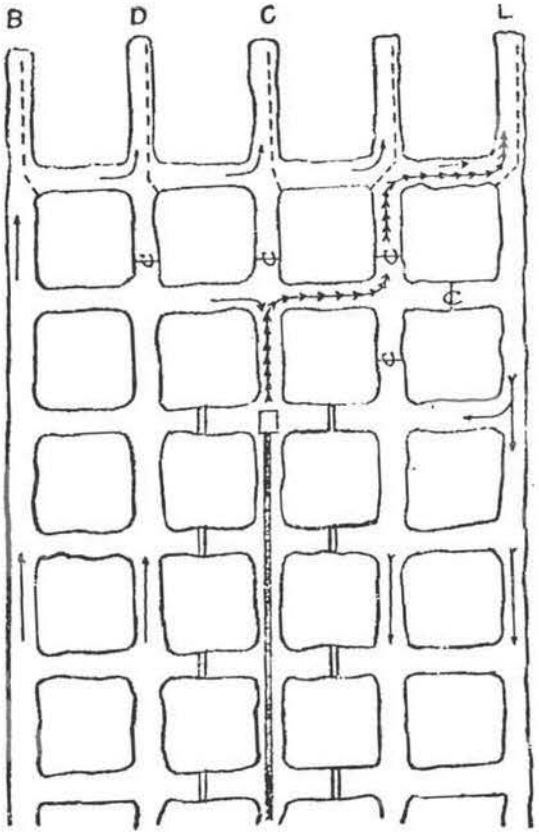
3. Roof Support

The pillars alone are seldom sufficient support to prevent smaller roof falls in the entries. Consequently, wooden posts and/or steel roof bolts are used to strengthen the roof and prevent these smaller, but often fatal falls.

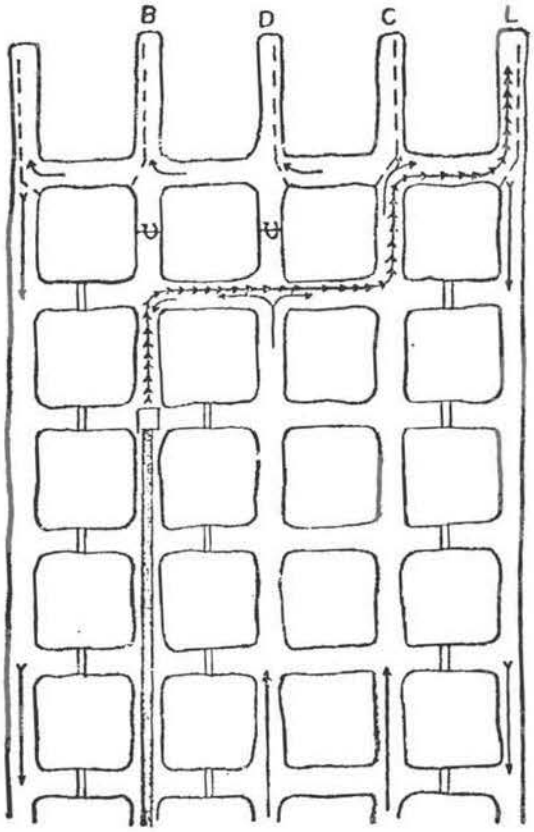
4. Ventilation

Large amounts of air must be blown into the mine to supply oxygen to the miners and to remove potentially explosive dust and gas. Air must be directed into selected entries, circulated, and removed from another entry. The direction of air current travel is controlled either by closing entries with permanent concrete block stoppings or, more frequently, by hanging air-check curtains (brattice) in entry intersections to deflect the airflow. The curtains are used to guide fresh air directly up to and across the active working coal faces where the greatest percentage of underground human activity is concentrated. The following diagram shows two typical ventilation systems which might be used to supply the required air.

TYPICAL VENTILATION SYSTEMS



SINGLE-SPLIT VENTILATION SYSTEM



DOUBLE-SPLIT VENTILATION SYSTEM

LEGEND

- — CHECK CURTAIN
- — LINE CURTAIN
- — DIRECTION OF AIR CURRENT
- II — PERMANENT STOPPING
- L — LOADING MACHINE
- B — BOLT MACHINE
- C — CUTTING MACHINE
- D — COAL DRILL
- — DIRECTION OF TRAVEL
- — BOX CHECK
- — BELT AND FEEDER

5. Retreat Mining

When the mine or a section of the mine is fully developed, the mine operator will begin extracting coal from the supporting pillars in a systematic manner until the roof caves-in. The caved-in area is called the "gob".

B. The Conventional Mining Style

Conventional mining is the oldest mining technique still in popular use in the United States. Approximately 55% of the mining in this country employs conventional mining techniques.

1. Operations

The sequentially required operations for this style are:

a. Undercutting the face
b. Drilling the face
c. Shooting the face
d. Loading and hauling the coal
e. Supporting the roof

Each of these operations can be broken down into work elements as follows:

a. Undercutting the Face

Conventional mining requires cutting into and along the bottom of the face or wall of the coal being worked. This provides a place for the coal to expand when it is subsequently shot (or blasted) and also results in a smooth, level floor.

b. Drilling the Face

Holes are drilled into the face to accommodate explosive charges. The location of these holes and their depth is carefully determined to ensure that all coal is loosened from the seam and that loading of the coal can be easily accomplished. The drill may be mounted on a vehicle or held by hand.

c. Shooting the Face

Shooting the face involves the following steps:

1) Wiring explosive charges and inserting them into the holes in the face
2) Packing the holes with clay sticks or water packs to contain the explosion
3) Stringing wire from the charges to a safe place around the corner from the face
4) Connecting the wire to a detonator
5) Verbally warning the other workers of the imminent explosion
6) Detonating the charge
7) Recovering the reusable wire
8) Testing for methane gas

d. Loading the Coal

Hand loading of coal after shooting the face has almost universally been replaced with loading machines. The function of these machines is to scoop up the coal, carry it on a conveyor, and deposit it into a waiting vehicle, usually a shuttle car.

e. Hauling the Coal

Shuttle cars are, in effect, conveyor lines on wheels. They receive the coal from the loading machine and transport it to the surface. The shuttle car operator can raise or lower the end of his conveyor to dump the coal onto the belt or gondola.

f. Supporting the Roof

After the coal has been loaded and hauled away from the face, the roof over the newly extracted area must be supported and made safe. This normally involves:

1) Measuring the height of the roof
2) Setting temporary supports (jacks and/or posts)
3) Scaling the roof and testing for methane gas
4) Measuring and marking the roof for roof bolt placement
5) Drilling holes into the roof through laminated shale until solid rock is encountered
6) Inserting long steel rods into the hole and tightening them, thereby expanding the top of the bolt to create a "solid beam" out of the laminated layers of shale
7) Removing the temporary support
8) Hand throwing or machine spraying rock dust to minimize the danger of coal dust explosions during the next cycle (cutting, drilling, shooting, and loading).

2. The Equipment

Mining industry equipment manufacturers have developed a variety of equipment to perform these basic mining operations. The primary

influence upon equipment shape, configuration and capacity is the height of the seam in which operation is intended. Each make and model of equipment has different feeds, speeds and capabilities.

Any given machine may also be designed to perform more than one basic operation. For example, the cutter may carry and power the face drill, and temporary support systems and roof bolters are built into some continuous mining machines.

Although the operations are standard, equipment selection greatly affects the speed at which work is performed and the crew size.

3. The Crew

A conventional mining work crew is typically composed of the following personnel:

- Foreman
- Undercutter Machine Operator
- Face Drill Machine Operator
- Shot Fireman
- Loading Machine Operator
- Loading Machine Helper
- #1 Shuttle Car Operator
- #2 Shuttle Car Operator
- Roof Bolting Machine Operator
- Electrician (Repairman)
- Belt Clean-up Man (or "Tailpiece Man")

Crew composition and size could vary from mine to mine or even section to section in the same mine. Some factors which affect the crew size and array are:

- Height of Seam
- Equipment Manning Requirements
- Local Available Work Force
- Absenteeism
- Use of the Helper or Buddy System
- Training New Workers on the Job
- Balancing Equipment Cycles
- Union Contract Stipulations

Since teamwork and improvisation are required during breakdowns, the possible crew array combinations are extremely variable. Some common variances to the crew make-up described are:

- The undercutter machine operator and the shot fireman may perform the face drilling operation.
- Roof bolting may be performed by one man or as many as four men.

C. The Continuous Mining Style

This style of mining began to gain acceptance in the United States shortly after its introduction in 1948. The continuous mining machine might be compared to the loading machine in conventional mining operations. The major difference in the continuous miner is the addition of a rotating "drum" with sharp bits which cut and "gouge" the coal directly from the coal seam onto the loading conveyor. In most continuous mining operations, the cutting "drum" rotates from top to bottom and the cutting head is sumped into the coal at the top of the seam by moving the entire machine forward. As the coal is broken, it falls to the floor where it is picked up by the loading arms. This system eliminates the undercutting, face drilling, and shooting operations associated with conventional mining.

The major advantages of the continuous mining style over the conventional style are:

- Reduction in section crew size.
- Elimination of cutting and drilling machines.
- Elimination of explosives' cost.
- Reduction in the total work cycle with a corresponding increase in labor productivity.

1. Operations

The three essential operations in continuous mining are:

a. Continuous mining
b. Hauling the coal
c. Supporting the roof

These operations can be described as follows:

a. Continuous Mining

The "miner" (continuous mining machine) drives an entry 16 to 22 feet into the coal. Depending upon the desired width of the entry, this might require 2 or 3 overlapping "sumps" by the miner, since the mining machine is usually narrower than the desired width of the entry. After loading 2 to 4 shuttle cars from a single sump, the miner will back out, reposition, and begin another sump to "even-up" his entry cut.

Deep sumps prevent effective face ventilation and increase the possibility of a methane gas ignition in a gassy mine. Liberation of methane gas may be such a problem in some mines that the miner must back out and resump after loading only a single shuttle in order to maintain an even, well-ventilated face. Backing up, repositioning, and resumping are time-consuming, non-productive operations and can decrease production considerably. Consequently, there is a trade-off between safety and production.

The length of the entry, normally 16 to 22 feet, depends upon the length of the continuous mining machine. The operator, located at the right rear of the machine, can drive ahead safely only to that point at which he still remains under supported roof. There is sometimes a temptation--perhaps generated by production pressure -- for the operator to continue his cut past the point at which he is protected by supported roof. This unsafe practice was observed several times during this study.

b. Hauling the Coal

Haulage operations in continuous mining are identical to those in conventional mining, described earlier.

c. Supporting the Roof

Roof support considerations and techniques in continuous mining are identical to those in conventional mining, with one exception. Typically, the linear distance moved during a conventional cycle is 9 to 13 feet (the length of the undercutter blade). The roof-bolt cycle which is involved in this operation consists of drilling and inserting 6 to 10 bolts. The number of bolts required after a 16 to 22 foot continuous mining cycle is normally 16 to 20 bolts.

3. The Crew

A typical continuous mining section crew consists of the following personnel:

- Foreman
- Continuous Miner Operator
- Continuous Miner Helper
- #1 Shuttle Car Operator
- #2 Shuttle Car Operator
- Roof Bolting Machine Operator
- Electrician (Repairman)
- Belt Clean-up Man (or "Tailpiece Man")

Crew composition and size variations are as common here as in conventional mining.

D. The Continuous Auger Mining Style

Underground continuous auger mining is normally conducted in seam heights under 3 feet. It is particularly popular in low seam, rough-floor mines which make shuttle haulage difficult or impractical, such as found in Harlan, Bell, and Knox counties in Eastern Kentucky. The system usually employs continuous belt haulage from face to surface.

The nature of the system is such that there is normally no work cycle rotation. All activity is confined to simultaneous operations at the "working face" (wherever the miner is operating at a particular moment in time). For a more detailed description of machine and crew positioning near the face, see Volume I, Chapter 14.

CHAPTER 2
MULTIFLOW PROCESS CHARTS

THE CONVENTIONAL MINING STYLE

- The following series of sketches (not to scale) illustrate the four basic pieces of equipment utilized in the Conventional Mining Style.

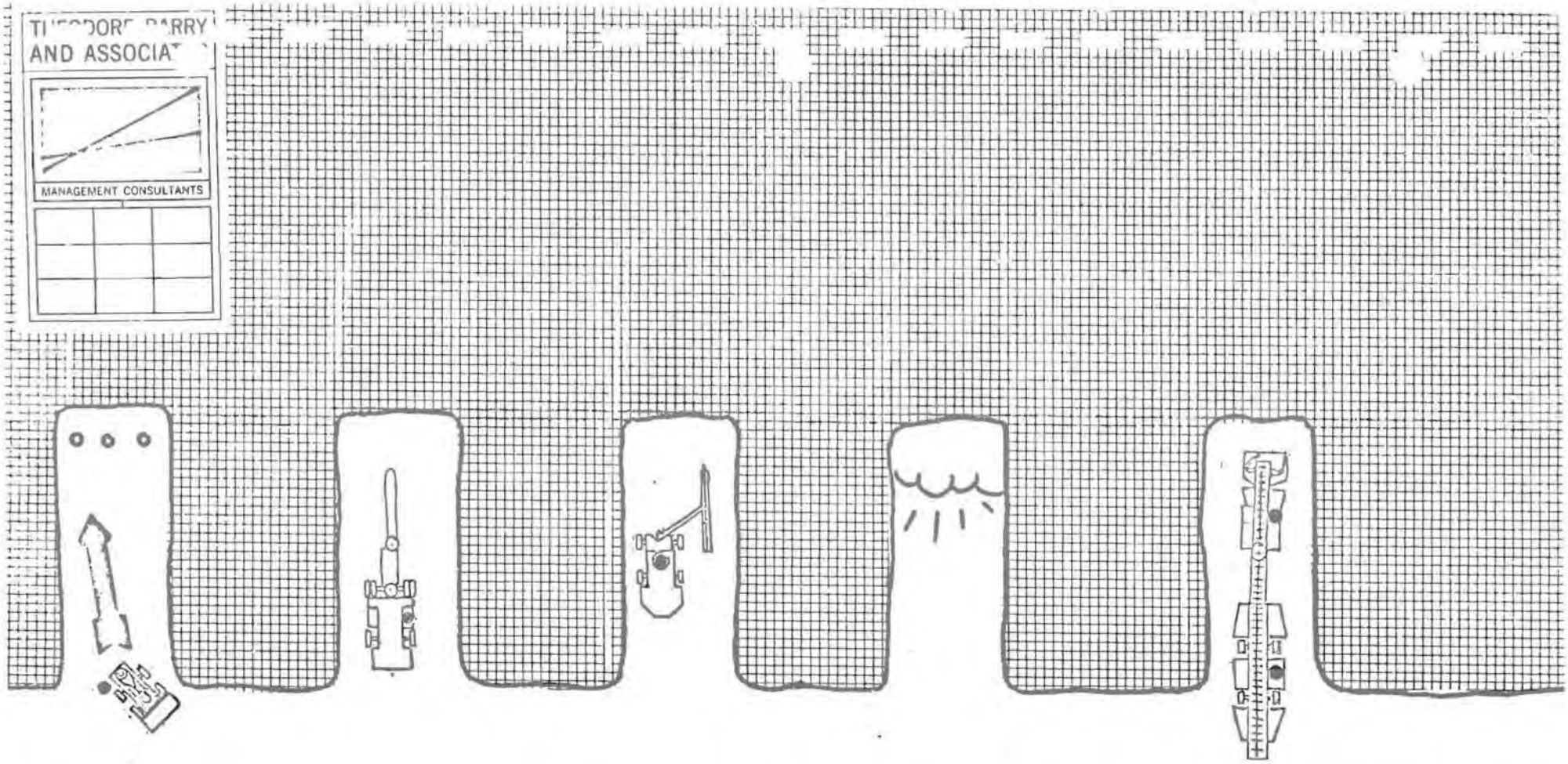
- Each sketch shows the normal five entries being worked simultaneously by the various pieces of equipment.

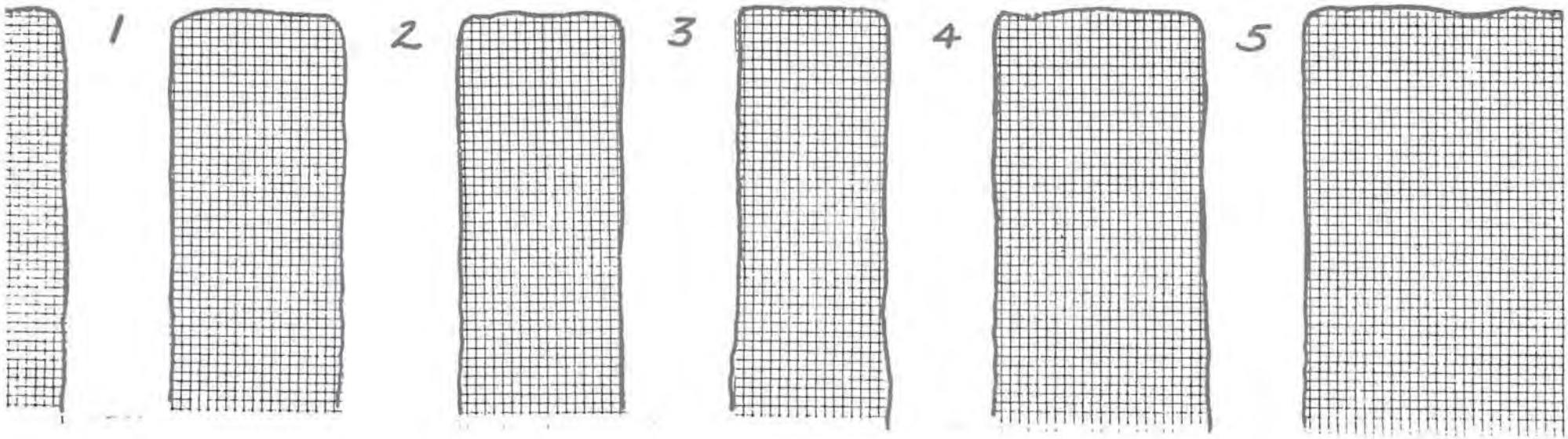
- Each entry (or face) being worked is usually referred to by number. Numbers usually range upward from left to right; that is, the first entry on the left is entry number one.

- The equipment is shown moving in a set sequence from right to left.

- The undercutter usually goes first, followed by the face drill, followed by the shot fireman, followed by the loader and shuttle cars, and finally the roof bolter. In many cases, the roof bolter is a bottleneck and other equipment is delayed.

- Often, the face drilling cycle is performed by a hand-held drill operating off the undercutter. This sequence of sketches shows a self-propelled drill rather than a hand-drill.





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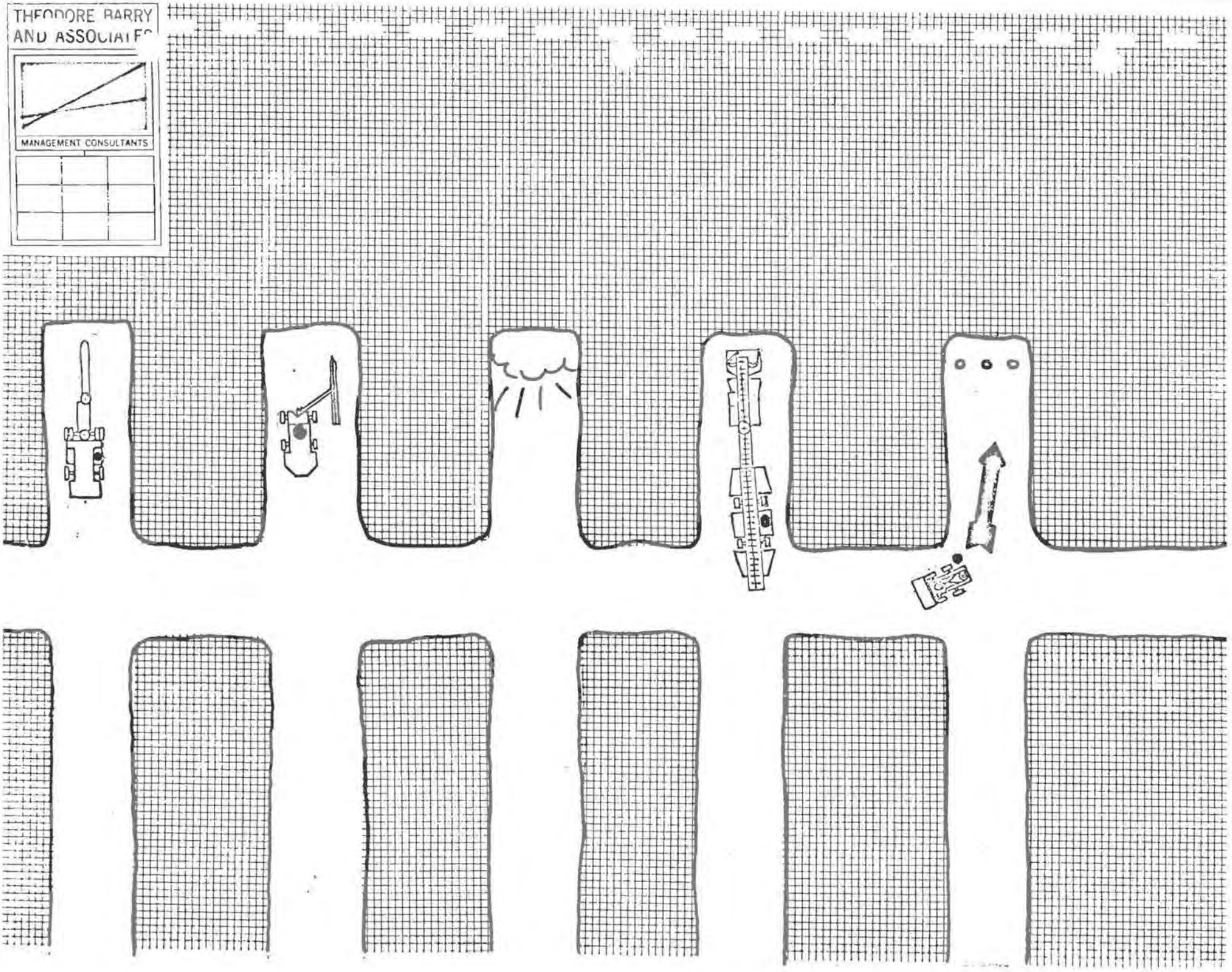

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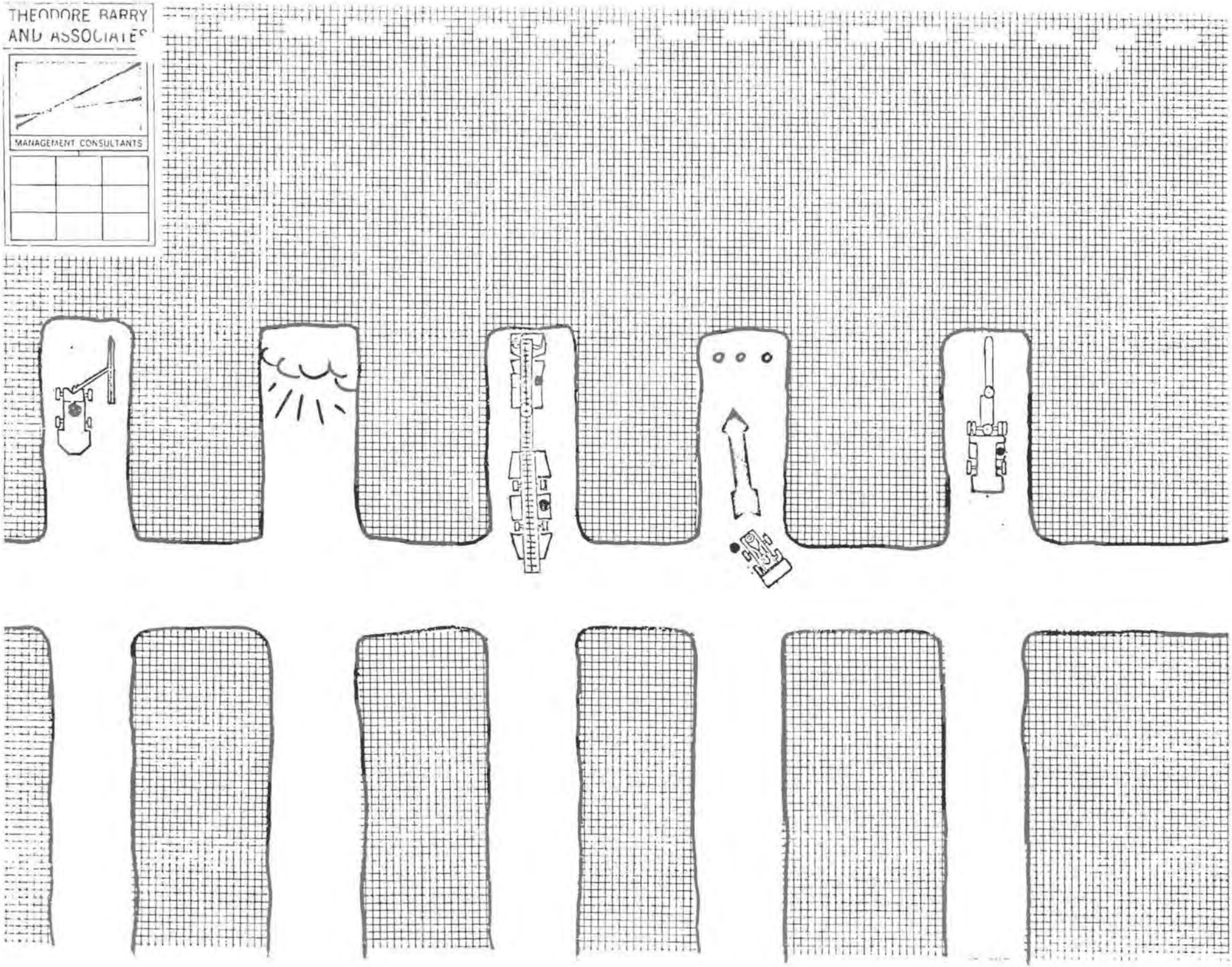

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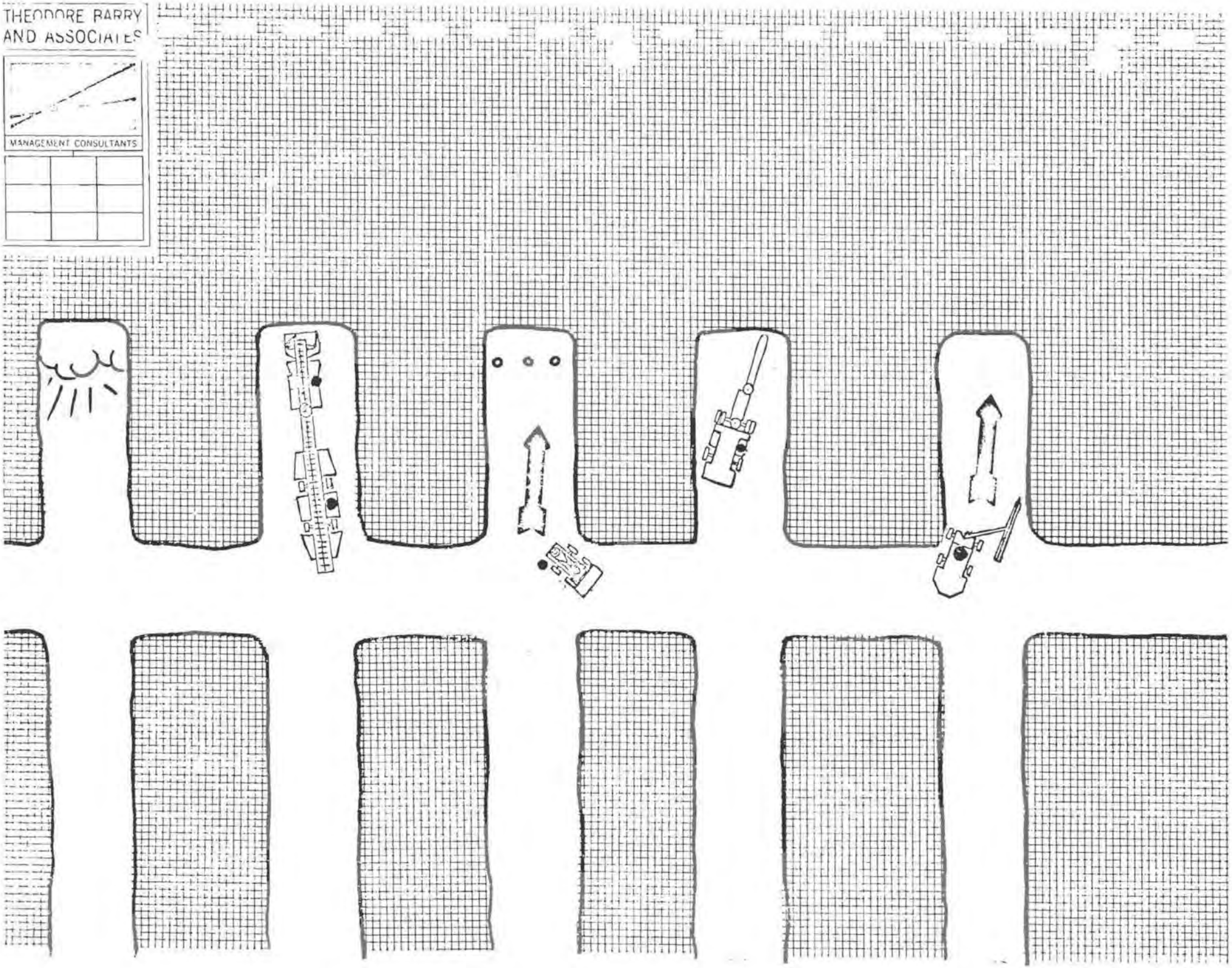

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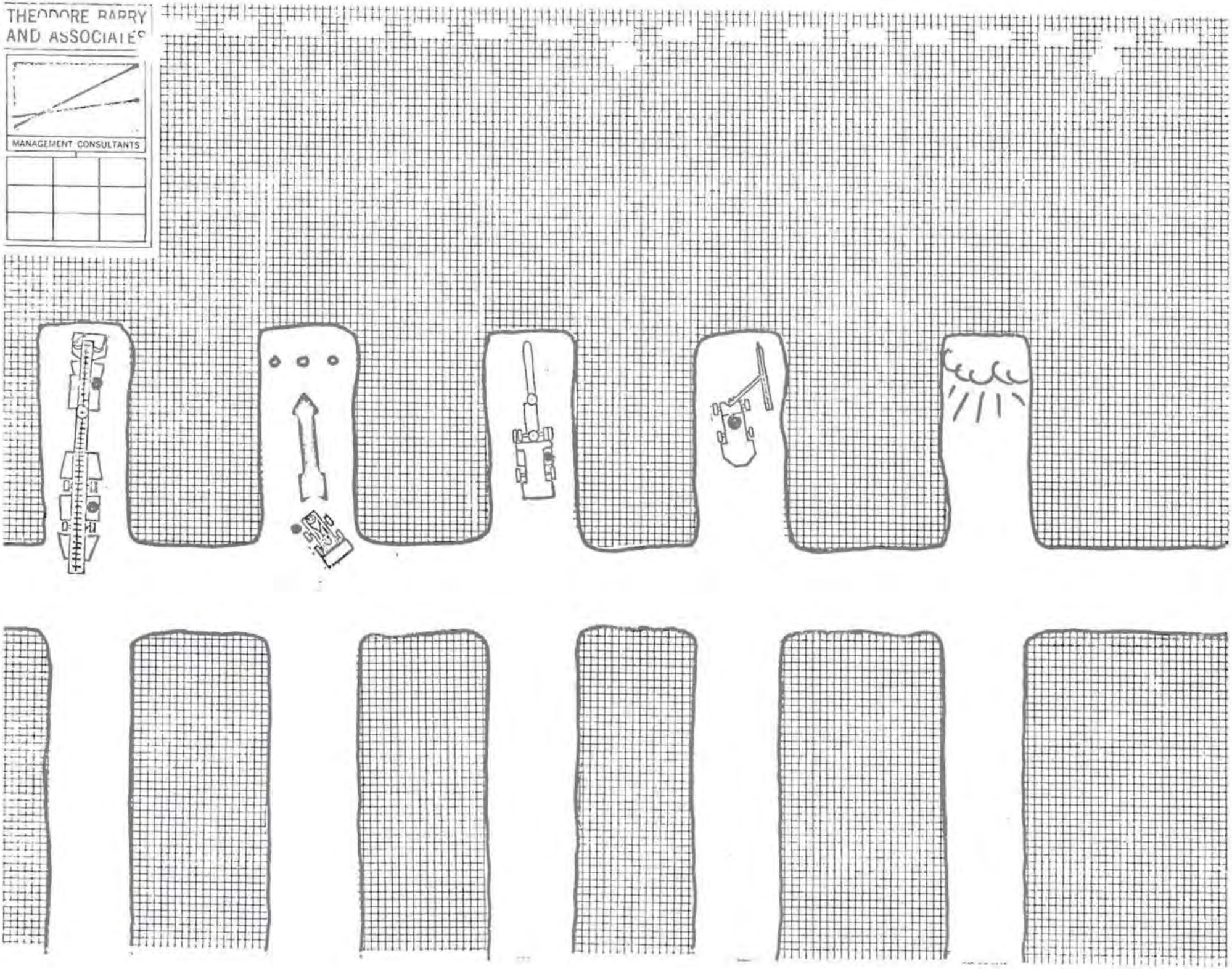

THE CONVENTIONAL MINING OPERATIONS

- The five following series of sketches show the detailed movements of Conventional Mining machines and operators as they move through their operational cycle.

- The operational sketches are presented in their normal sequence:

  - Undercutting
  - Drilling
  - Shooting
  - Loading
  - Roof Bolting

UNDERCUTTING OPERATION

The times shown here and on the following sketches do not represent basic work element times. Rather, time is the total elapsed time for the various work elements represented by one sketch.

Sketch Number	Illustration	Typical Time
1	Tram 90 feet to new face	2.00 minutes
2	Position equipment into face	.50
3	Sump into face	1.56
4	Force cut face -- right to left	.51
5	Position blade down -- jackknife left	.43
6	Force cut face -- right to left	2.47
7	Position blade down -- jackknife left	.43
8	Force cut face -- right to left	2.47
9	Cut face -- square up corner	2.50
10	Position equipment out of face	.50
11	Tram 90 feet to new face	2.00

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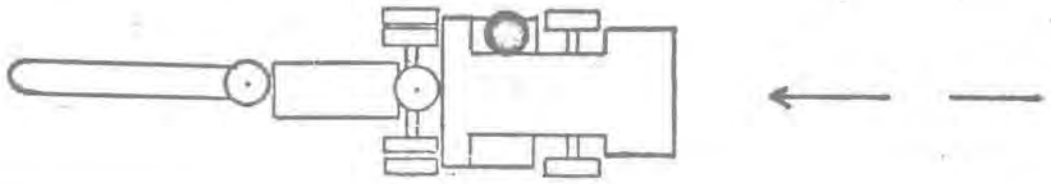
1	Tram 90 feet to new face	2.00 minutes



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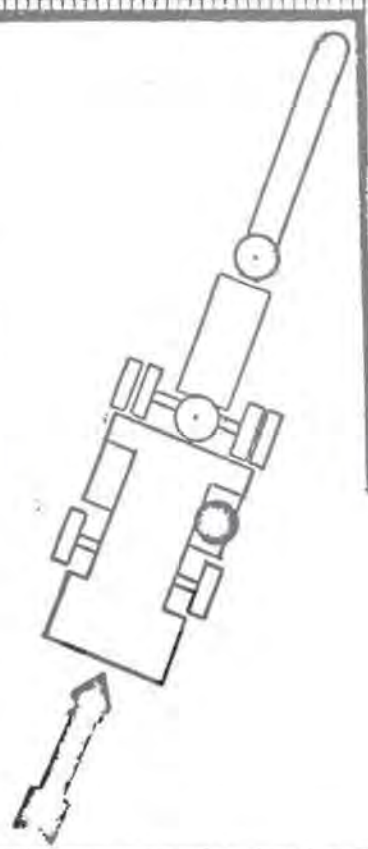
2	Position equipment into face	.50



3 Sump into face 1.56

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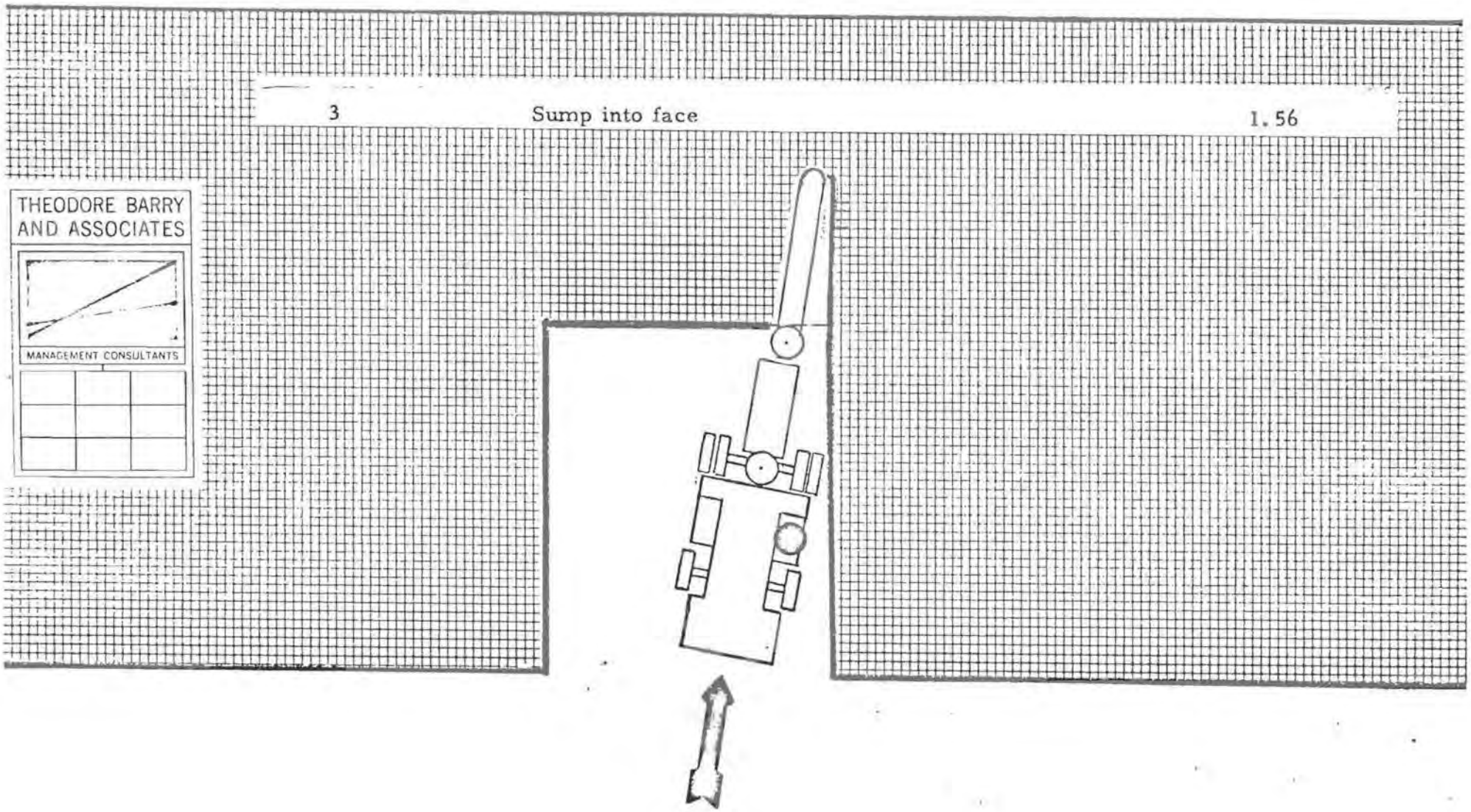

Force cut face -- right to left

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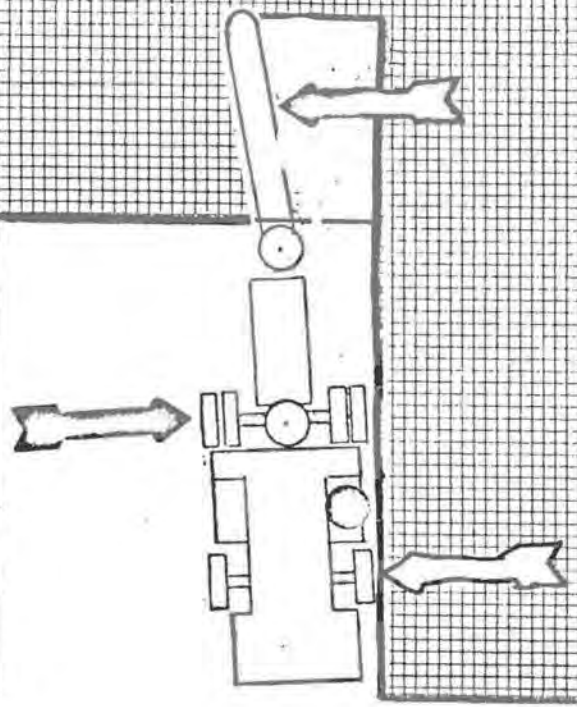

5 Position blade down -- jackknife left .43

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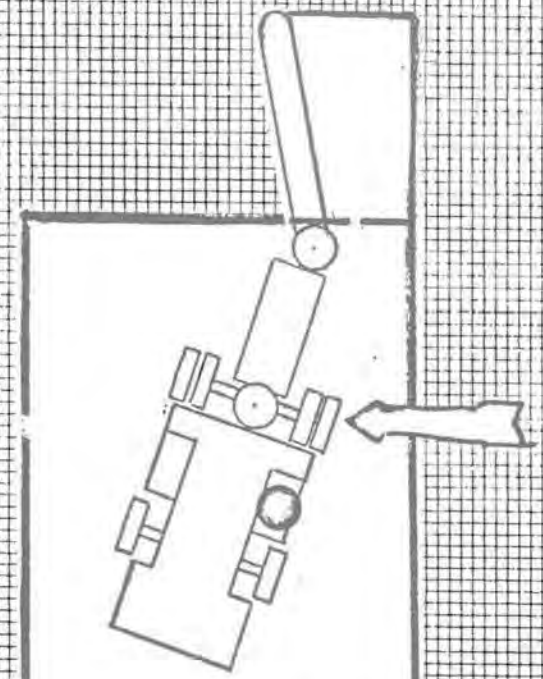

6 Force cut face -- right to left 2.47

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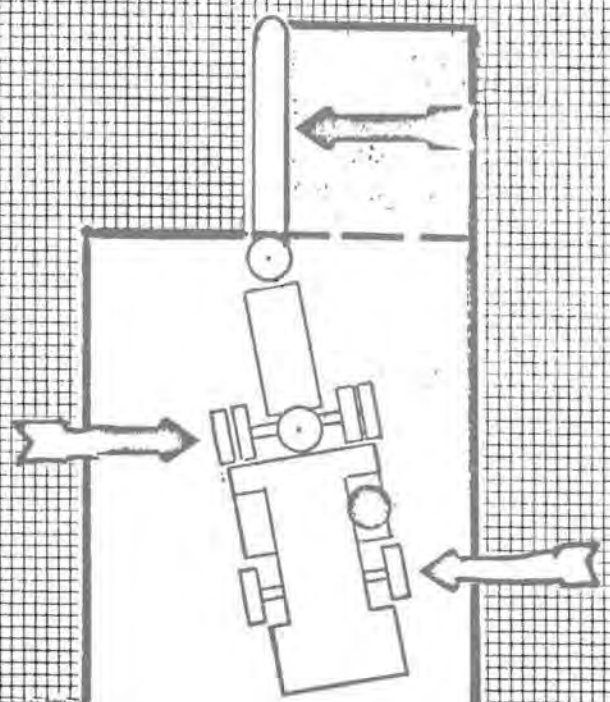

7 Position blade down -- jackknife left .43

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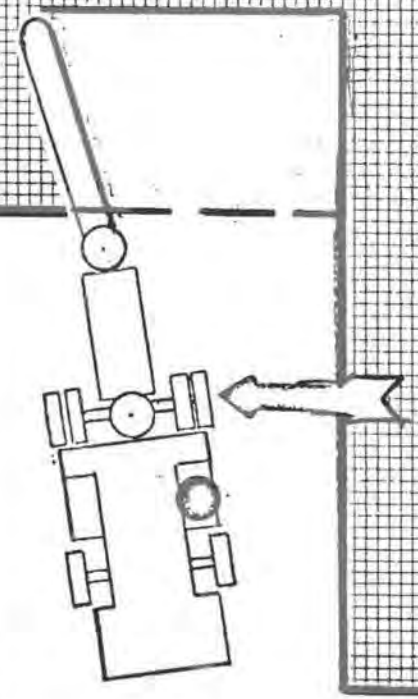

8 Force cut face -- right to left 2.47

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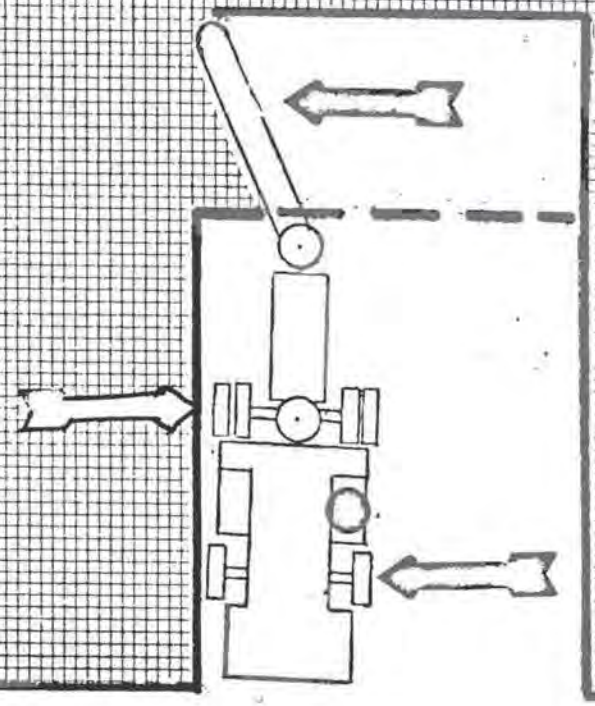

9 Cut face -- square up corner 2.50

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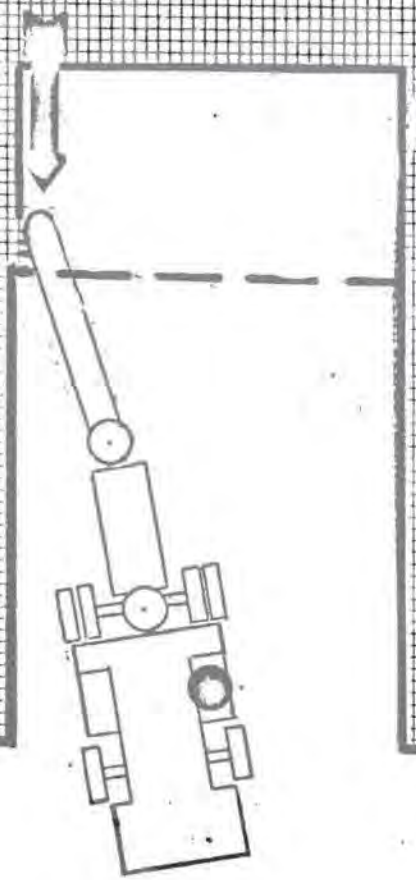

10 Position equipment out of face .50

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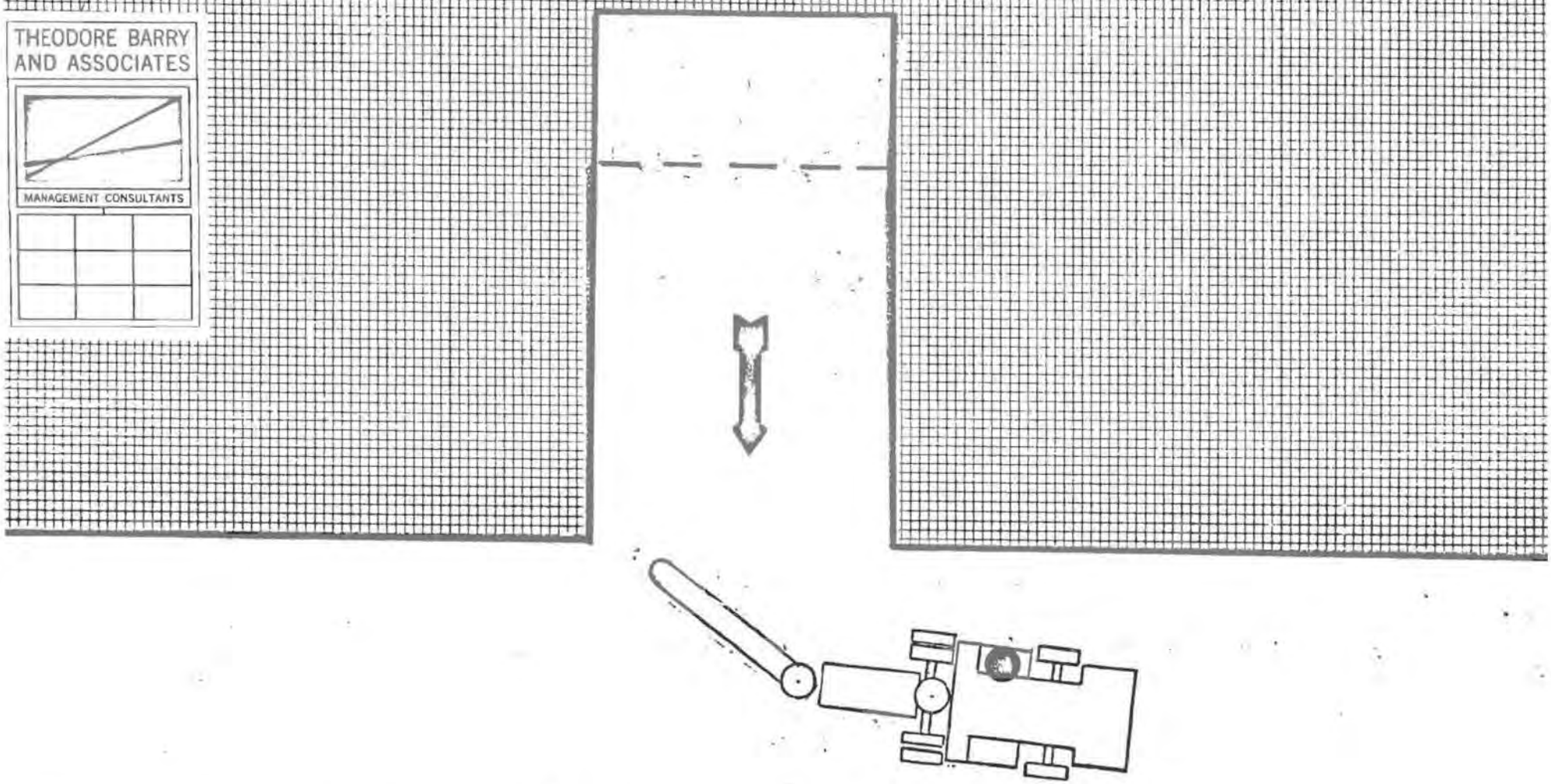

11	Tram 90 feet to new face	2.00

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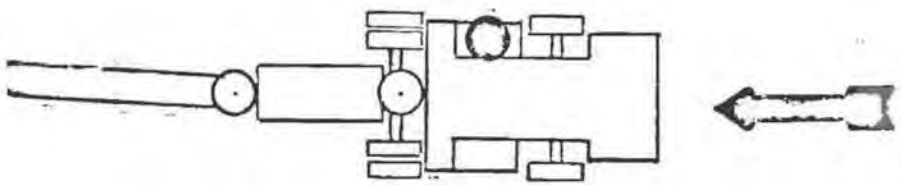


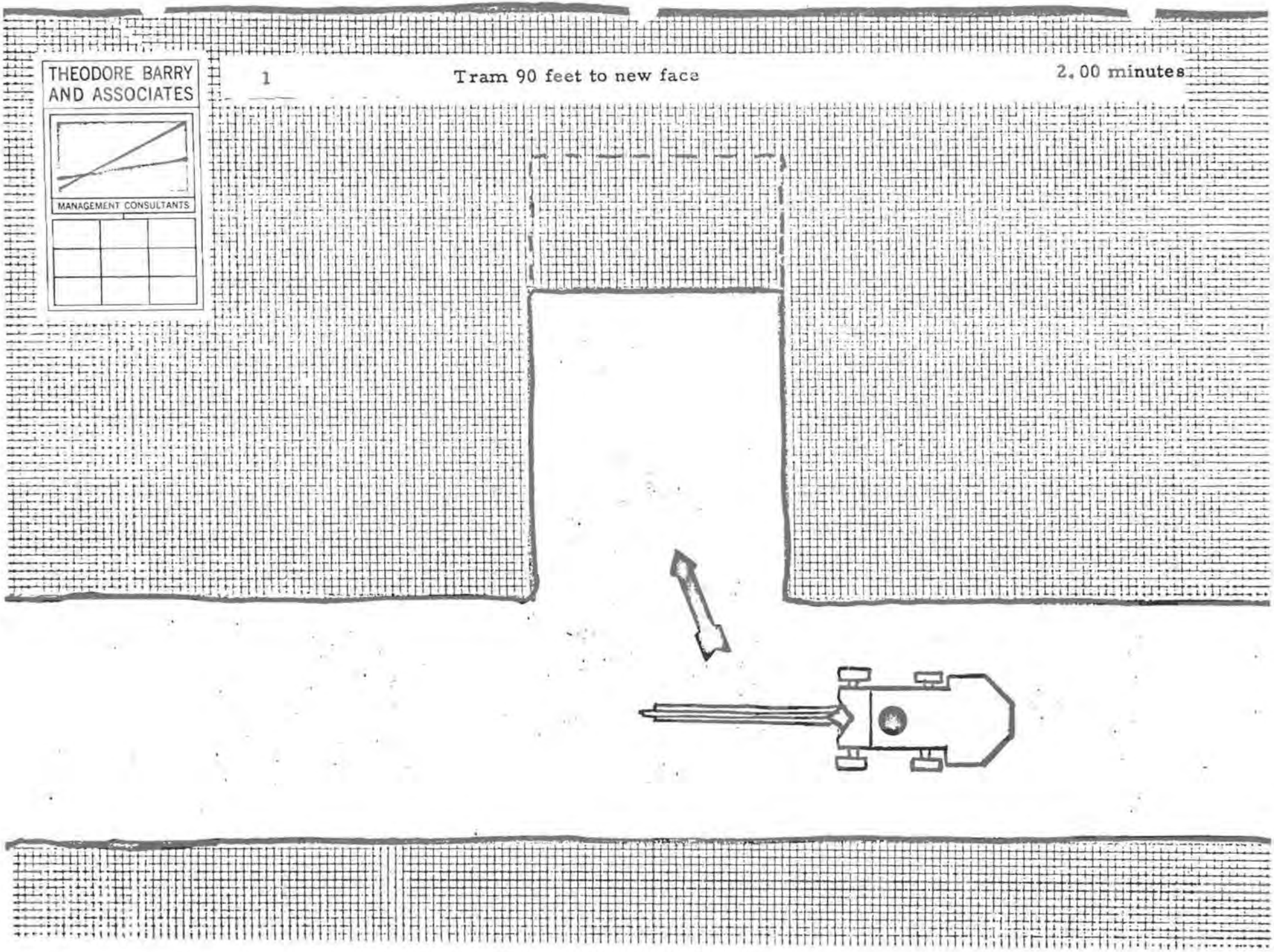
FACE DRILLING OPERATION

Sketch Number	Illustration	Typical Time
1	Tram 90 feet to new face	2.00 minutes
2	Position drill arm right and drill first hole (low)	1.35
3	Raise drill arm and drill second hole (high)	1.05
4	Position drill arm to center and drill third hole (low)	1.35
5	Raise drill arm and drill fourth hole (high)	1.05
6	Position drill arm left and drill fifth hole (low)	1.35
7	Raise drill arm and drill sixth hole (high)	1.05
8	Position equipment out of face area	.30
9	Tram 90 feet to new face	1.00

THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

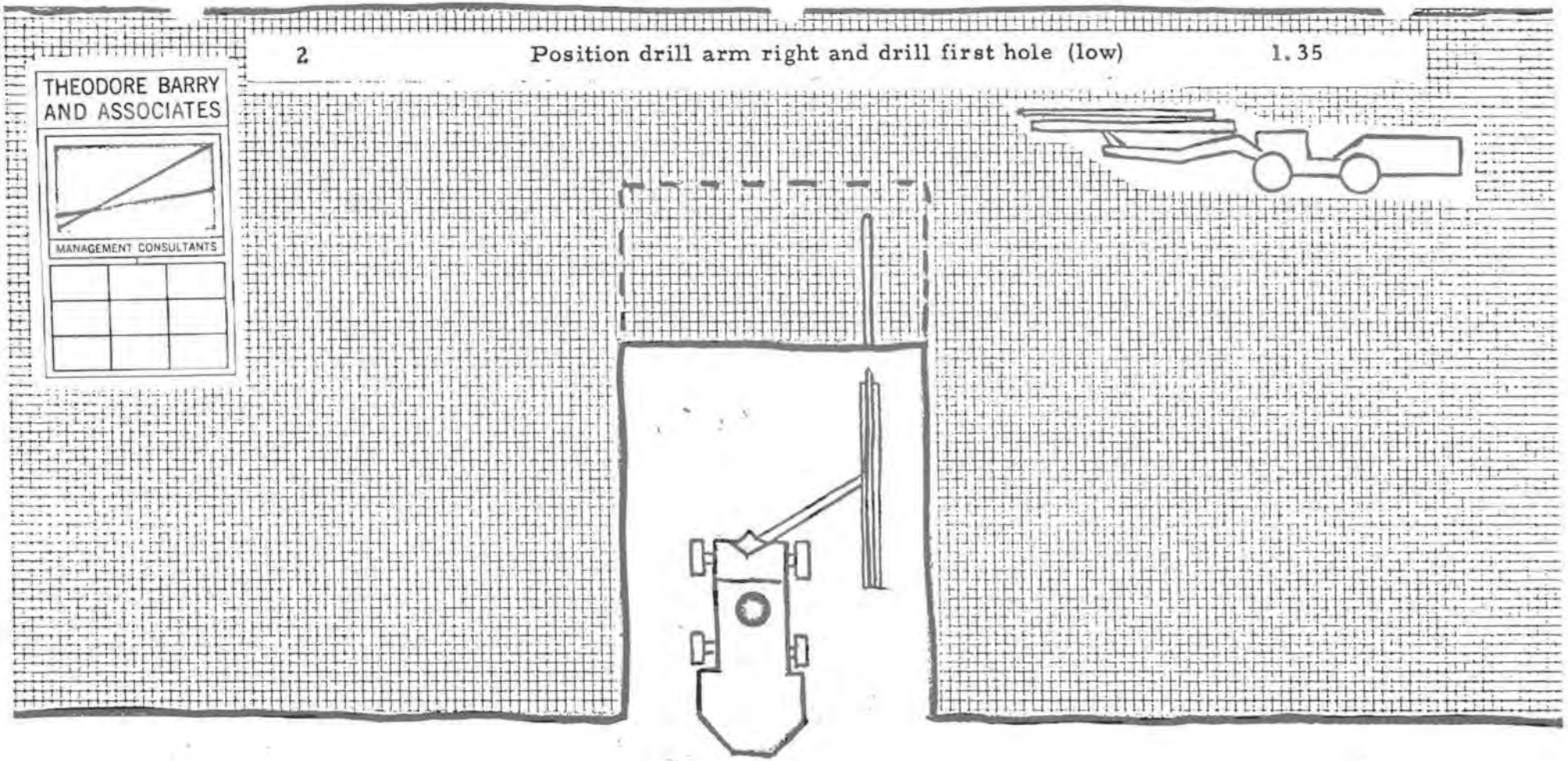
1 Tram 90 feet to new face 2.00 minutes



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

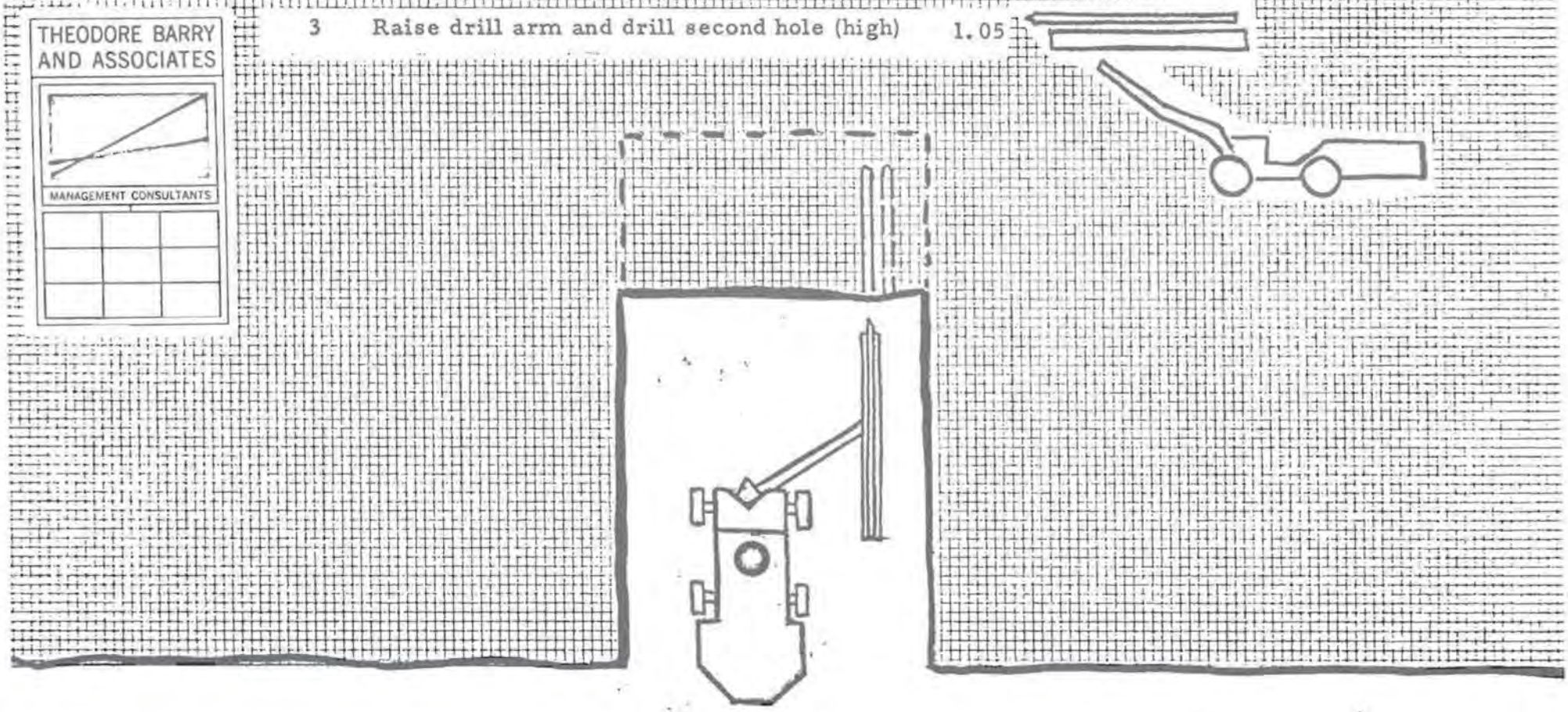
2 Position drill arm right and drill first hole (low) 1.35



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

3 Raise drill arm and drill second hole (high) 1.05



THEODORE BARRY AND ASSOCIATES

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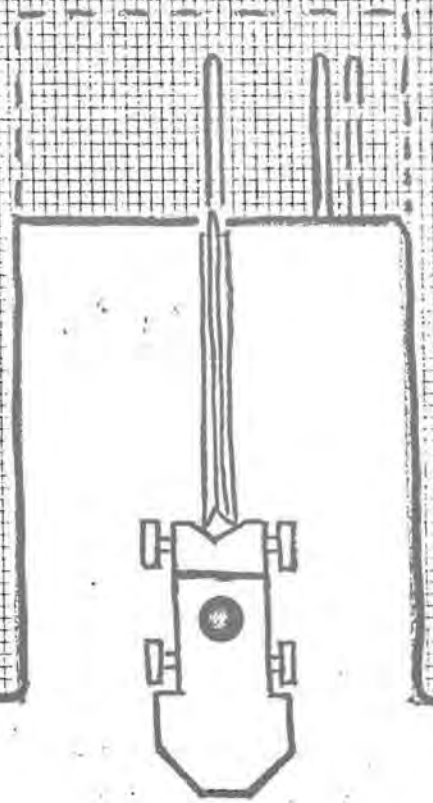
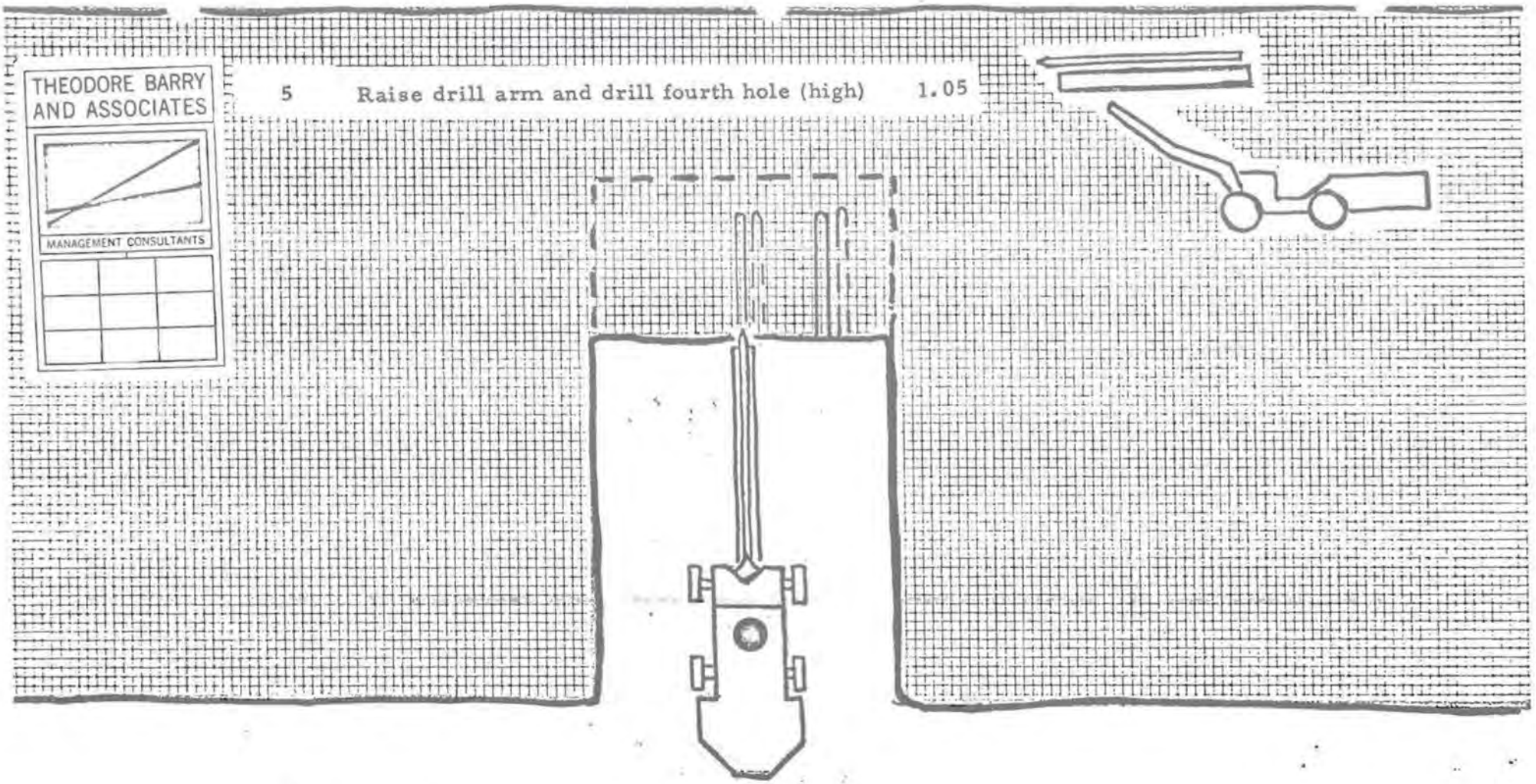
4 Position drill arm to center and drill third hole (low) 1.35



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

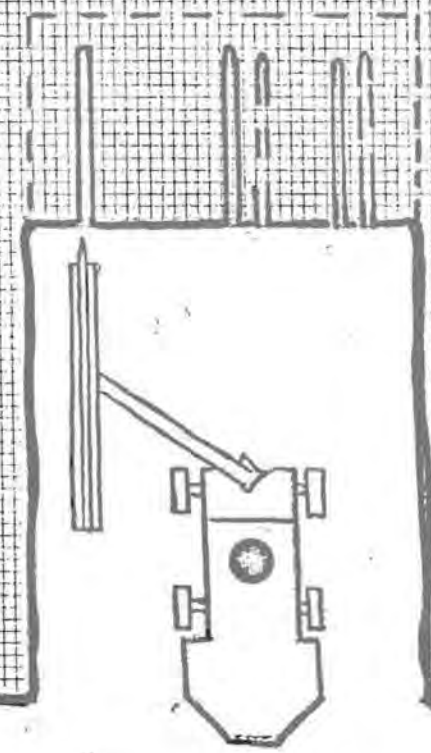
5 Raise drill arm and drill fourth hole (high) 1.05

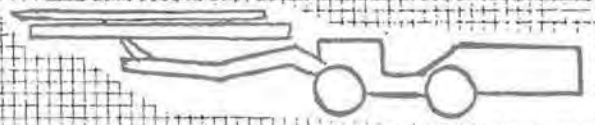


THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

6 Position drill arm left and drill fifth hole (low) 1.35

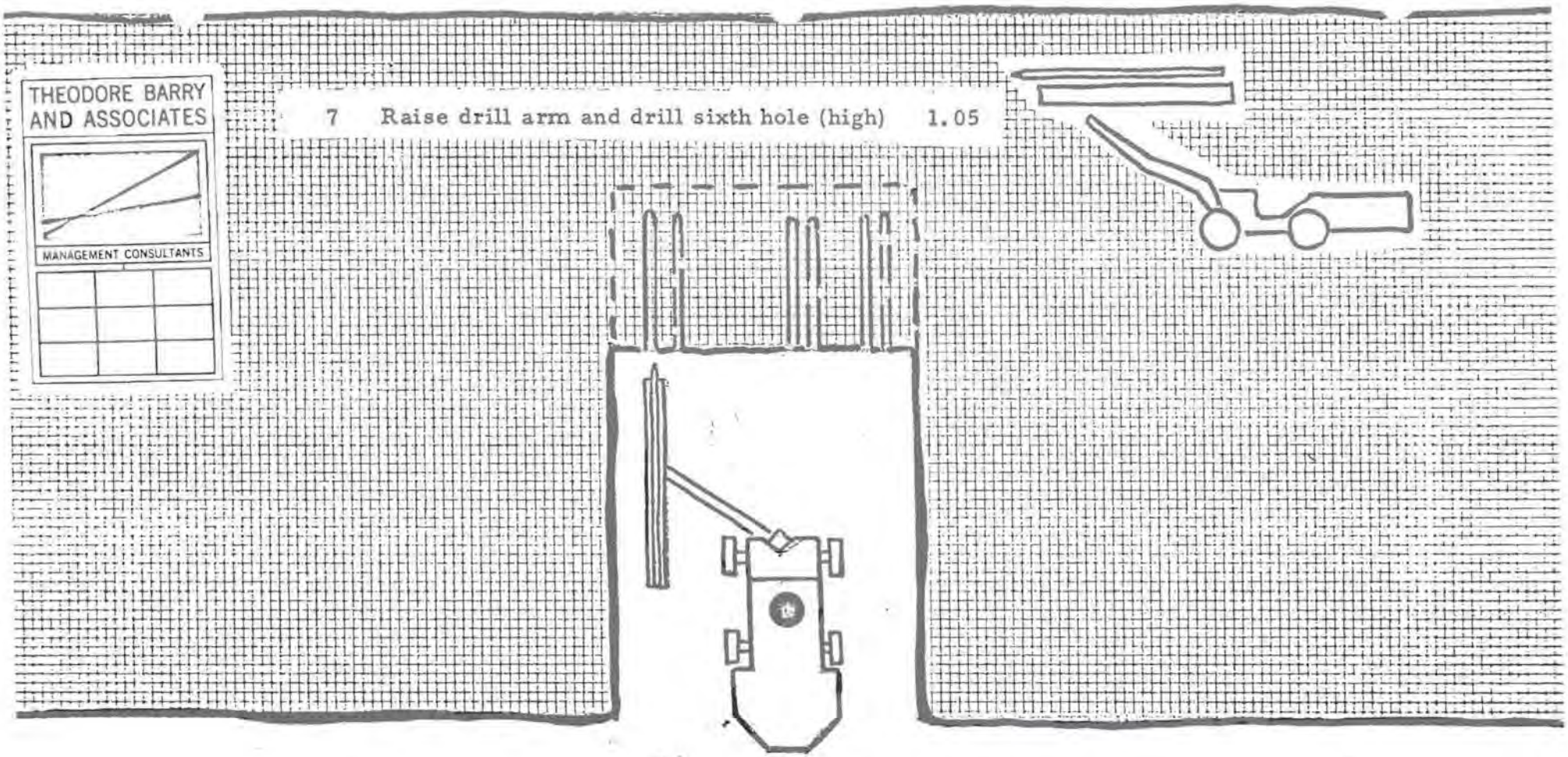




THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

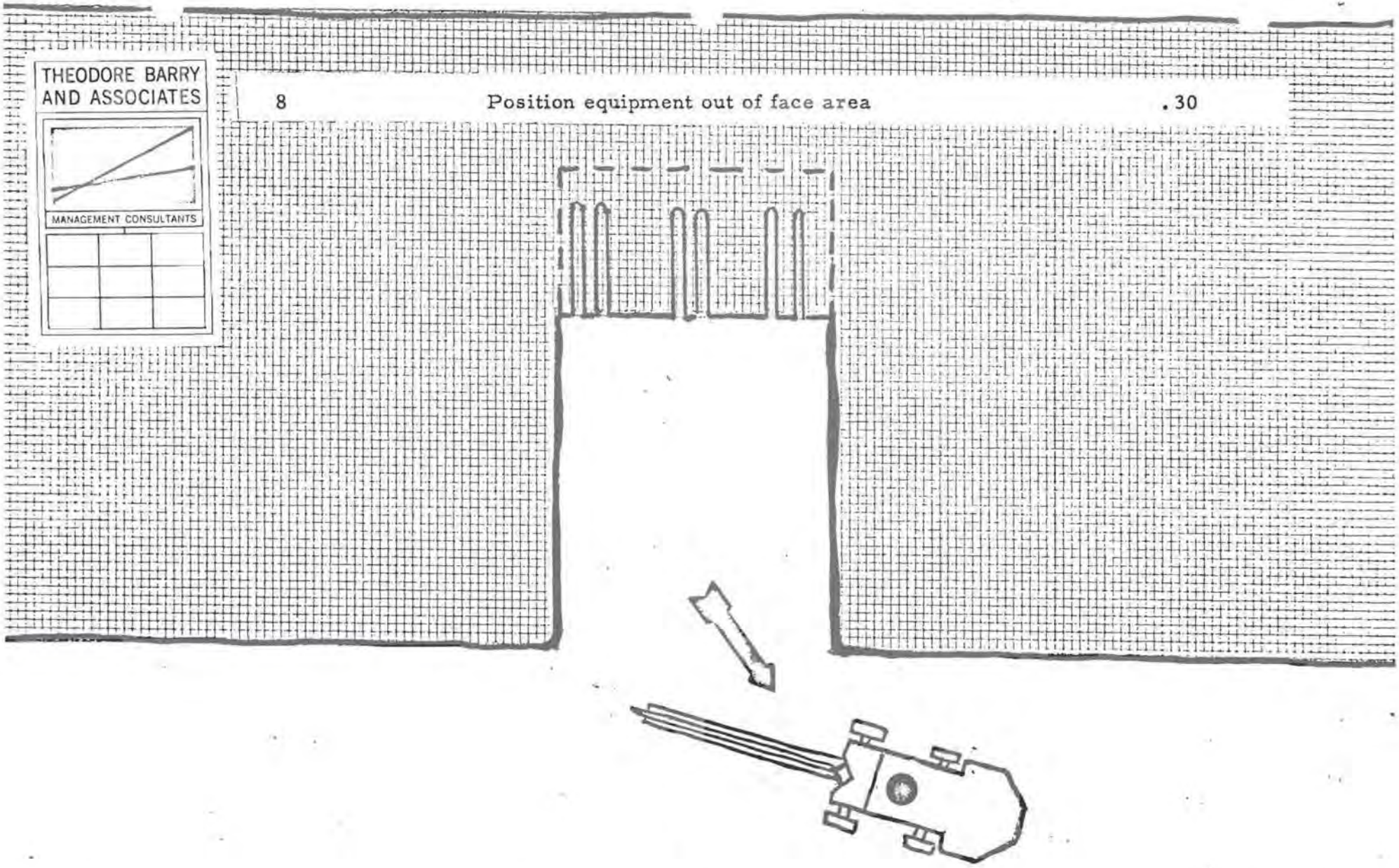
7 Raise drill arm and drill sixth hole (high) 1.05



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

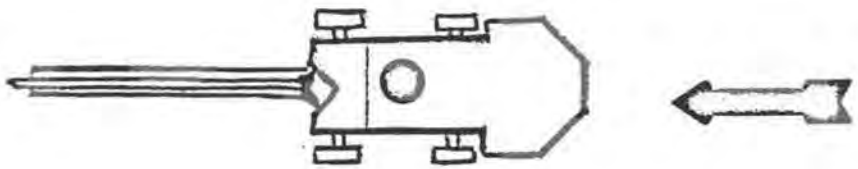
8 Position equipment out of face area .30



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

9	Tram 90 feet to new face	1.00



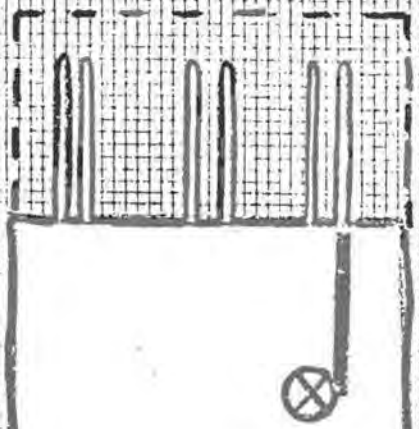
SHOOTING

Sketch Number	Illustration	Typical Time
1	Measure depth of hole	1.00
2	Insert 3 charges and clay dummies - first hole (high)	1.76
3	Insert 3 charges and clay dummies - second hole (low)	1.66
4	Insert 3 charges and clay dummies - third hole (high)	1.66
5	Insert 3 charges and clay dummies - fourth hole (low)	1.66
6	Insert 3 charges and clay dummies - fifth hole (high)	1.66
7	Insert 3 charges and clay dummies - sixth hole (low)	1.66
8	Connect fifth and sixth hole charges	.70
9	Connect third and fourth hole charges	.70
10	Connect first and second hole charges	.70
11	Unreel wire to safe position, connect to detonator and verbally warn the crew	.70
12	Detonate charges - blow coal from face	.20
13	Rewind wire for reuse	1.30
14	Crawl over "shot" coal to methane test at ceiling (inherently hazardous)	2.00

THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

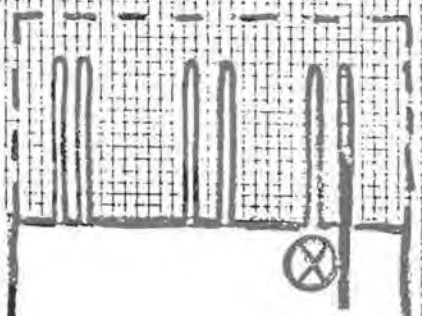
1	Measure depth of hole	1.00



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

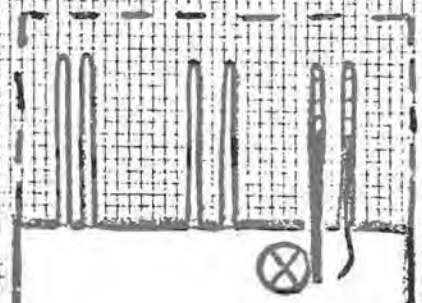
2 Insert 3 charges and clay dummies - first hole (high) 1.76



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

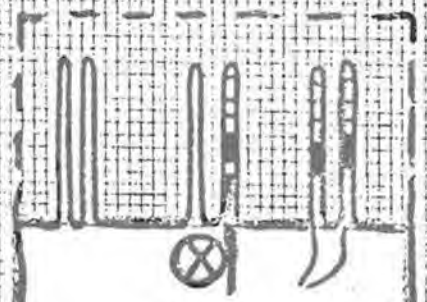
3 Insert 3 charges and clay dummies - second hole (low) 1.66



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

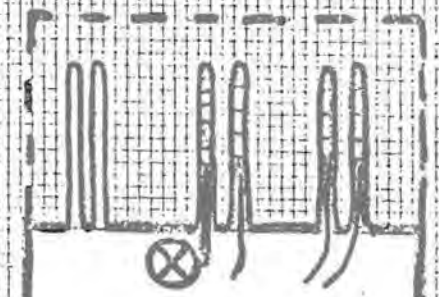
4 Insert 3 charges and clay dummies - third hole (high) 1.66



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

5 Insert 3 charges and clay dummies - fourth hole (low) 1.66

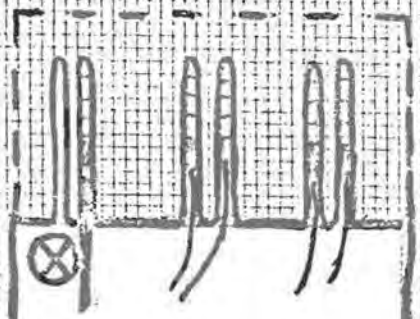


THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

6

Insert 3 charges and clay dummies - fifth hole (high) 1.66

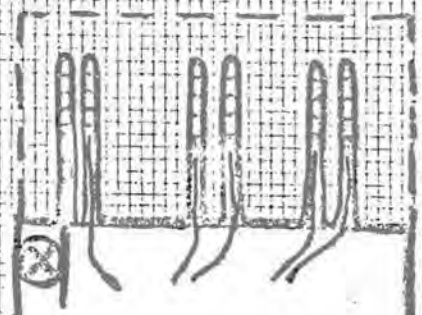


THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

7

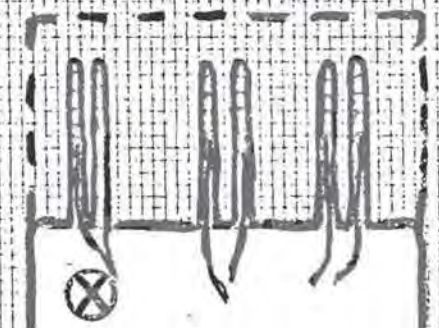
Insert 3 charges and clay dummies - sixth hole (low) 1.66



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

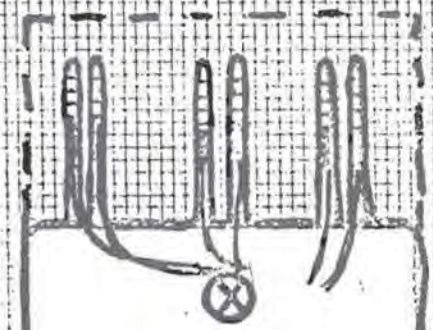
8 Connect fifth and sixth hole charges .70



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

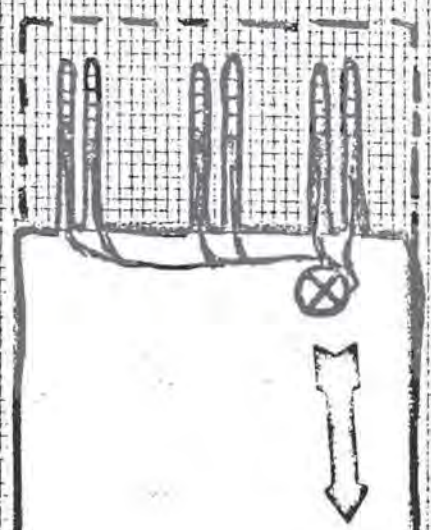
9 Connect third and fourth hole charges .70



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

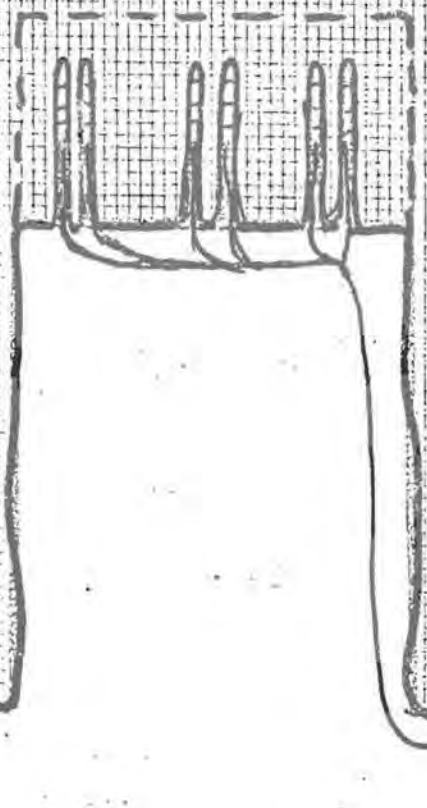
10 Connect first and second hole charges .70



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

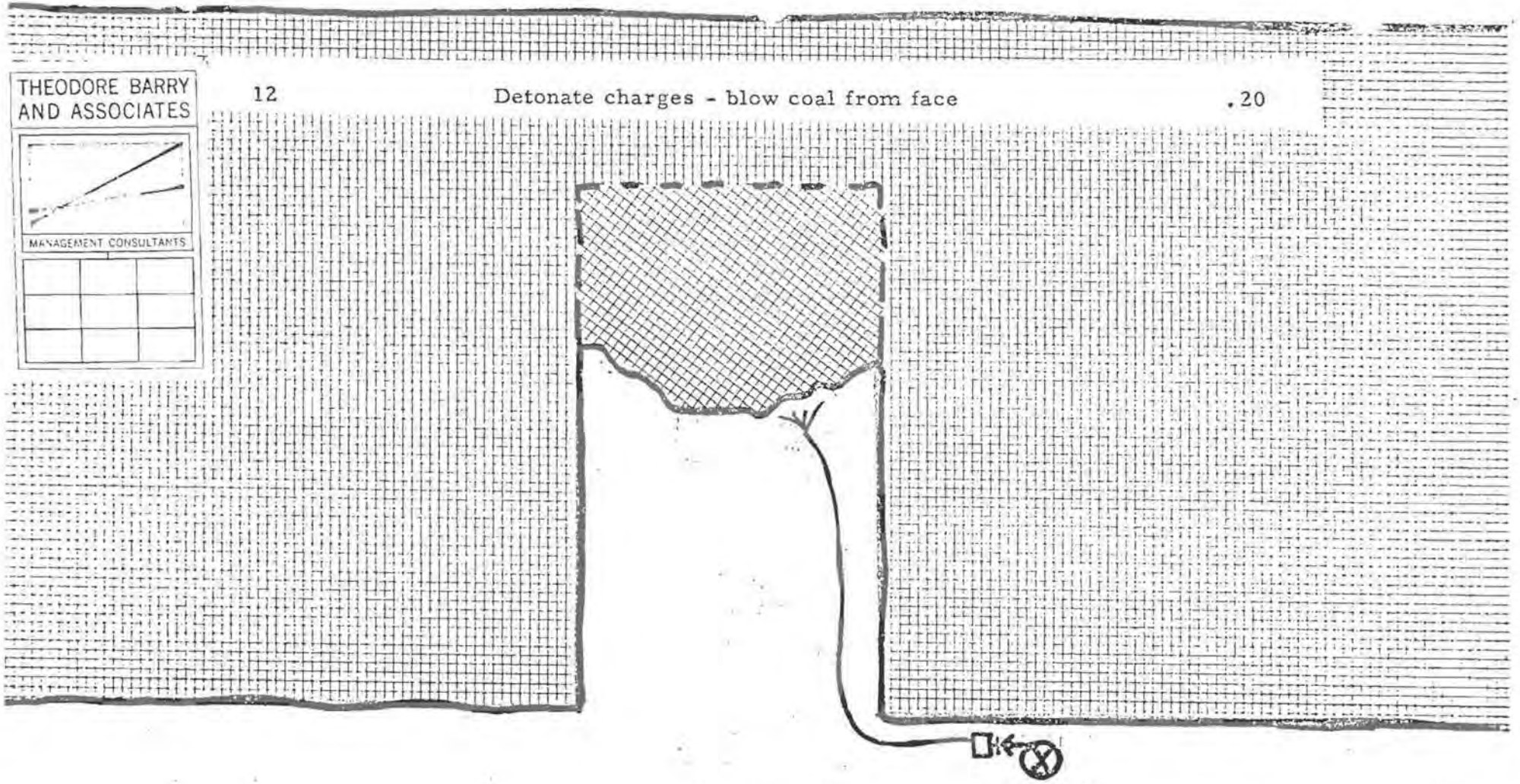
11 Unreel wire to safe position, connect to detonator and verbally warn the crew .70



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

12 Detonate charges - blow coal from face .20



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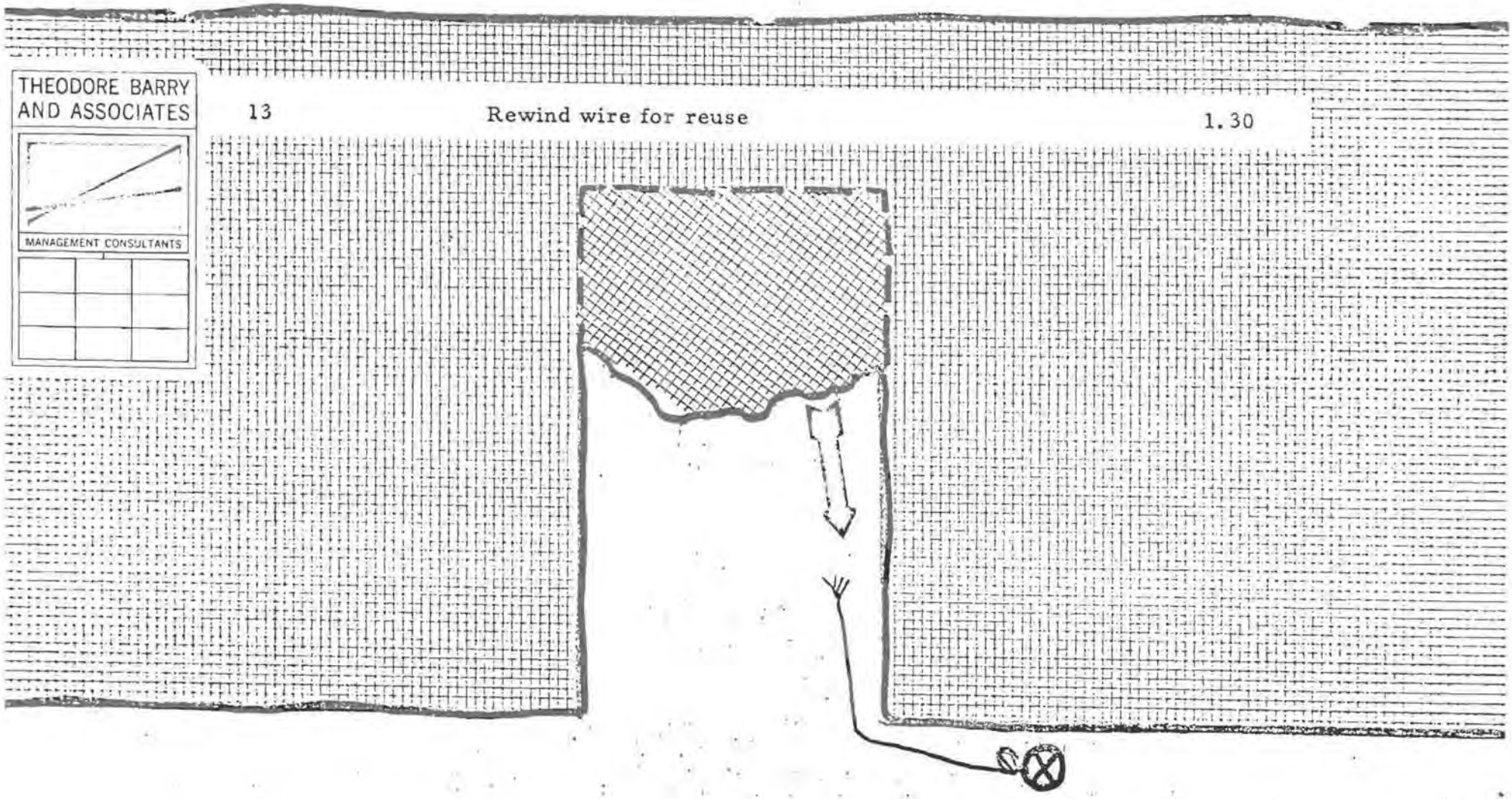
MANAGEMENT CONSULTANTS

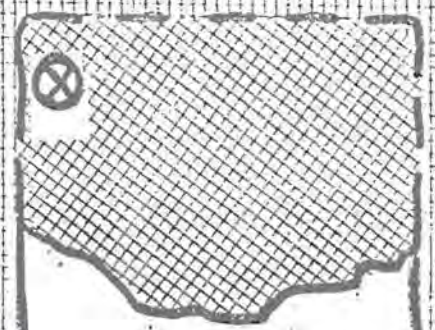
13 Rewind wire for reuse 1.30



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

14 Crawl over "shot" coal to methane test at ceiling 2.00
(inherently hazardous, since most often done under unsupported roof)



LOADING

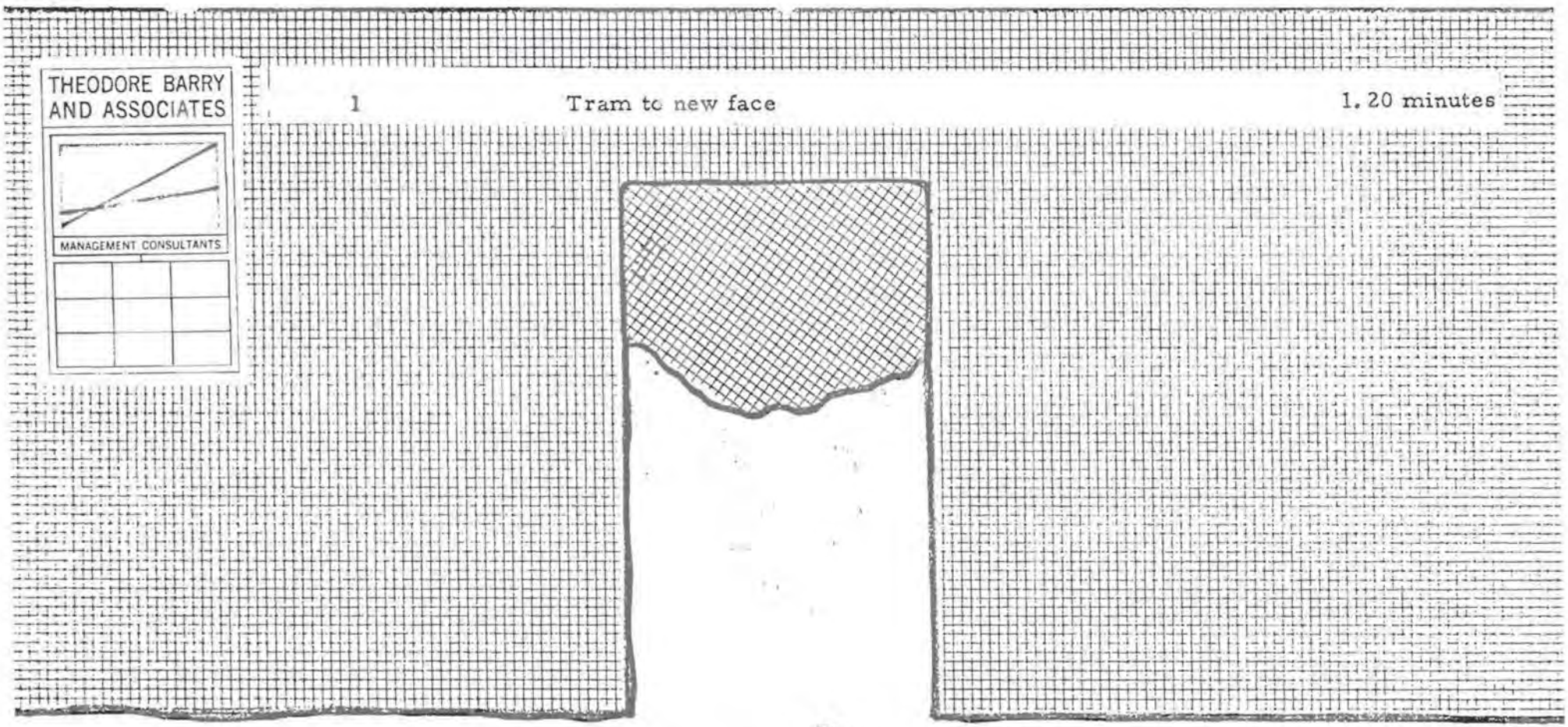
Sketch Number	Illustration	Typical Time
1	Tram to new face	1.20 minutes
2	Position loader into "shot" coal	.27
3	Load coal to conveyor capacity and wait for #1 shuttle car	.65
4	Discharge coal from loader to #1 shuttle car	1.35
5	Load coal and wait for #2 shuttle car	1.10
6	Discharge coal from loader to #2 shuttle car	1.40
7	Position loader back	.20
8	Position loader in and right	.27
9	Load and discharge coal to #1 shuttle car	1.20
10	Load coal and wait for #2 shuttle car	1.27
11	Load and discharge coal to #2 shuttle car	1.30
12	Position loader out	.30
13	Position loader in and right -- position #1 shuttle car in -- load and discharge	1.40

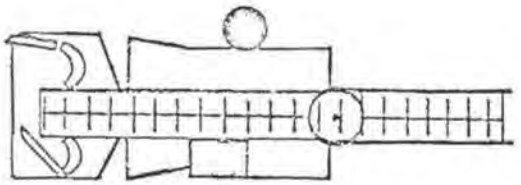
Sketch Number	Illustration	Typical Time
14	Load coal and wait for #2 shuttle car	1.70
15	Load coal and discharge to #2 shuttle car	1.30
16	Position loader back	.29
17	Position loader in and right -- position #1 shuttle car in -- load and discharge (left floor clean-up)	.40
18	Reposition out and in -- right both loader and #1 shuttle car	.49
19	Load and discharge (center floor clean-up)	.50
20	Reposition out and in -- right both loader and #1 shuttle car	.60
21	Load and discharge (right floor clean-up)	.70
22	Position loader out -- shuttle car away	.37
23	Tram 90 feet to new face	1.50

THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

1 Tram to new face 1.20 minutes

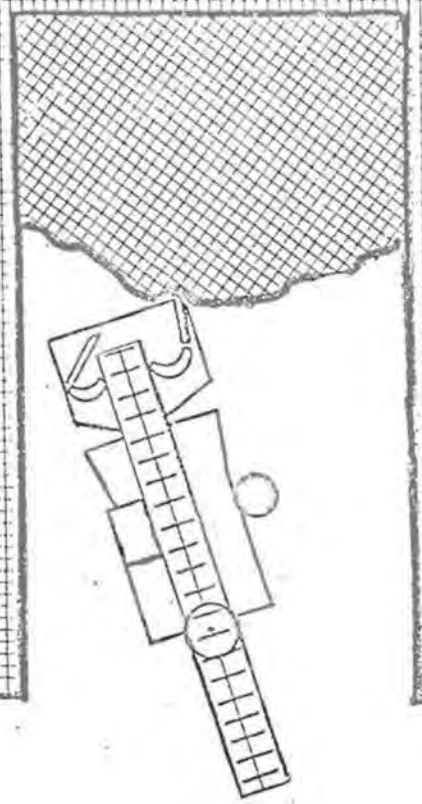




THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

2 Position loader into "shot" coal .27



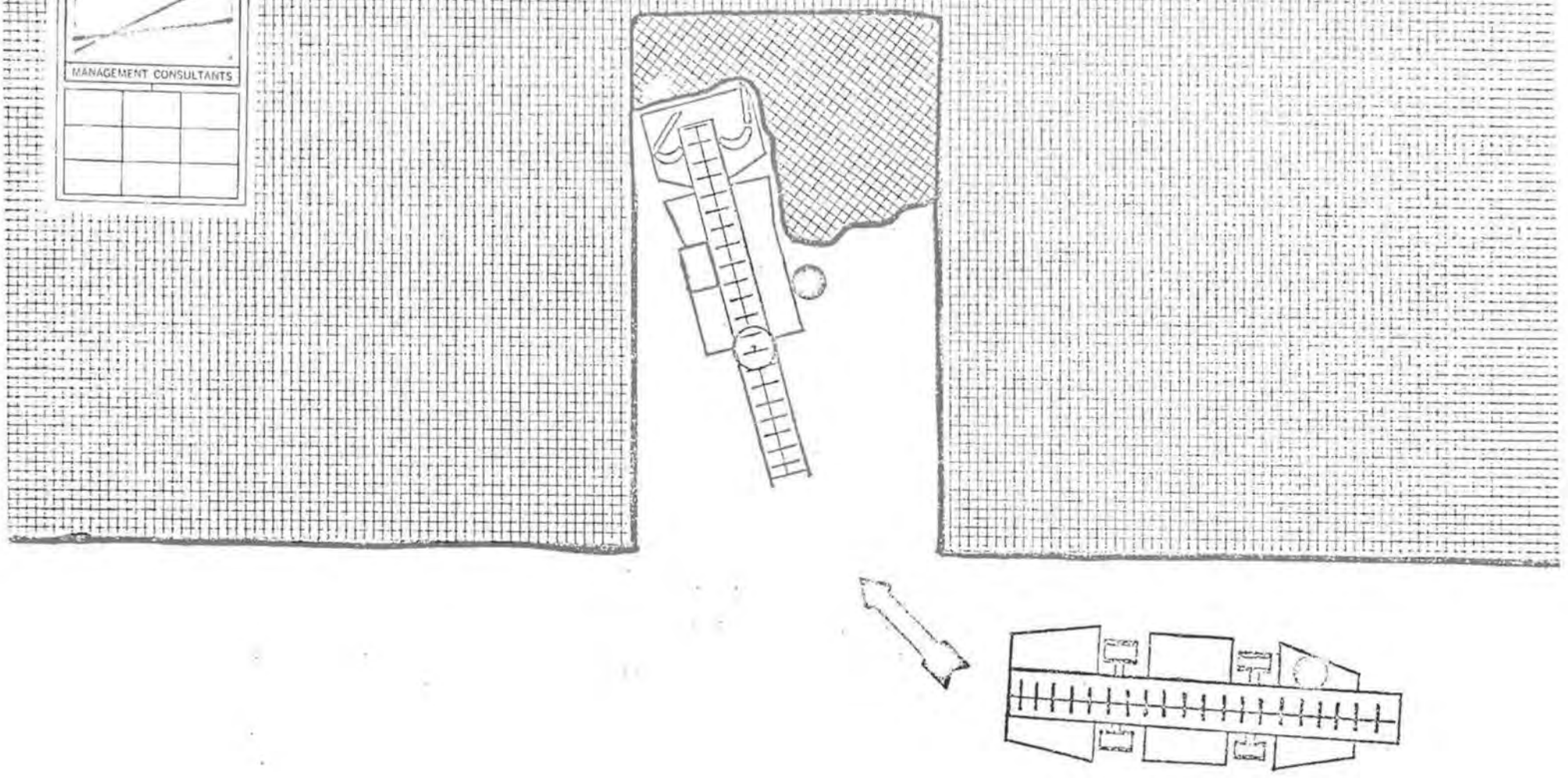
THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

3

Load coal to conveyor capacity and wait for # shuttle car

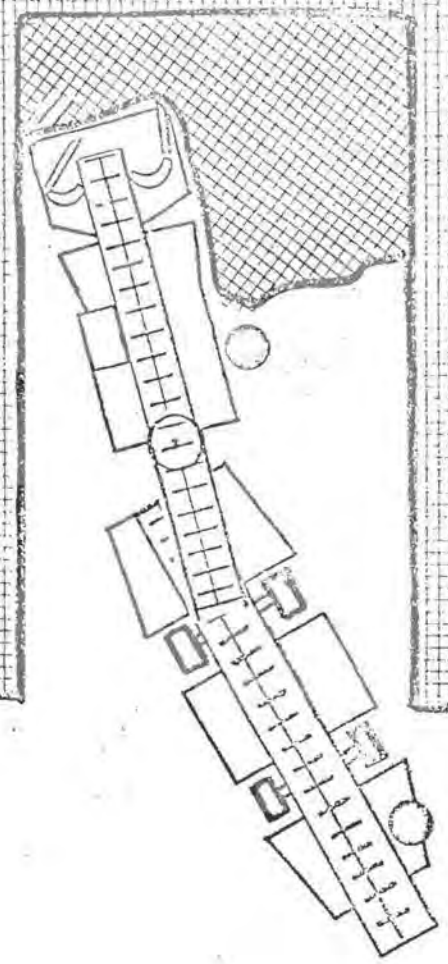
.65



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

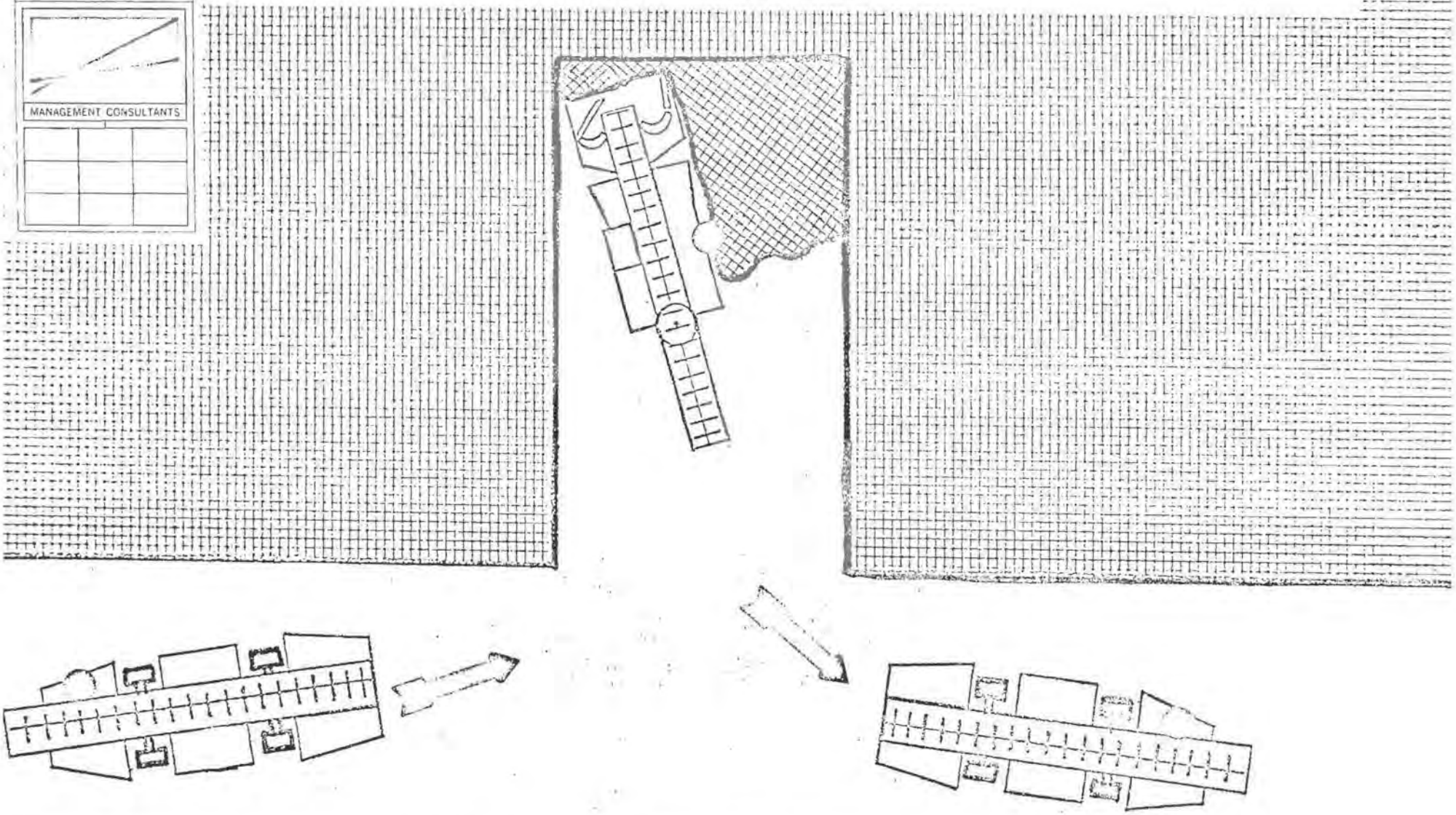
4	Discharge coal from loader to #1 shuttle car	1.35



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

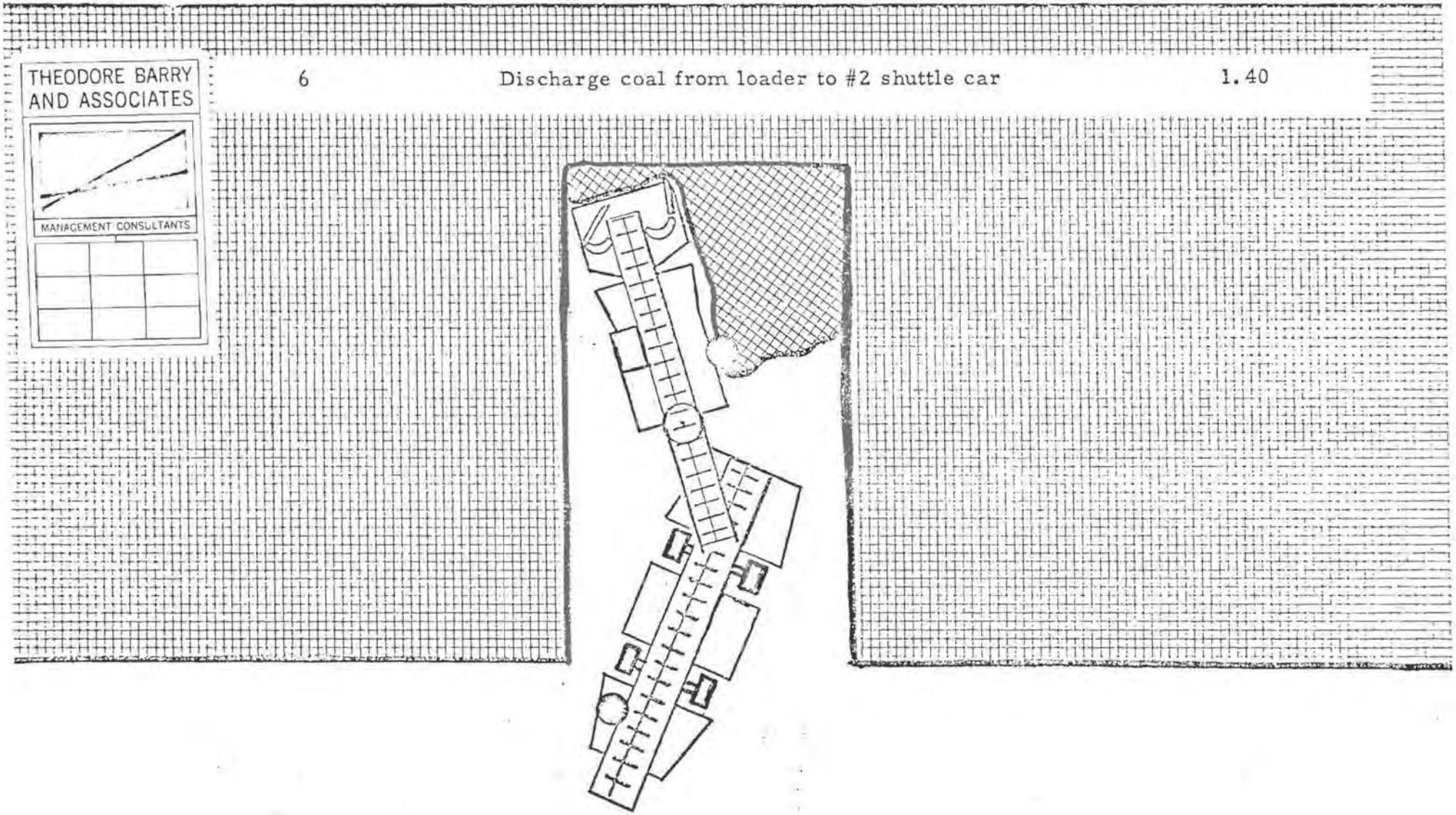
5 Load coal and wait for #2 shuttle car 1.10



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

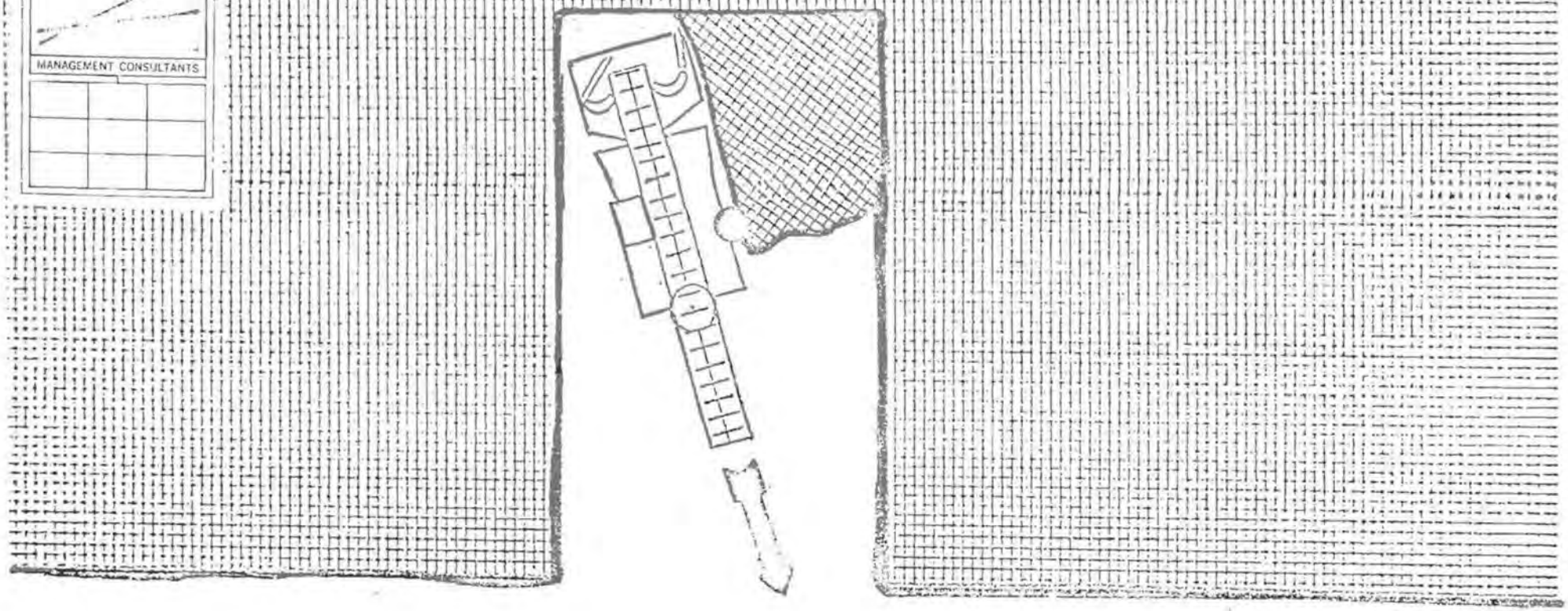
6 Discharge coal from loader to #2 shuttle car 1.40

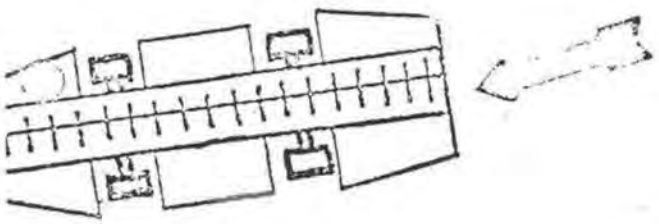


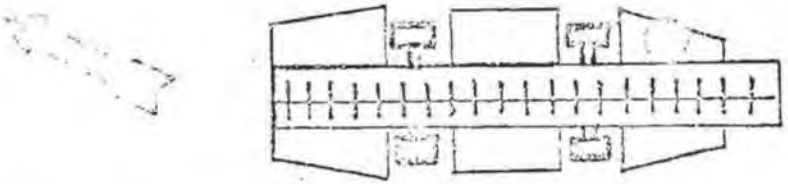
THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

7 Position loader back .20



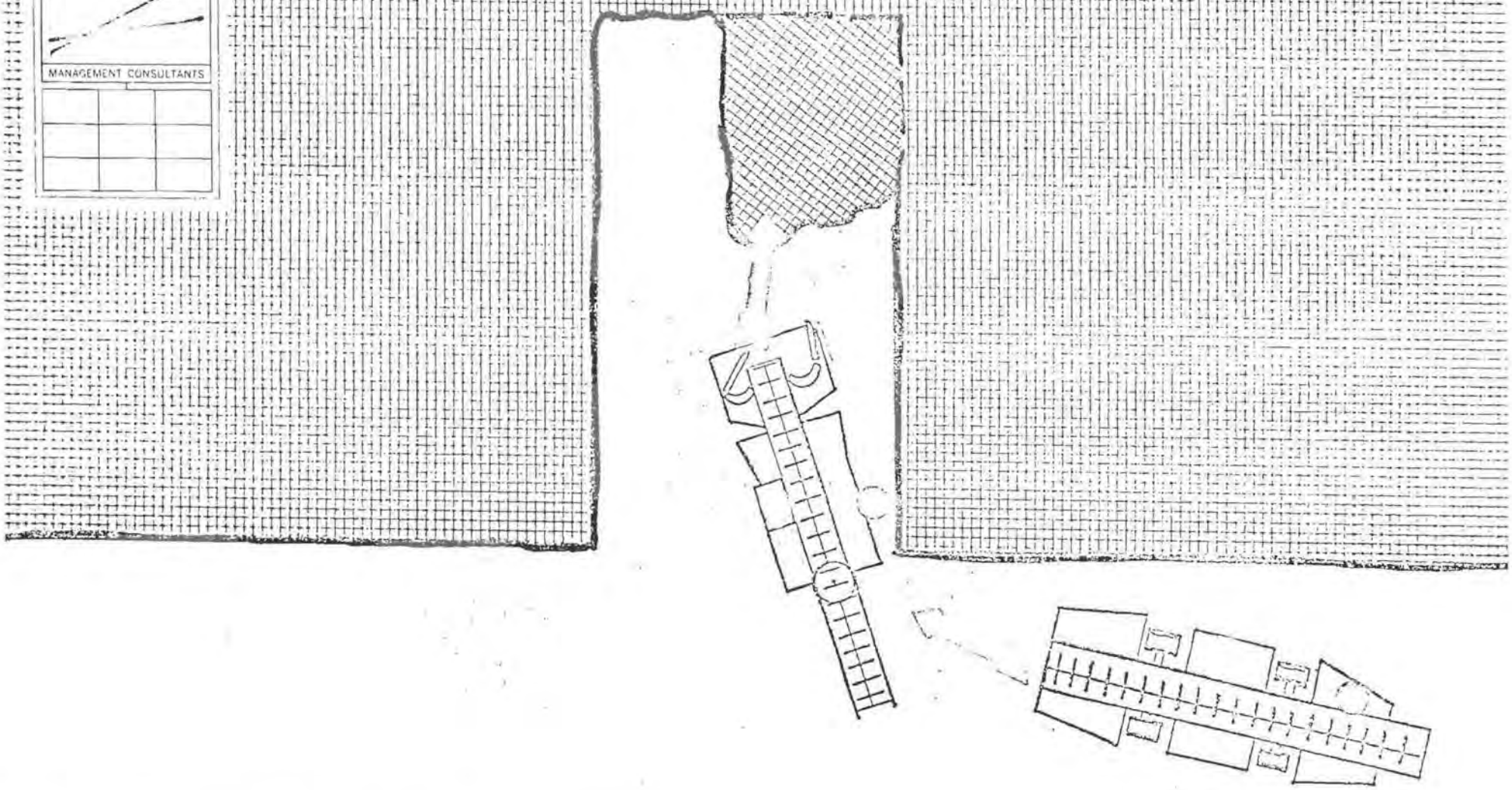




THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

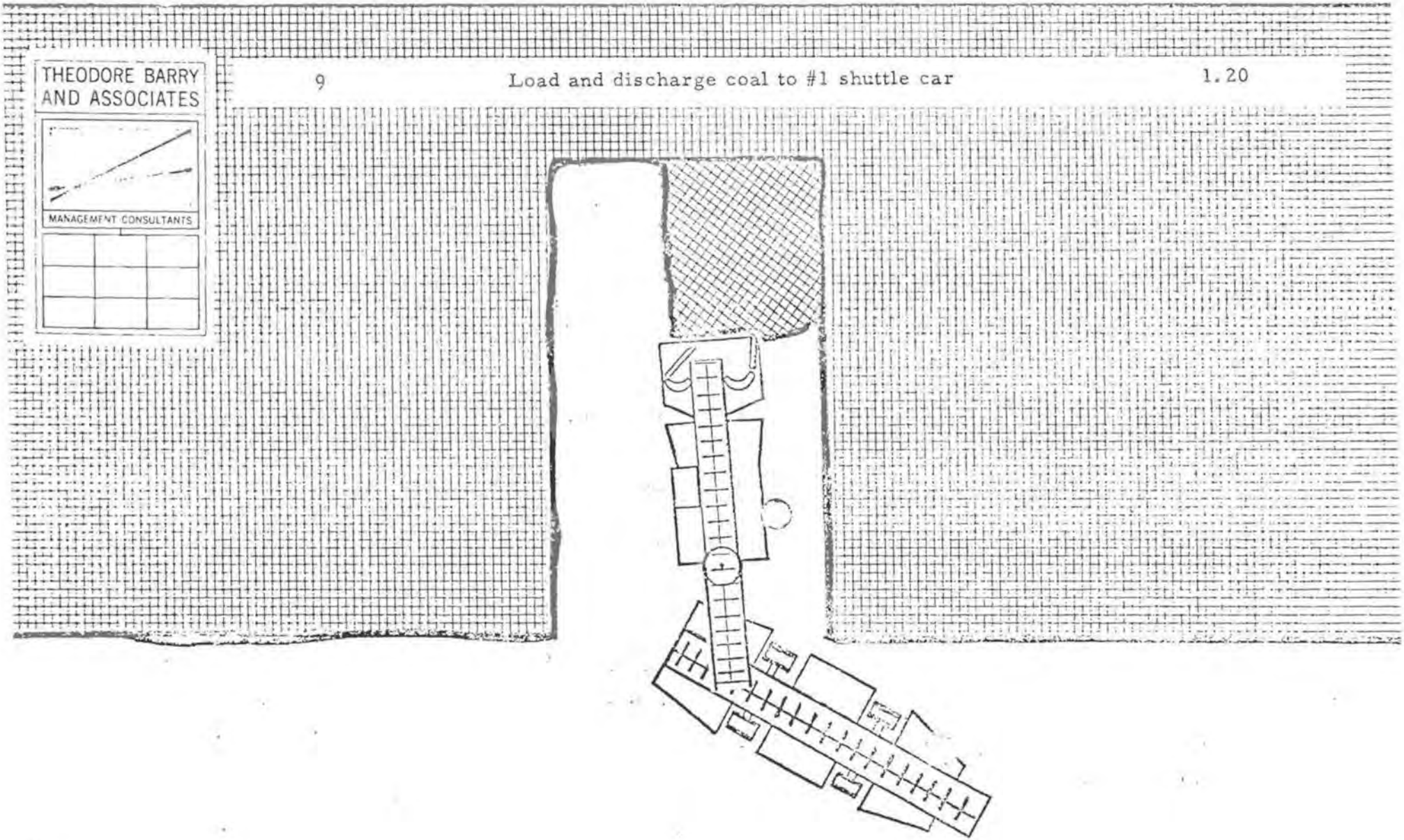
8 Position loader in and right .27



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

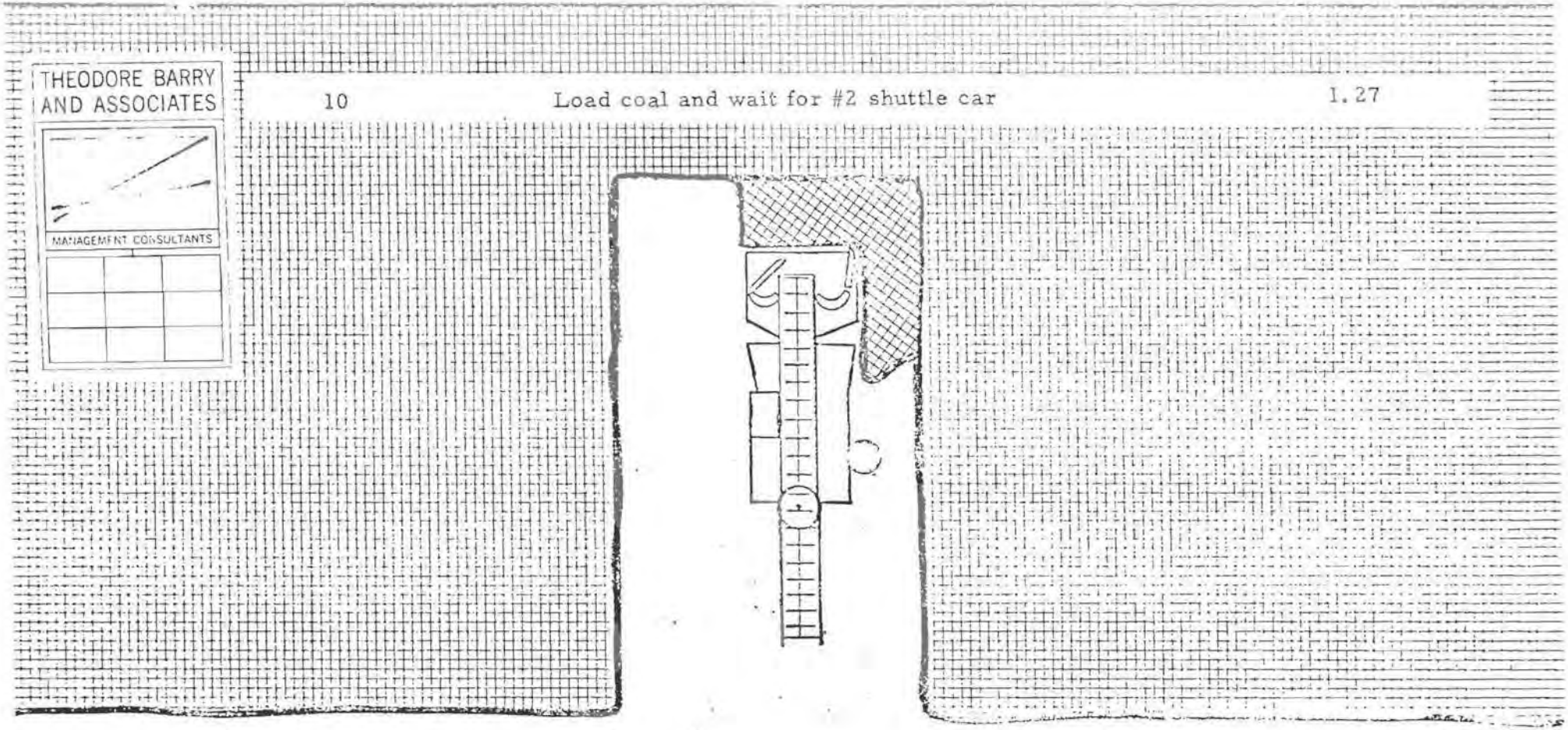
9 Load and discharge coal to #1 shuttle car 1.20

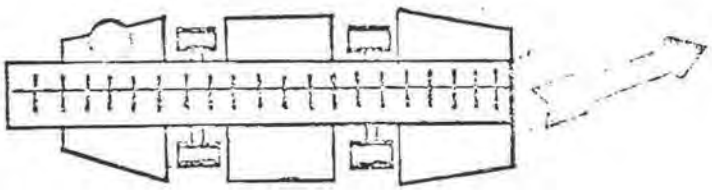


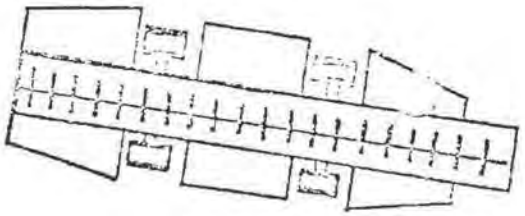
THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

10 Load coal and wait for #2 shuttle car 1.27



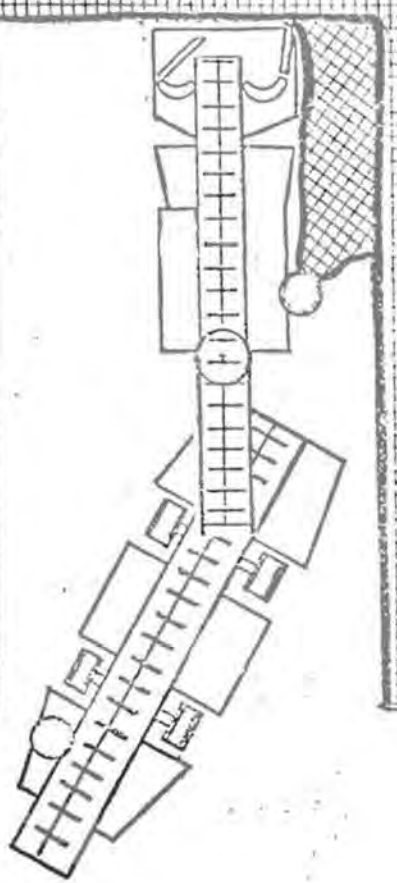




THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

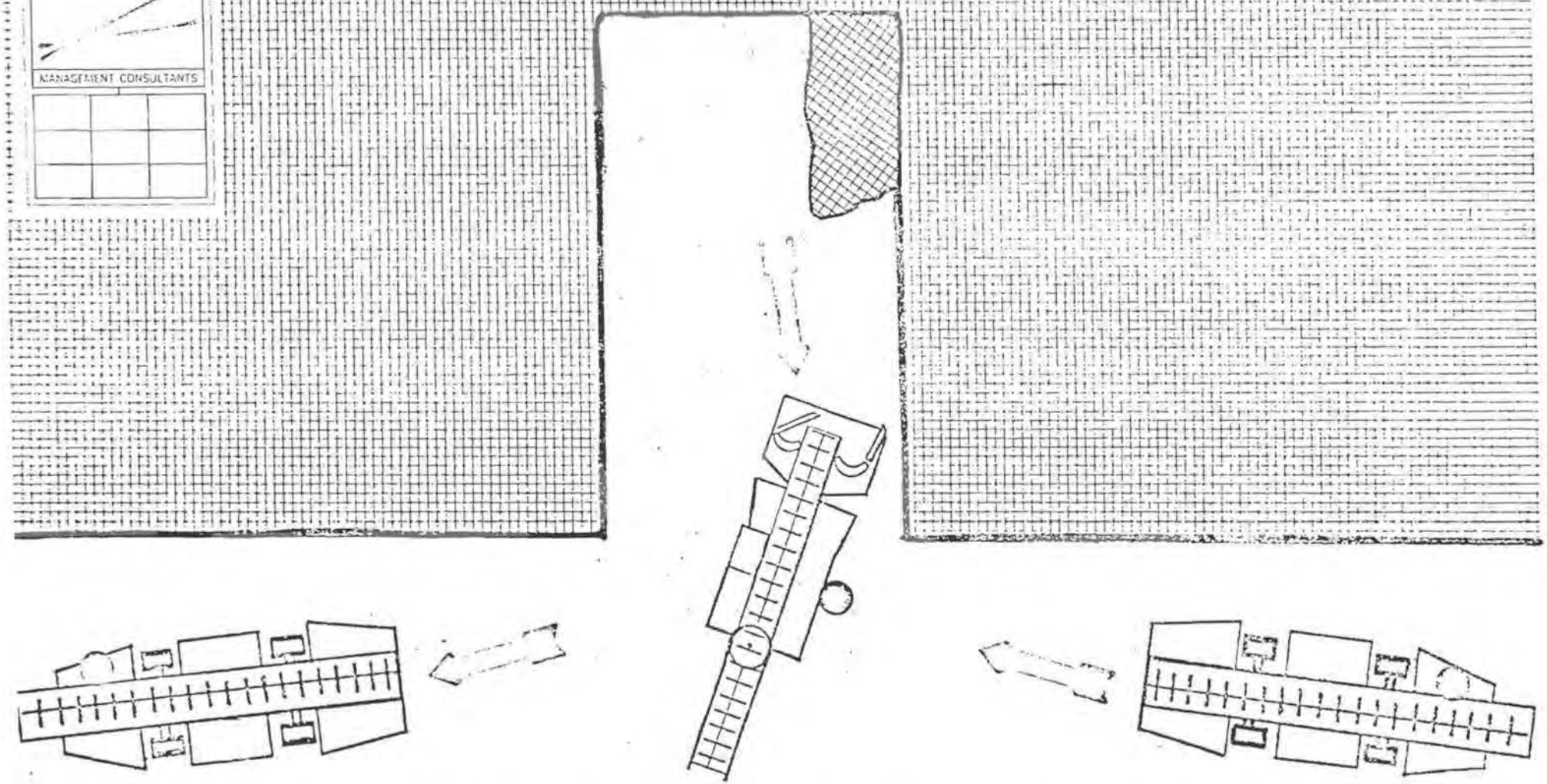
11 Load and discharge coal to #2 shuttle car 1.30



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

12 Position loader out .30



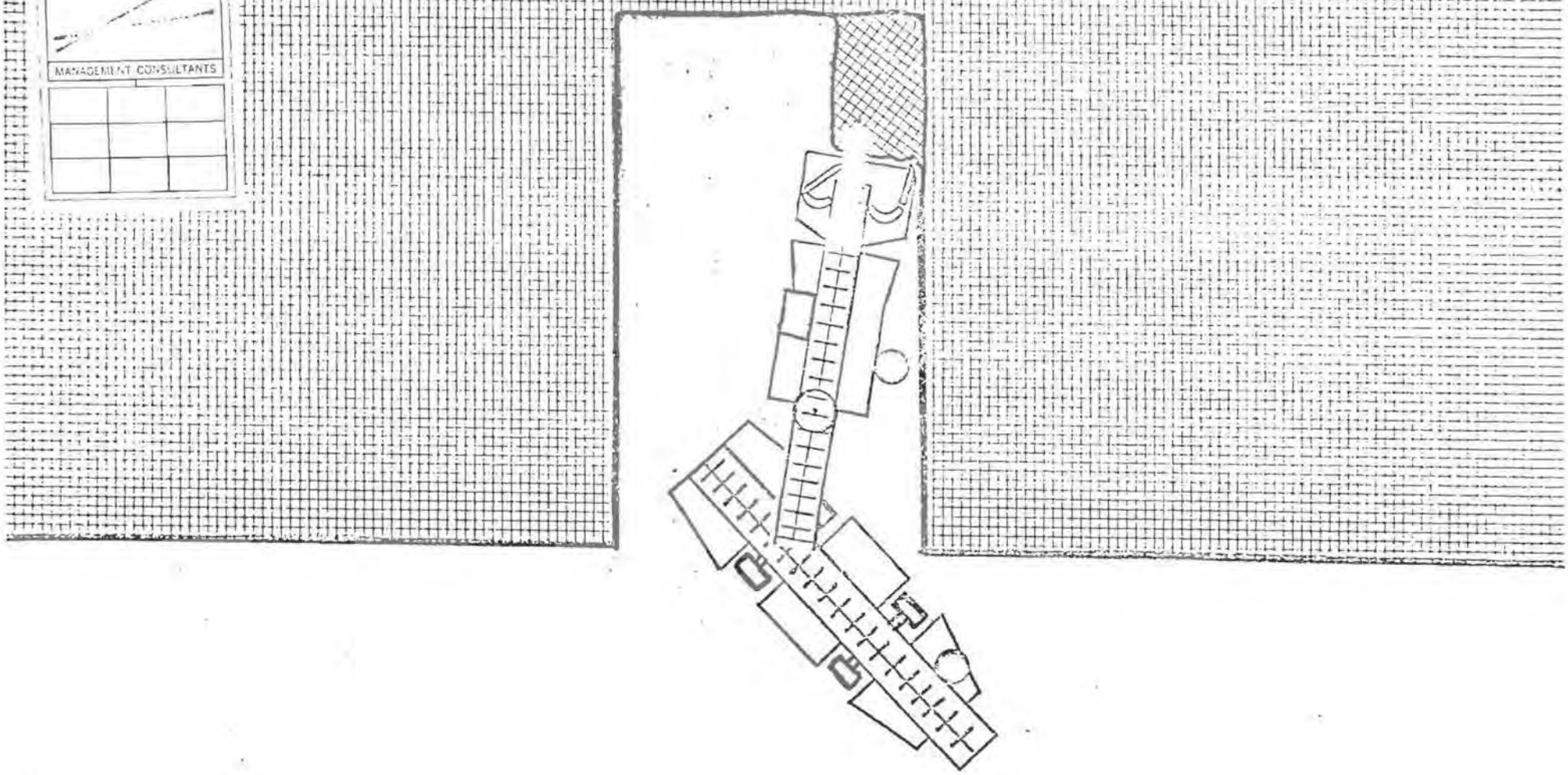
THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

13

Position loader in and right -- position #1 shuttle car in -- load and discharge

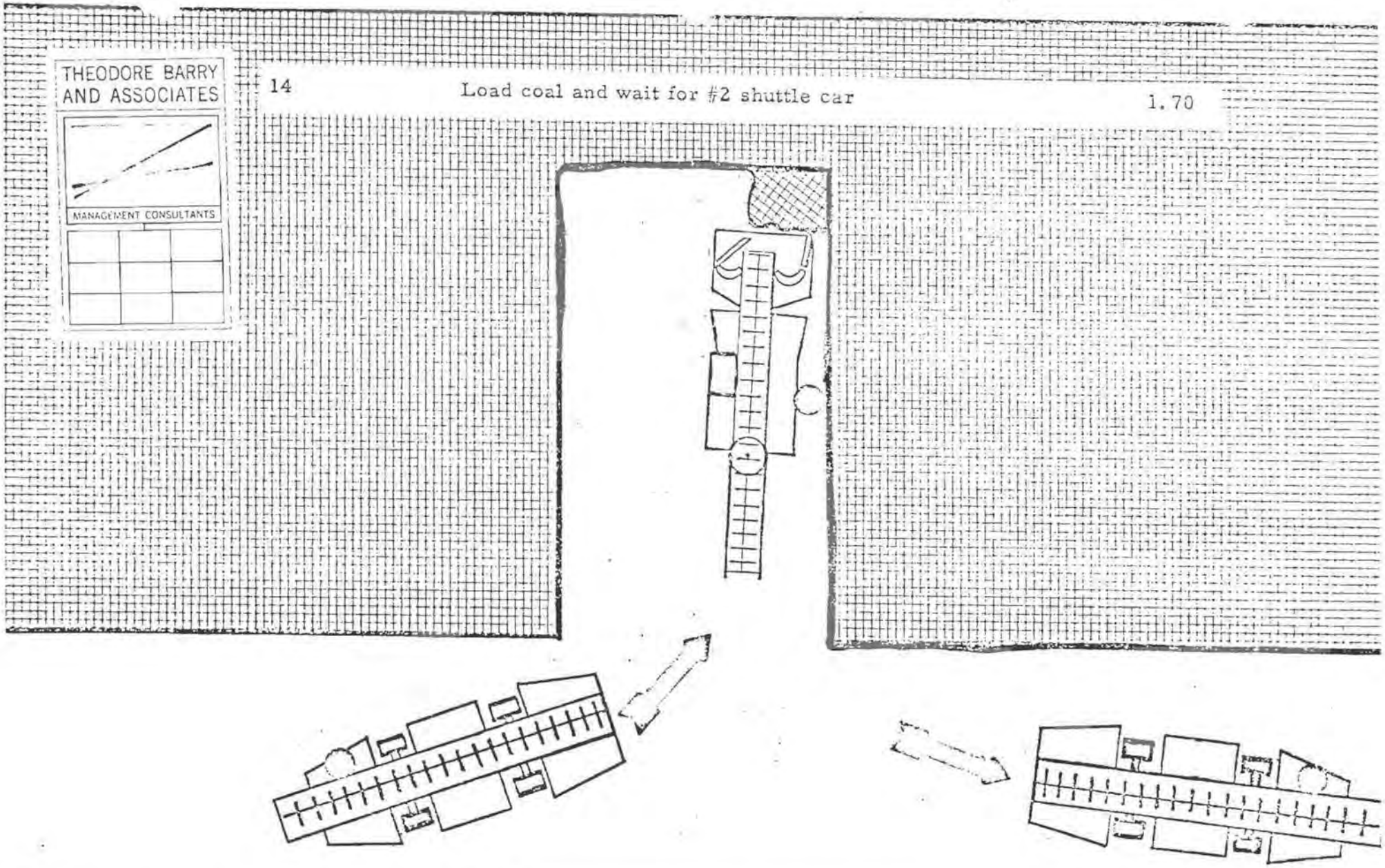
1.40



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

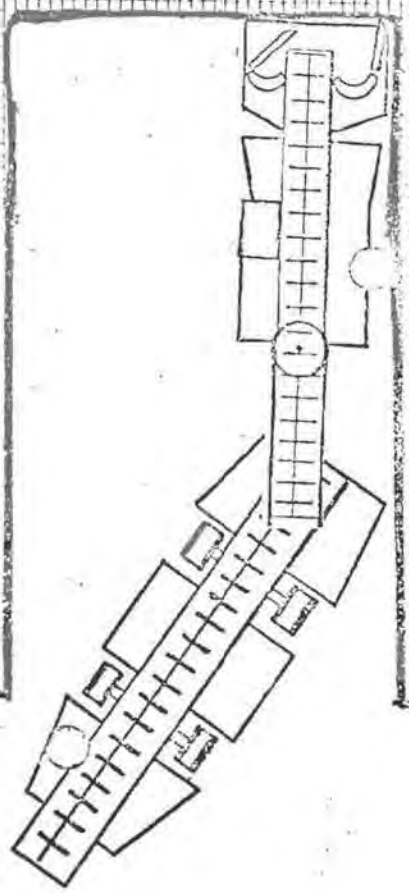
14 Load coal and wait for #2 shuttle car 1.70



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

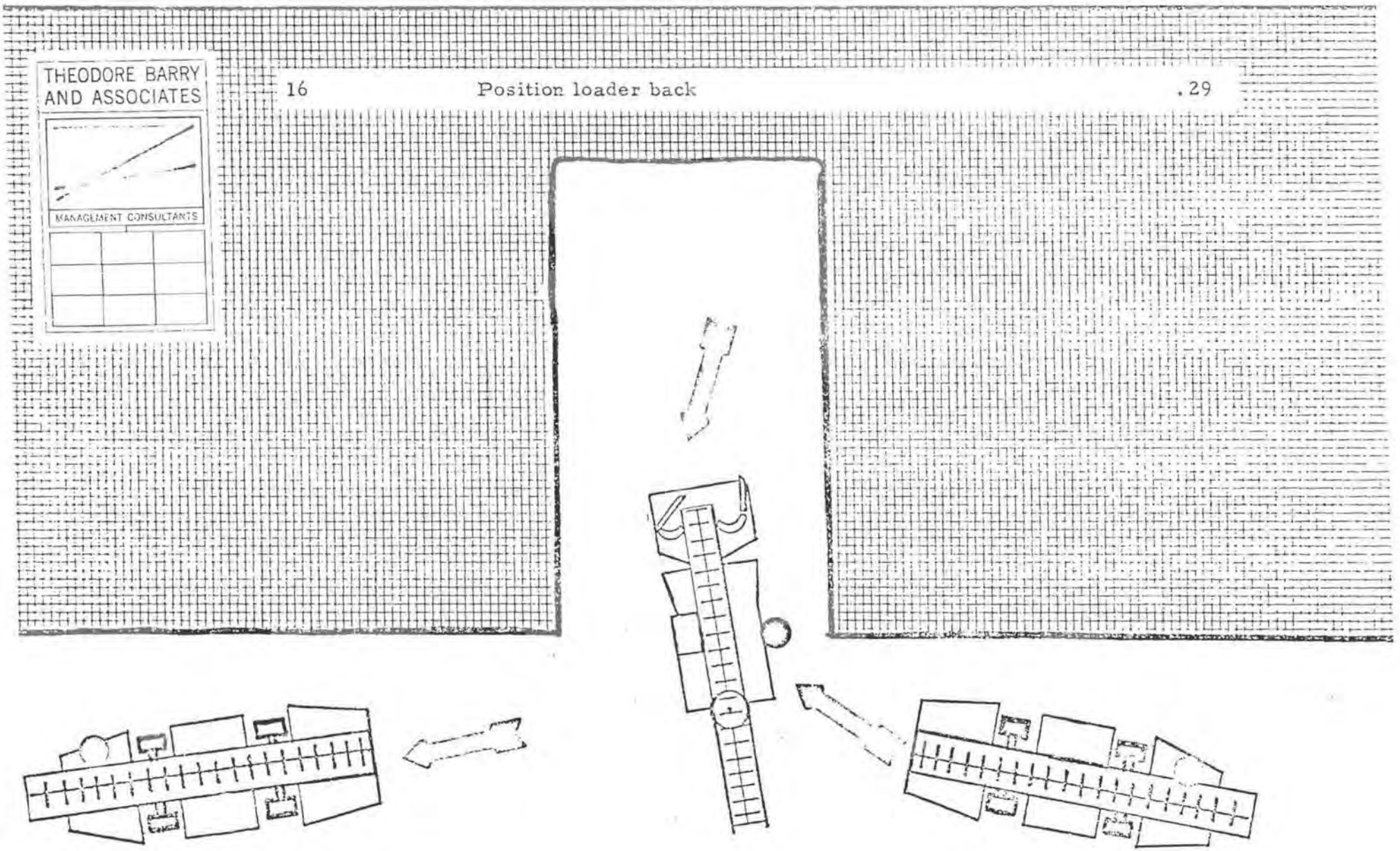
15 Load coal and discharge to #2 shuttle car 1.30



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

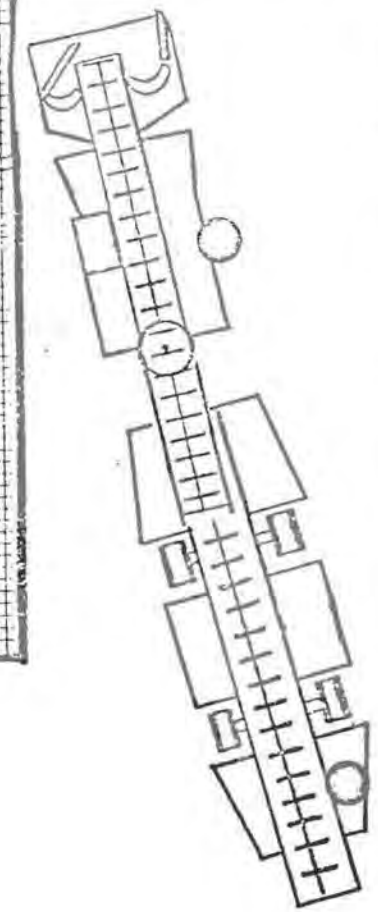
16 Position loader back .29



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

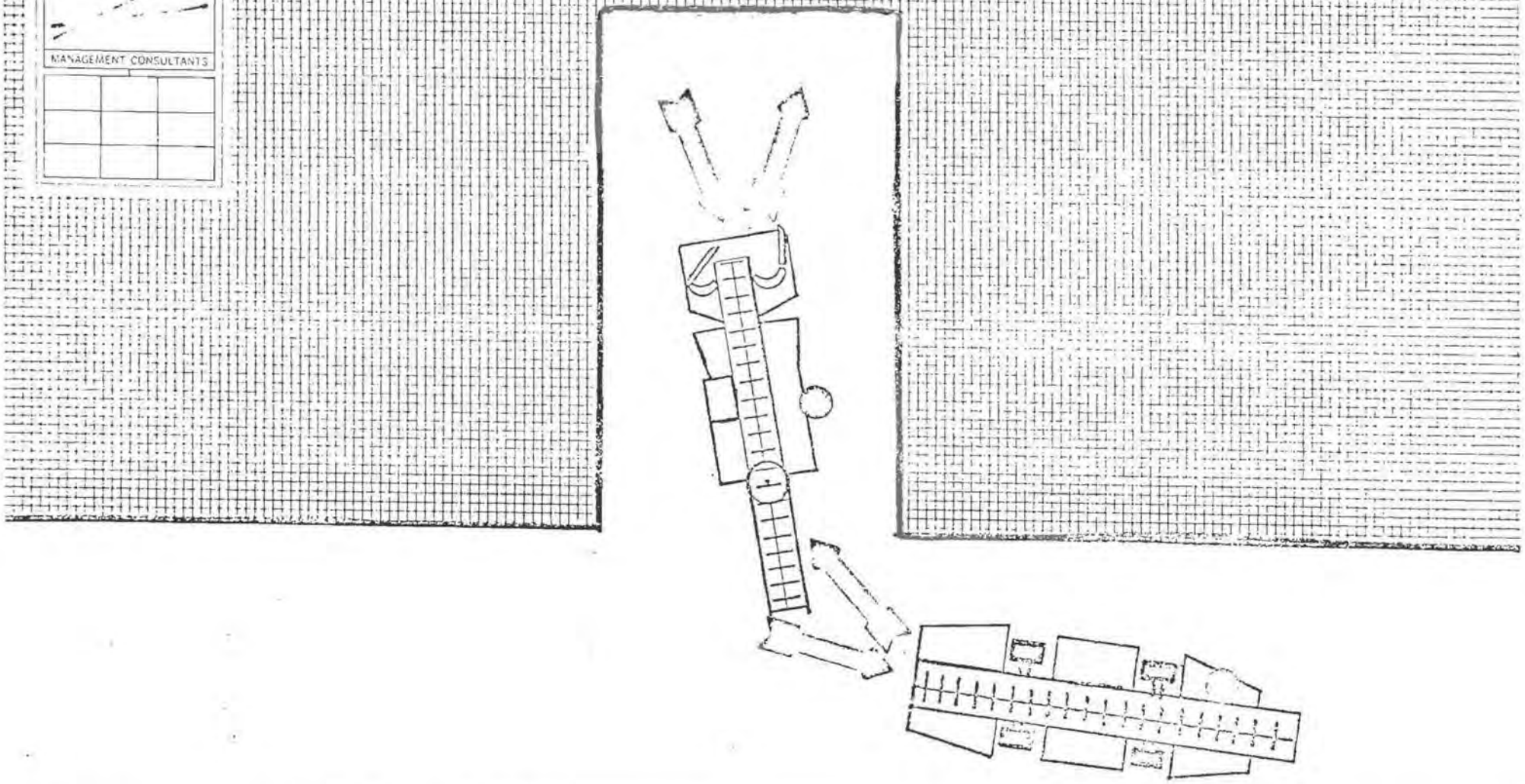
17 Position loader in and right -- position #1 shuttle car in -- load and discharge (left floor clean-up) .40



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

18 Reposition out and in -- right both loader and #1 shuttle car .49



THEODORE BARRY AND ASSOCIATES

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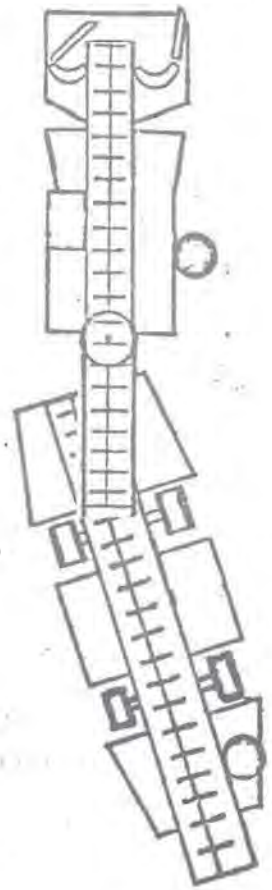
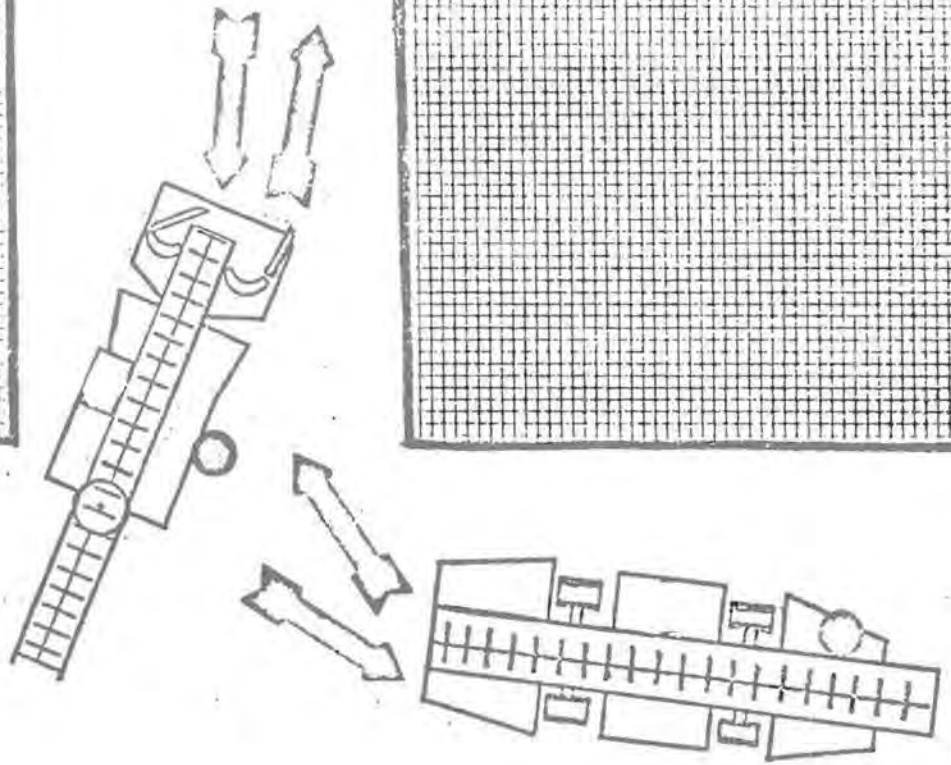
19 Load and discharge (center floor clean-up) .50



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

20 Reposition out and in -- right both loader and #1 shuttle car .60



THEODORE BARRY AND ASSOCIATES

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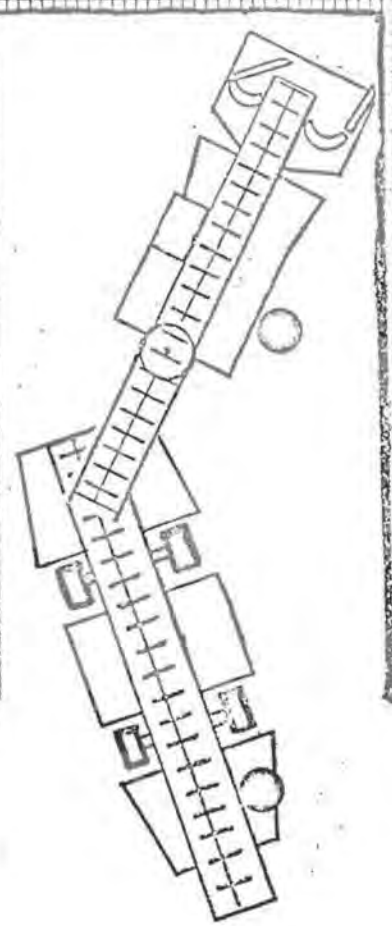
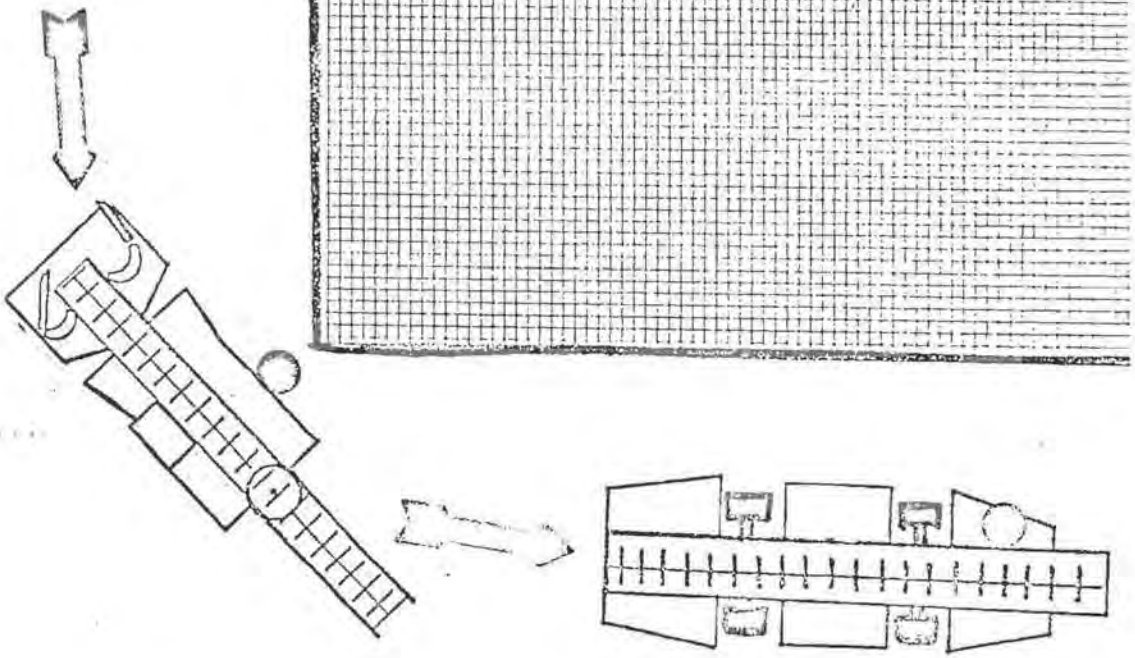
21 Load and discharge (right floor clean-up) .70



THEODORE BARRY AND ASSOCIATES

MANAGEMENT CONSULTANTS

22 Position loader out -- shuttle car away .37



THEODORE BARRY AND ASSOCIATES

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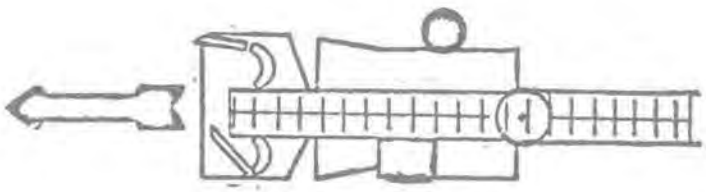
23 Tram 90 feet to new face 1.50



ROOF BOLTING

Sketch Number	Illustration	Typical Tir
1	Tram 90 feet to new face	1.35 min
2	Test and scale roof, move first post forward and methane test	1.70
3	Test and scale roof and move first post forward and methane test	2.10
4	Position roof bolter in right, drill and bolt first hole. (This operation includes first drill and rebit, second drill and rebit, third drill, remove drills, bend and insert bolt, tighten bolt and torque check.)	3.60
5	Test roof, scale and move second post	1.80
6	Position roof bolter back-right	.41
7	Position roof bolter in, drill and bolt second hole	3.60
8	Position roof bolter out-right	.30
9	Position roof bolter in-right, drill and bolt third hole	3.60
10	Position roof bolter out-left	.35
11	Test and scale roof and reposition third post in	2.05
12	Position roof bolter in, drill and bolt fourth hole	3.60
13	Position roof bolter out-right	.40

Sketch Number	Illustration	Typical Time
14	Position roof bolter in, test and scale roof, and move first post forward	1.10
15	Test and scale roof and move second post forward	.90
16	Test and scale roof and move third post forward	.80
17	Position roof bolter in, drill and bolt fifth hole	3.60
18	Position equipment out	.40
19	Position equipment in, drill and bolt sixth hole	3.60
20	Position roof bolter out	.28
21	Position roof bolter in, drill and bolt seventh hole	3.60
22	Position roof bolter out	.25
23	Position roof bolter in, drill and bolt eighth hole	3.60
24	Remove post (and headers)	.10
25	Remove post	.15
26	Remove post	.30
27	Stack posts at one side of entry for next cycle	.30
28	Empty dust box	1.00
29	Tram 90 feet to new face	1.00

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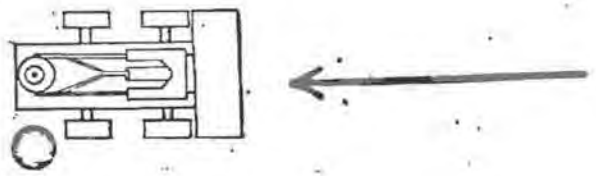
1 Tram 90 feet to new face 1.35 mi



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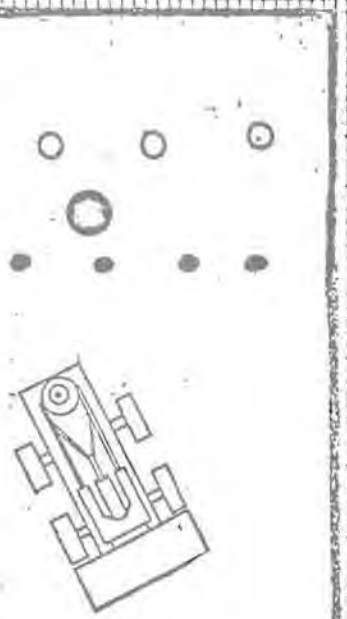
2 Test and scale roof 1.70



THEODORE BARRY AND ASSOCIATES

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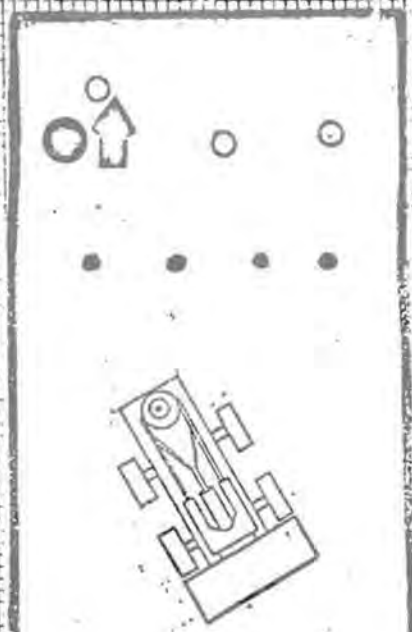
3 Test and scale roof and move first post forward and methane test 2.10



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4 Position roof bolter in right and drill and bolt first hole. (This operation includes first drill and rebit, second drill and rebit, third drill, remove drills, and bend and insert bolt, tighten bolt and torque check.) 3.60

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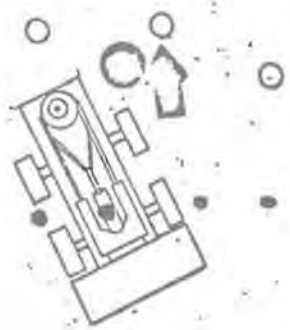
5 Test roof, scale and move second post 1.80



THEODORE BARRY AND ASSOCIATES

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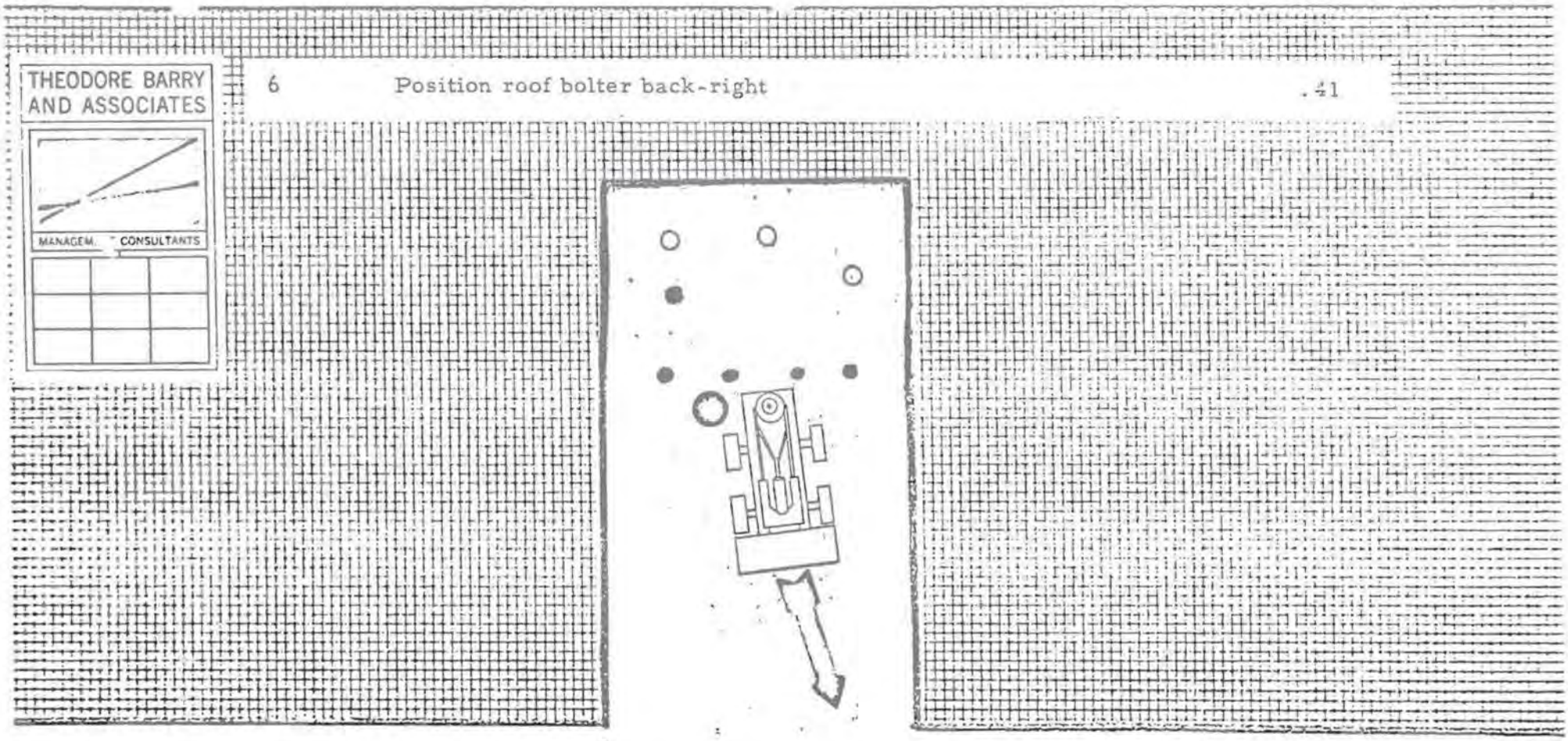
6 Position roof bolter back-right .41



THEODORE BARRY AND ASSOCIATES

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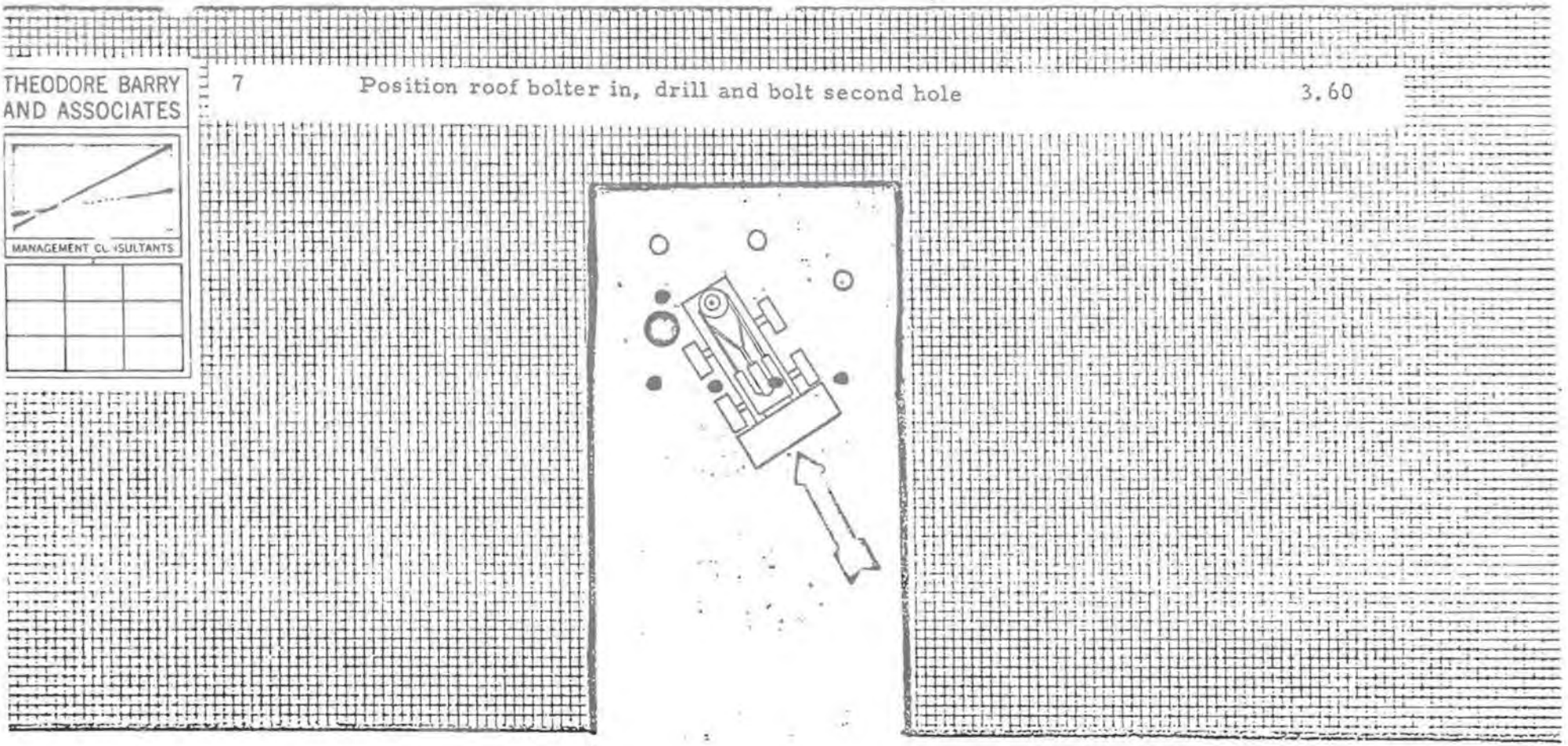
7 Position roof bolter in, drill and bolt second hole 3.60



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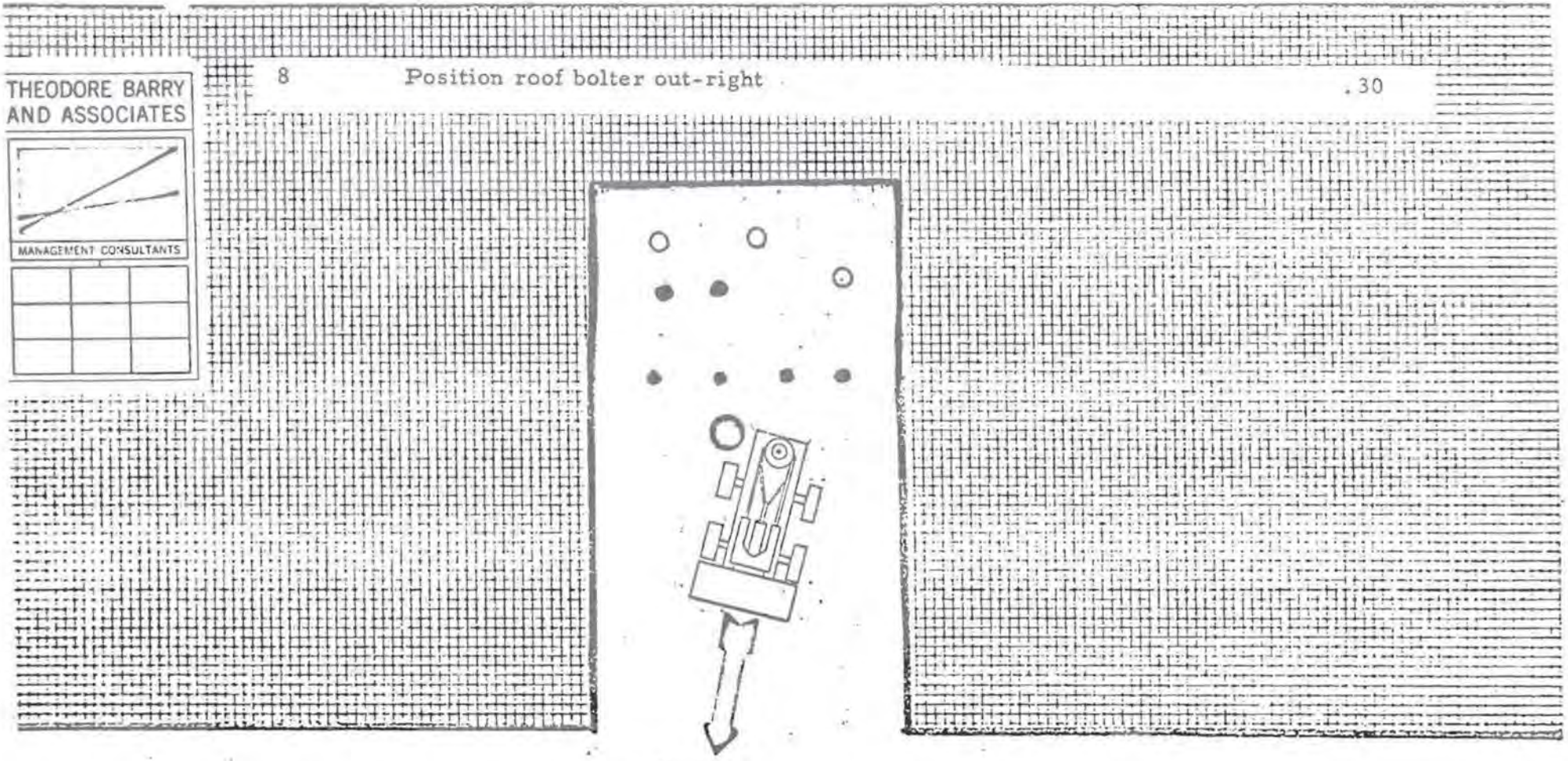
8 Position roof bolter out-right .30



THEODORE BARRY AND ASSOCIATES

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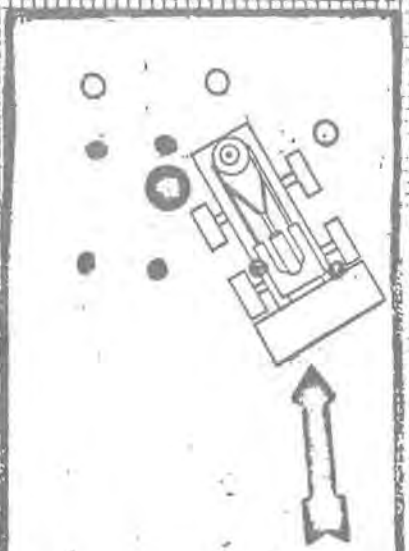
9 Position roof bolter in-right, drill and bolt third hole 3.60



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10 Position roof bolter out-left .35

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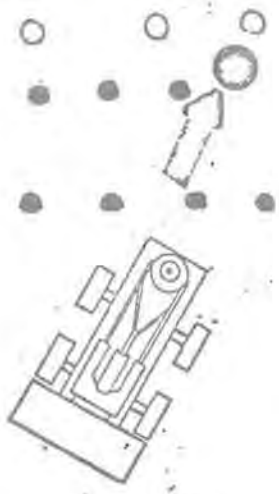
11 Test and scale roof and reposition third post in 2.05



THEODORE BARRY AND ASSOCIATES

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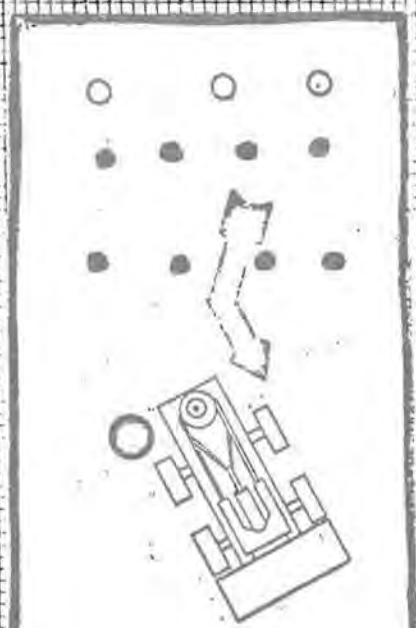
12 Position roof bolter in, drill and bolt fourth hole 3.60



THEODORE BARRY AND ASSOCIATES

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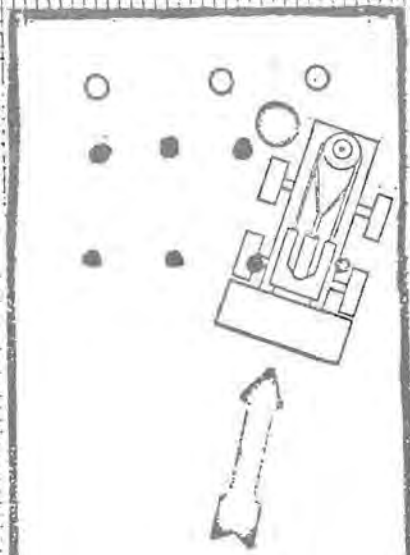
13 Position roof bolter out-right .40



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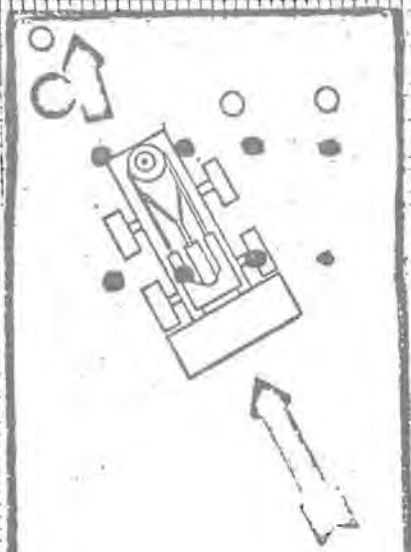
14 Position roof bolter in, test and scale roof, and move first post forward 1.10



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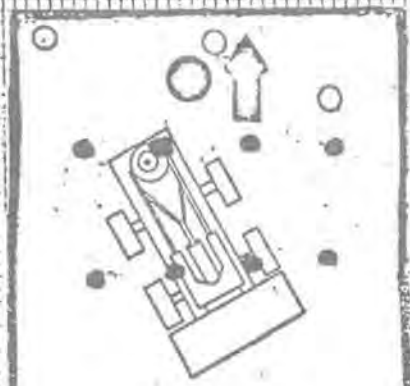
15 Test and scale roof and move second post forward .90



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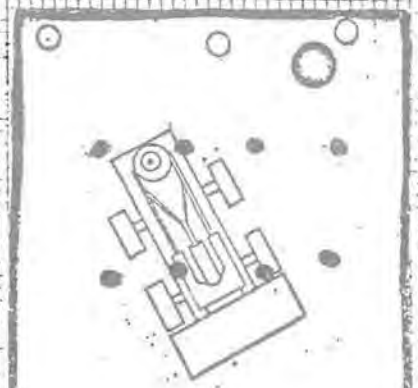
16 Test and scale roof and move third post forward .80



THEODORE BARRY AND ASSOCIATES

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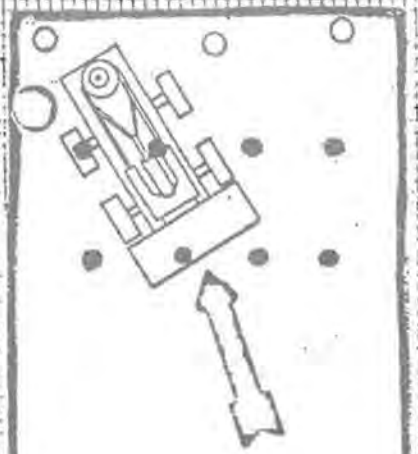
17 Position roof bolter in, drill and bolt fifth hole 3.60



THEODORE BARRY AND ASSOCIATES

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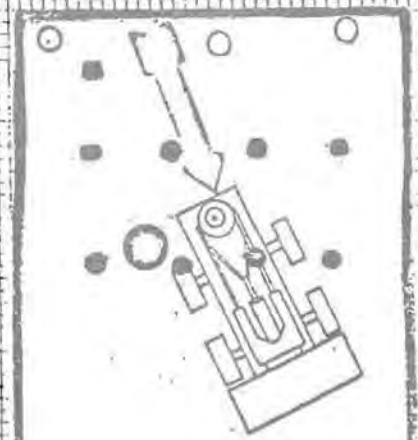
18 Position equipment out

.40



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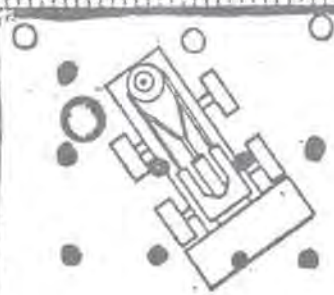
19 Position equipment in, drill and bolt sixth hole 3.60



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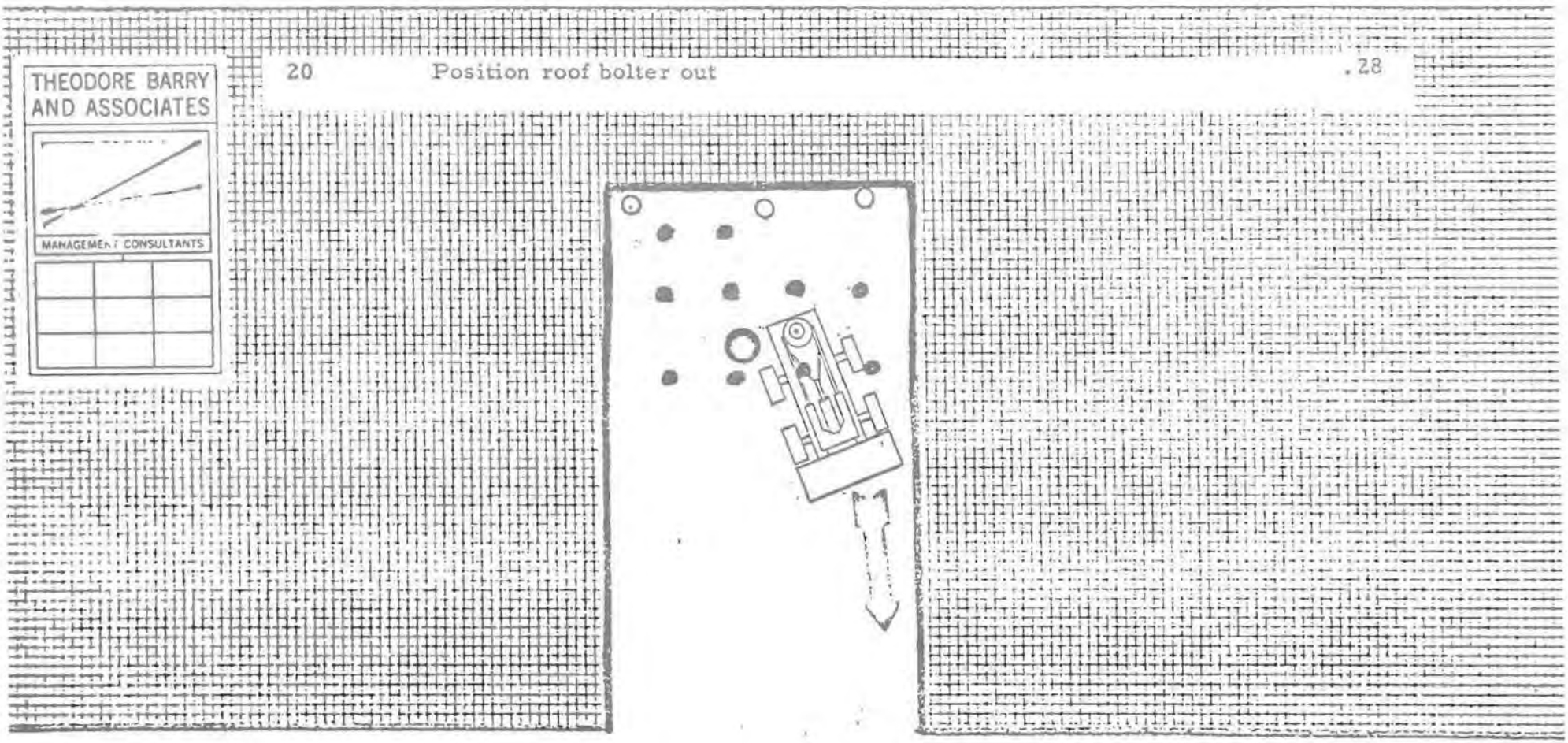
20 Position roof bolter out .28



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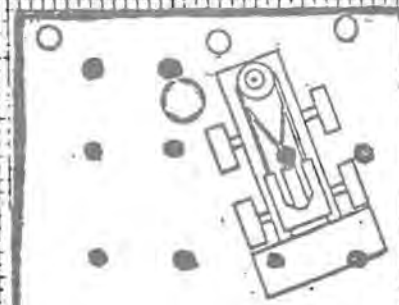
21 Position roof bolter in, drill and bolt seventh hole 3.60



THEODORE BARRY AND ASSOCIATES

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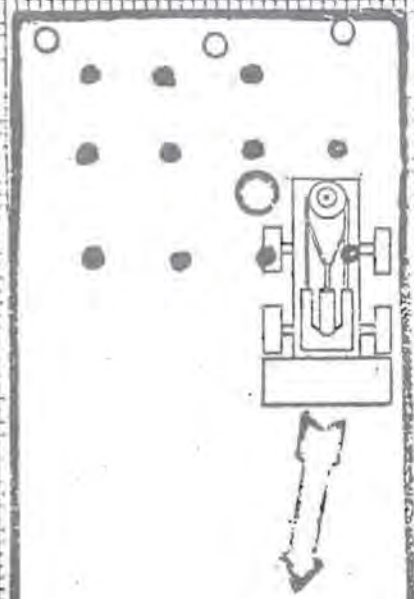
22 Position roof bolter out .25



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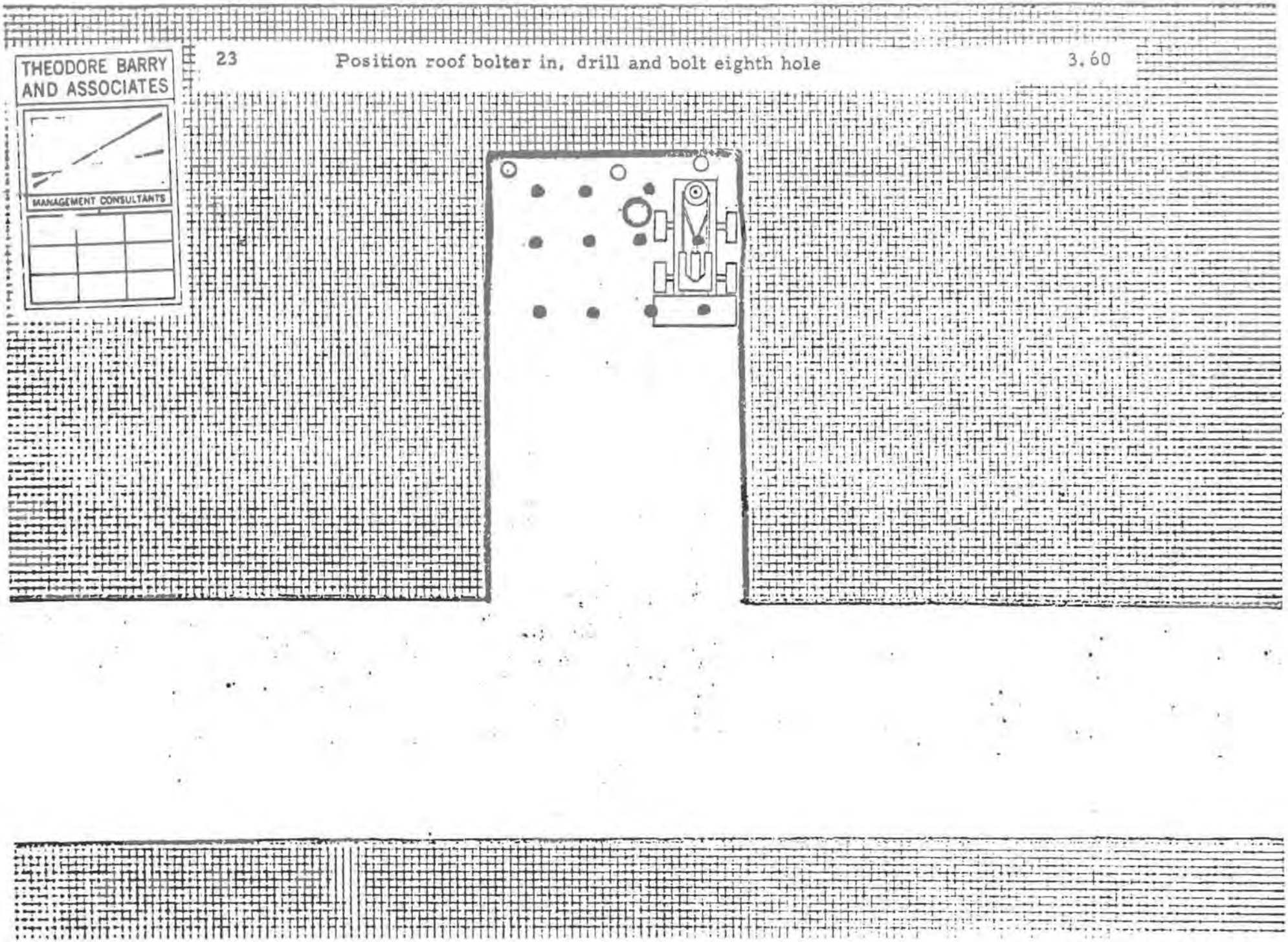
23 Position roof bolter in, drill and bolt eighth hole 3.60



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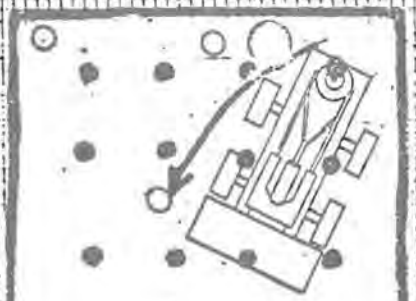
24 Remove post (and headers) .10



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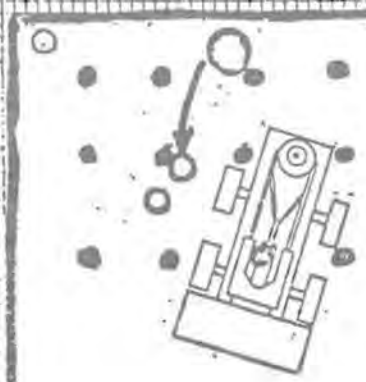
25 Remove post .15



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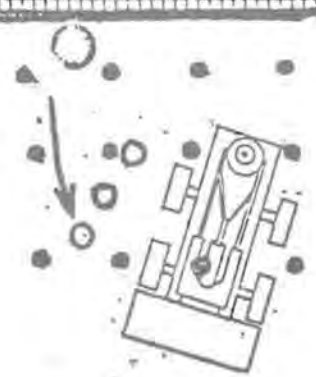
26 Remove post .30



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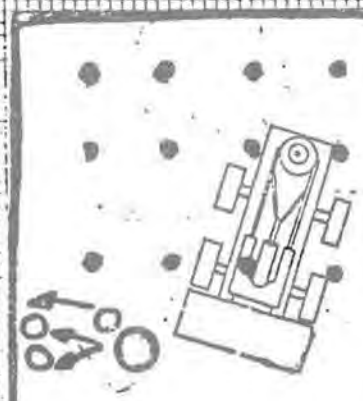
27 Stack posts at one side of entry for next cycle .30



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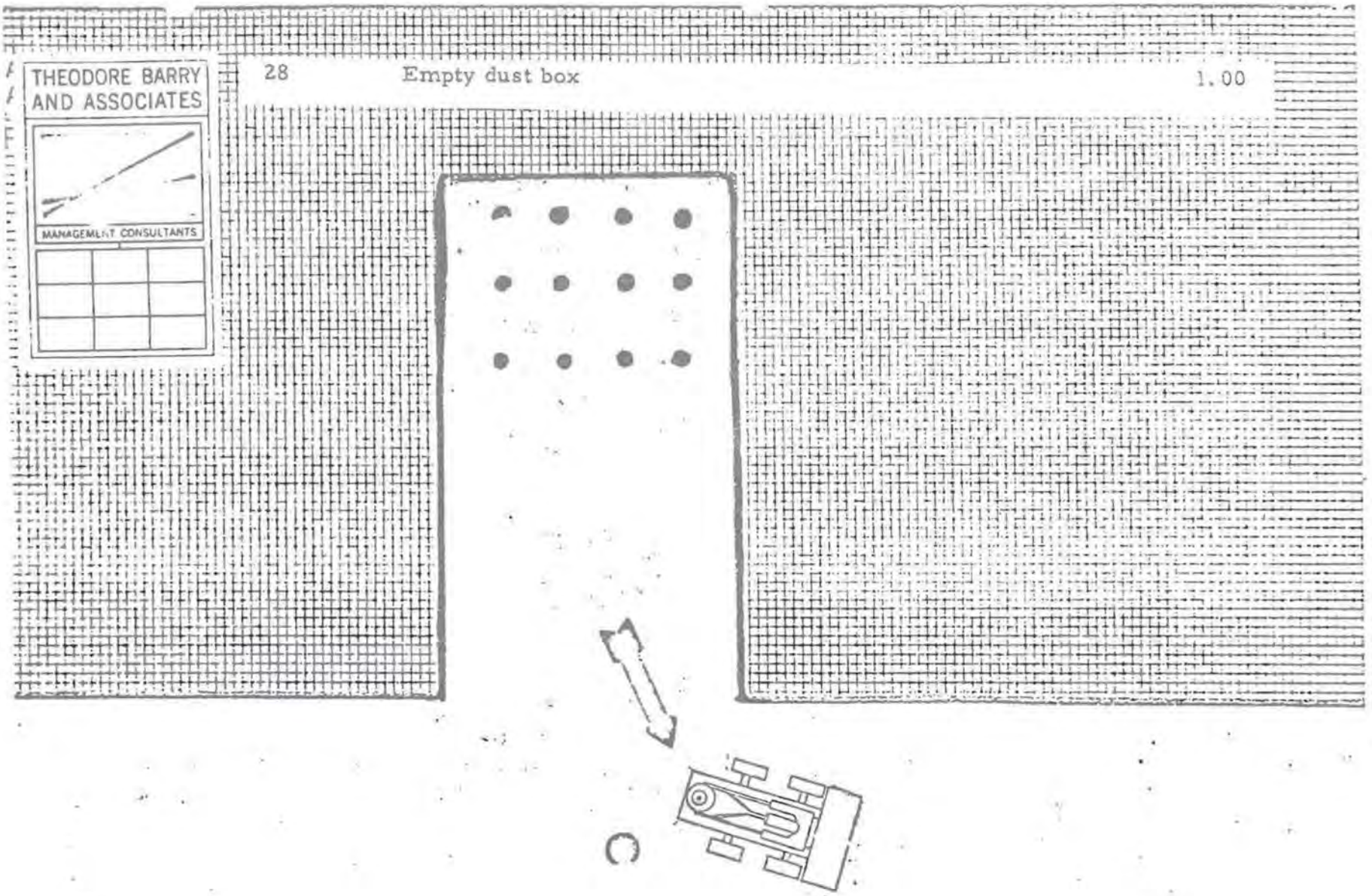
28 Empty dust box 1.00



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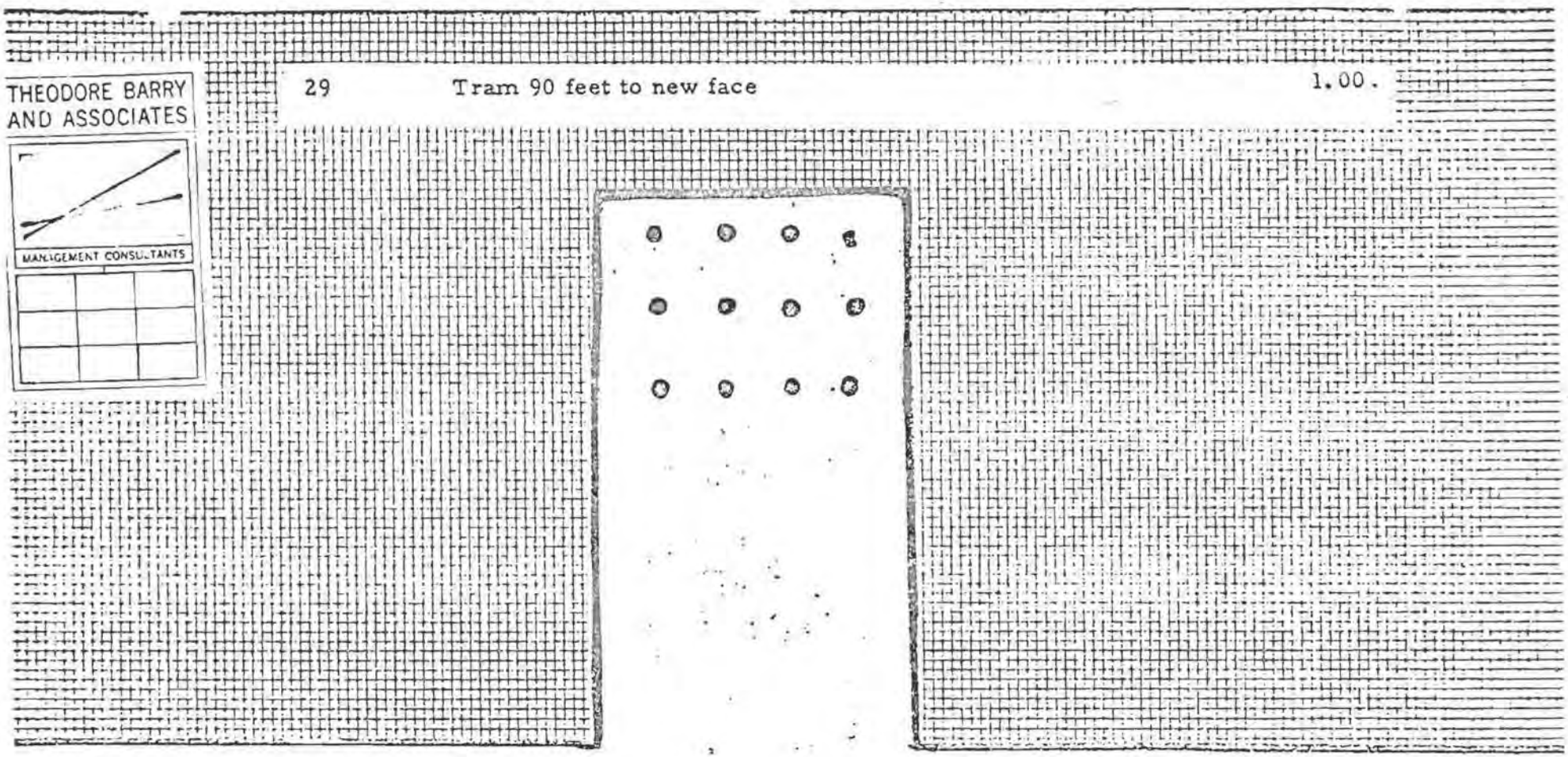
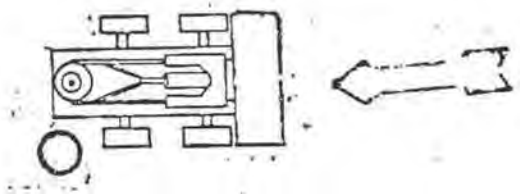
29 Tram 90 feet to new face 1.00.





CONTINUOUS MINING OPERATIONS

- The overall mining cycle for continuous mining is too simple to warrant a series of mining style sketches.

- The continuous miner proceeds first, serviced by the shuttle cars which haul the coal to the main haulage device. After the continuous miner completes the cut and trams to a new face, it is followed by the roof bolter.

- The roof bolting method of operation in continuous mining is the same as already shown in conventional mining. The only difference is the number of bolts inserted: 16-20 in a continuous mining bolting cycle as opposed to 6-8 in the conventional cycle. Therefore, the roof bolting operation is not repeated here.

- During idle time while waiting for the arrival of a shuttle car, the operator may brush the roof, brush the floor, or clean-up the ribs with the cutting drum of the machine.

CONTINUOUS MINING OPERATIONS

Sketch Number	Illustration	Typical Time
1	Tram to new face	4.05 minutes
2	Position C.M. into face -- left	1.60
3	Mine and load #1 shuttle car	2.45
4	Reposition and wait for #2 shuttle car	1.10
5	Mine and load #2 shuttle car	2.05
6	Reposition and wait for #1 shuttle car	1.00
7	Mine and load #1 shuttle car	2.55
8	Position out	.40
9	Position in -- right mine and wait for #2 shuttle car	1.20
10	Mine and load #2 shuttle car	2.20
11	Mine and wait for #1 shuttle car	1.30
12	Mine and load #1 shuttle car	2.40
13	Mine and wait for #2 shuttle car	1.20
14	Mine and load #2 shuttle car	2.40

Sketch Number	Illustration	Typical Time
15	Position miner back	.50
16	Position miner in -- left	.60
17	Mine and load #2 shuttle car	2.35
18	Mine and wait for #1 shuttle car	1.10
19	Mine and load #1 shuttle car	2.45
20	Mine and wait for #2 shuttle car	1.10
21	Mine and load #2 shuttle car	2.35
22	Position back and in -- right	1.10
23	Mine and load #1 shuttle car	2.45
24	Mine and wait for #2 shuttle car	1.15
25	Mine and load #2 shuttle car	2.50
26	Position back and out of cut	.70
27	Tram to new face	3.45

Note: A normal 20 foot cut might require 15 to 18 shuttle car loads. Only a representative number of mine-and-load subcycles are shown here. For a complete typical mining cycle, see Chapter 3, Typical Work-Cycle Times.

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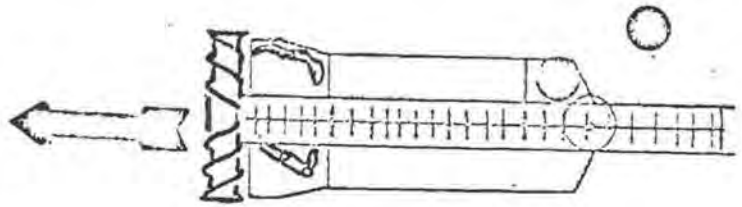
1 Tram to new face 4.05 minu



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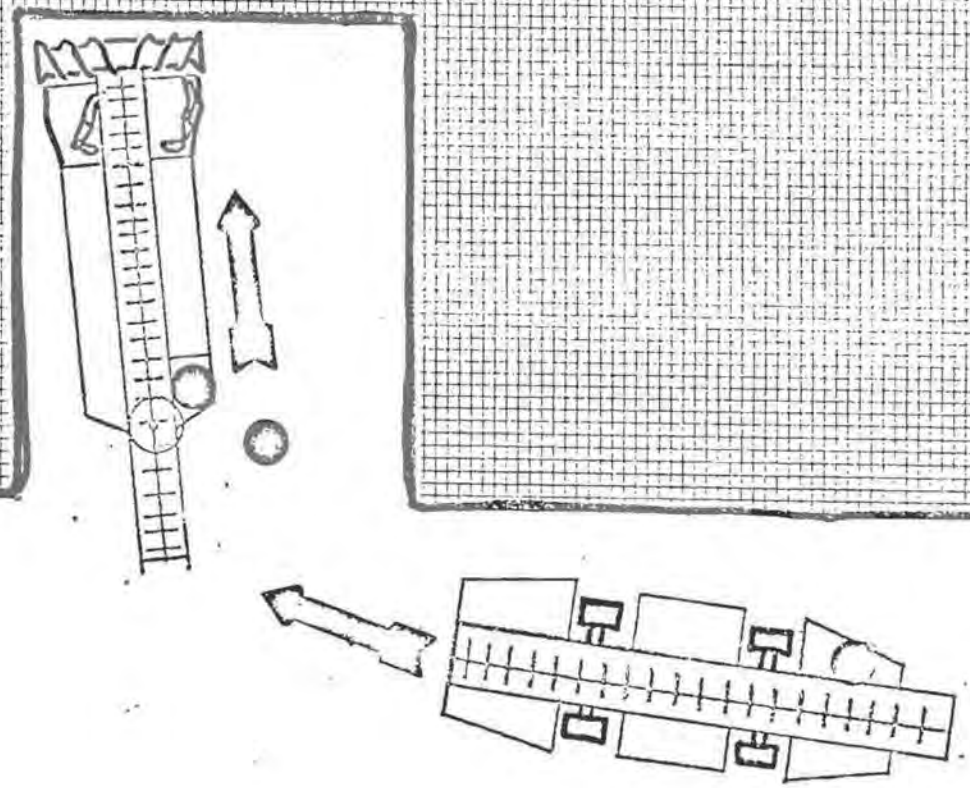
2 Position C.M. into face -- left 1.60



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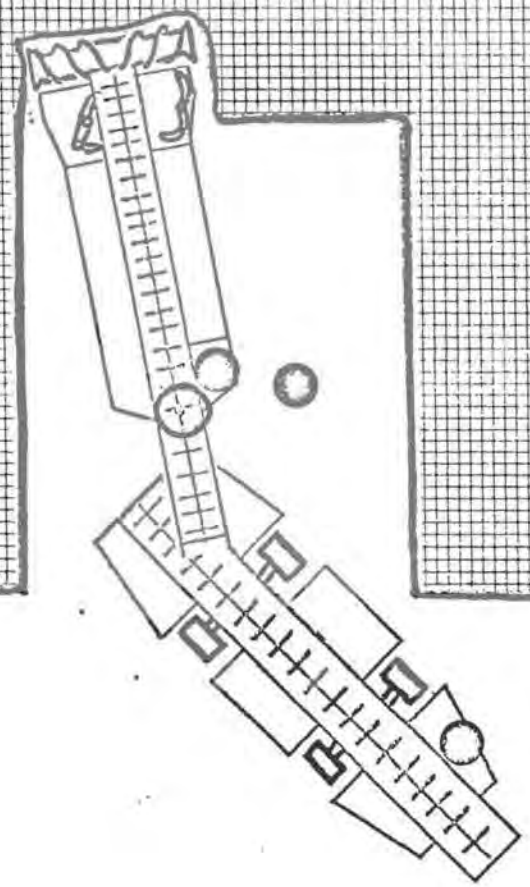
3	Mine and load #1 shuttle car	2.45



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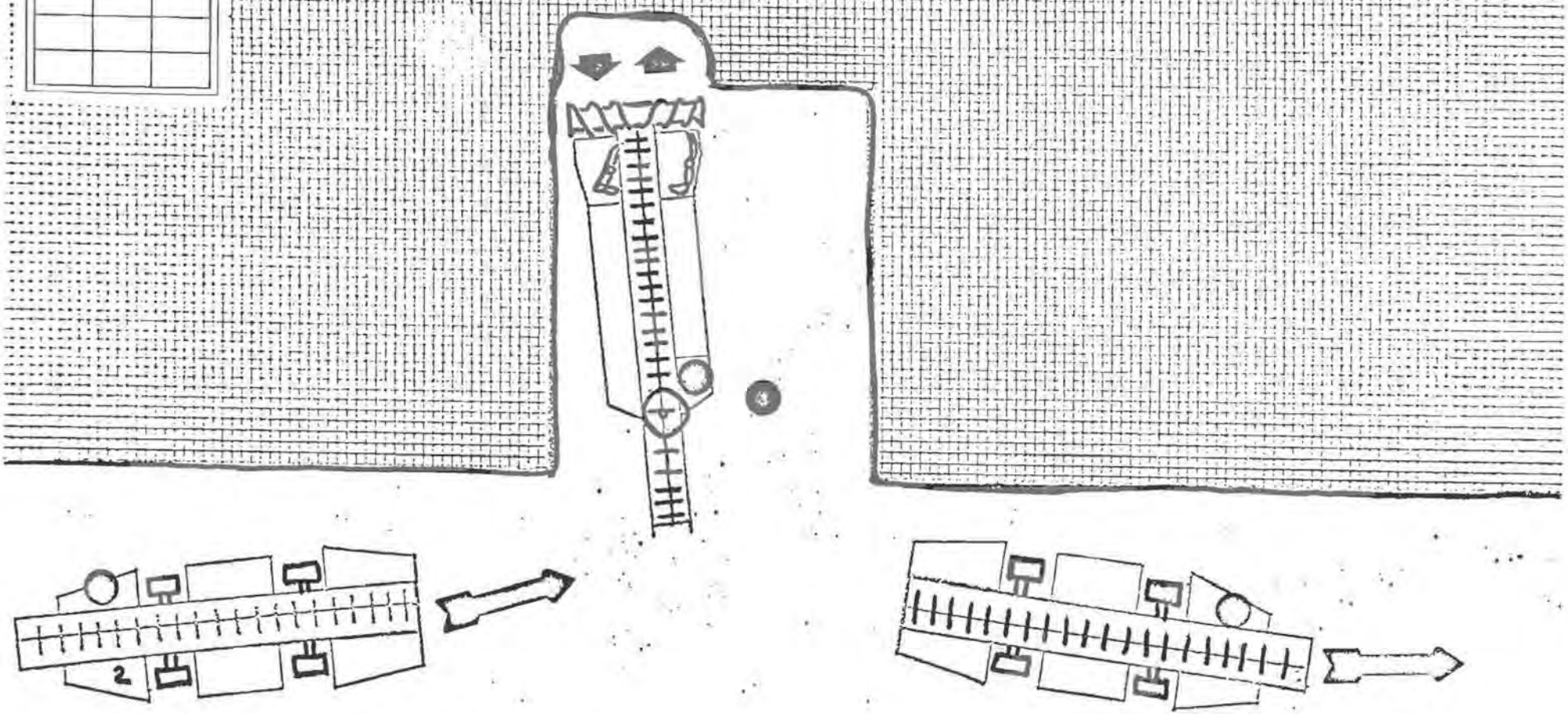
4 Reposition and wait for #2 shuttle car 1.10



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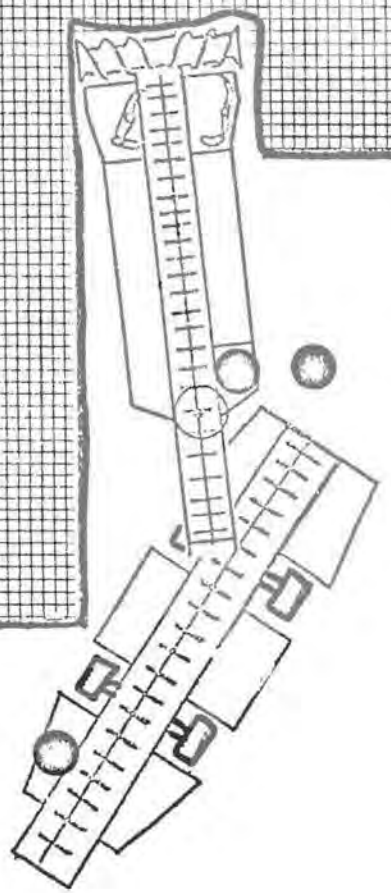
5 Mine and load #2 shuttle car 2.05



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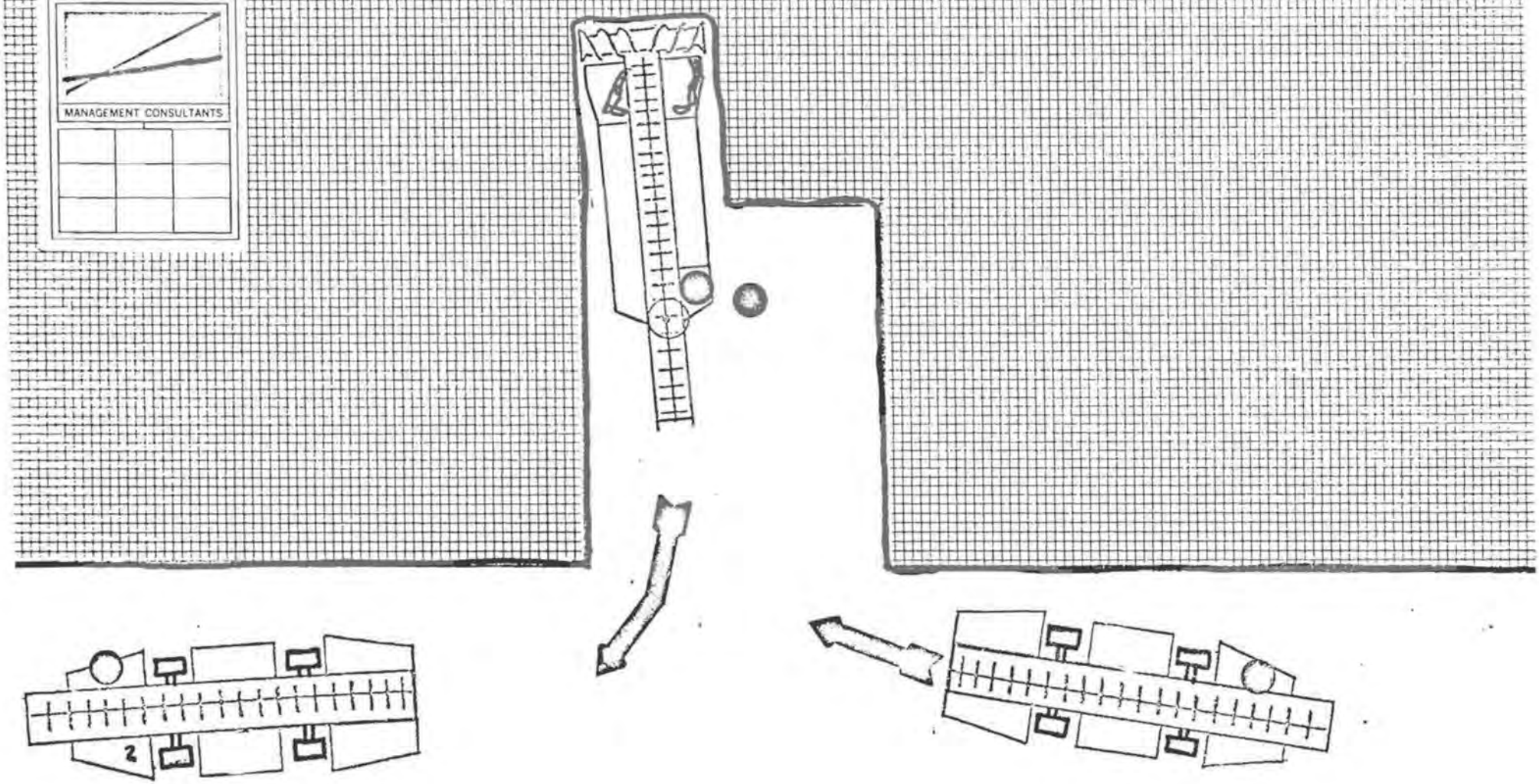
6	Reposition and wait for #1 shuttle car	1.00



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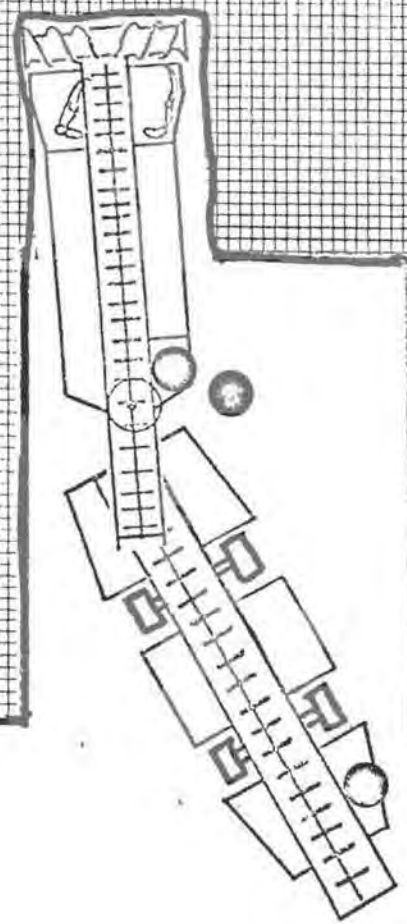
7 Mine and load #1 shuttle car 2.55



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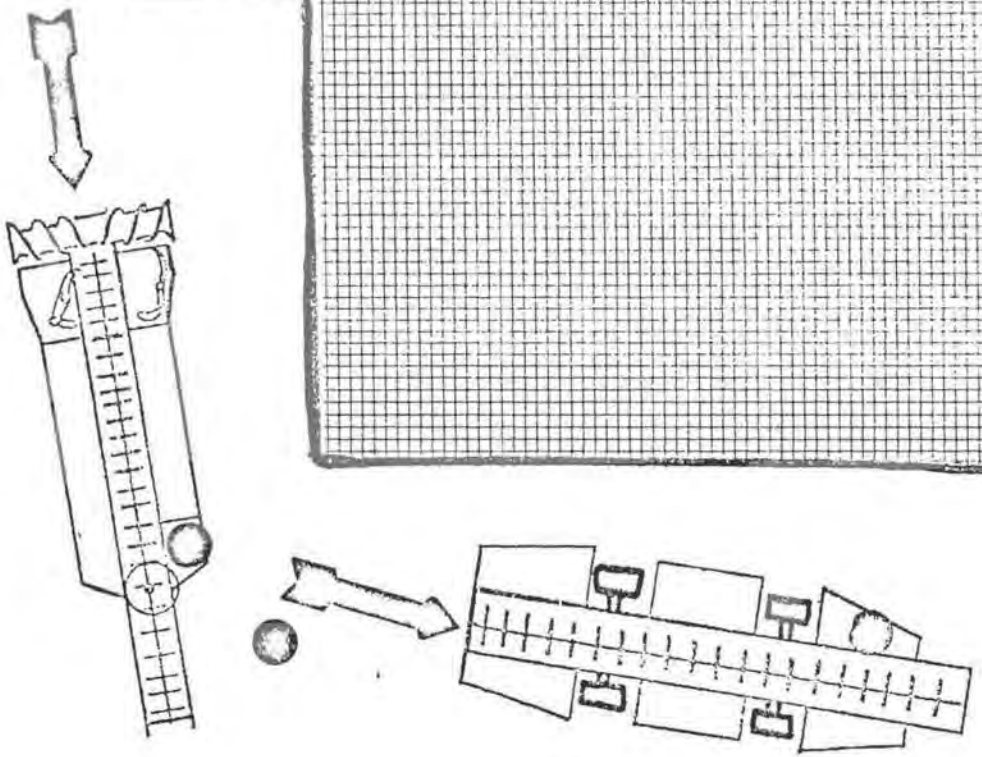
8 Position out .40



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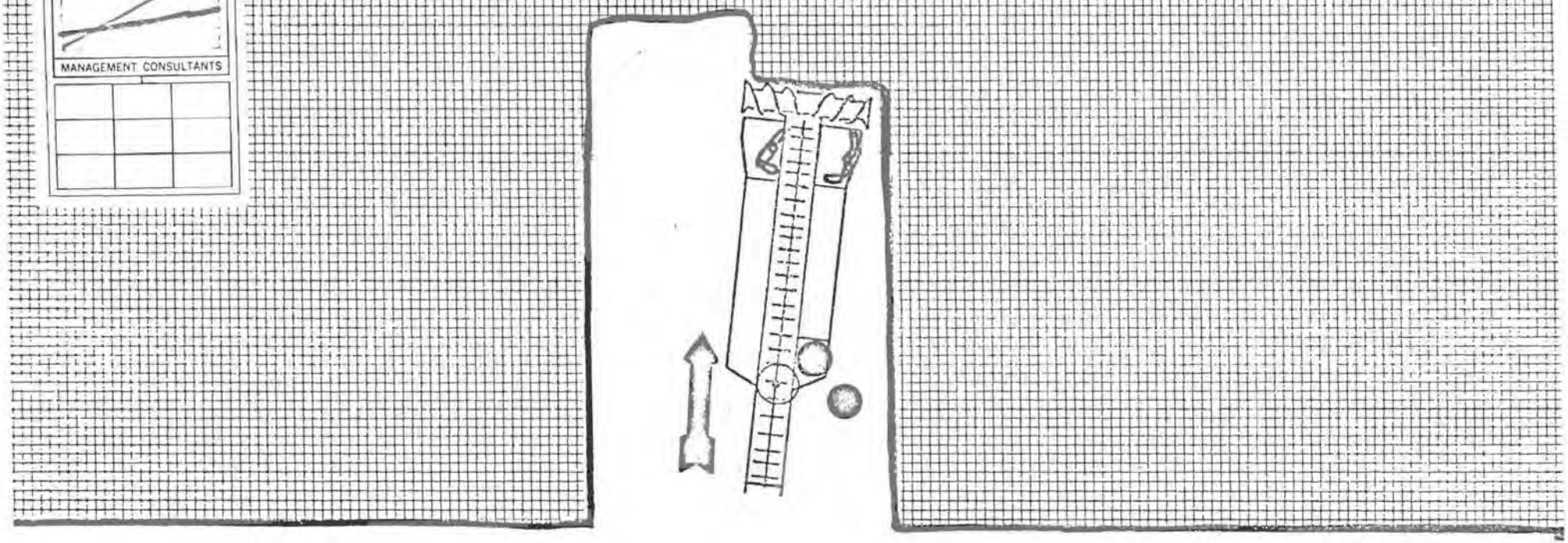
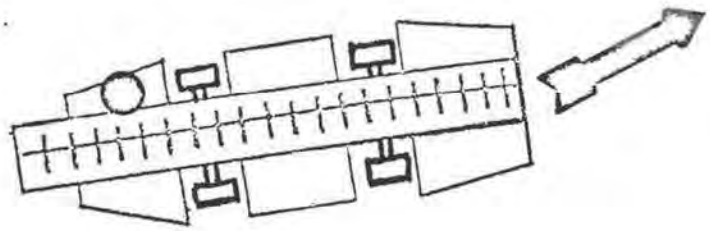
9 Position in -- right mine and wait for #2 shuttle car 1.20





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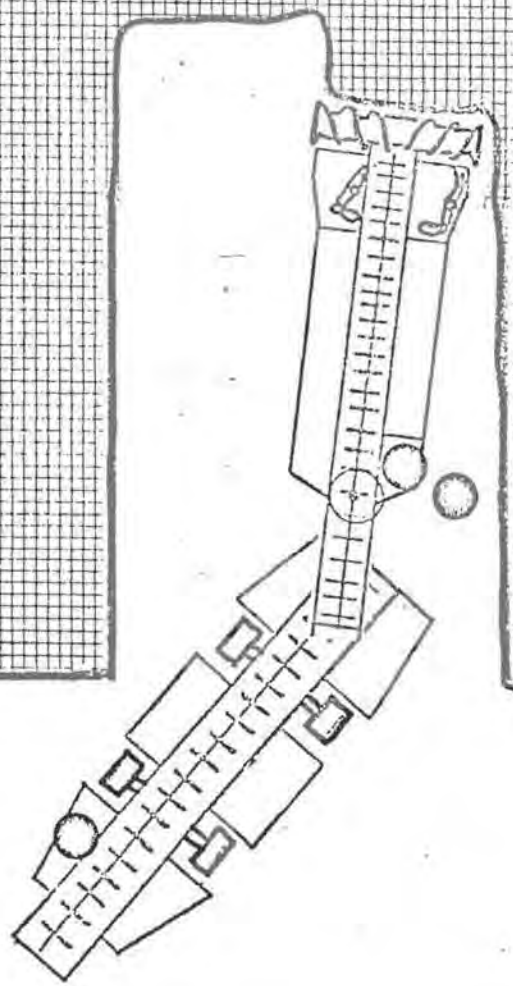
10 Mine and load #2 shuttle car 2.20



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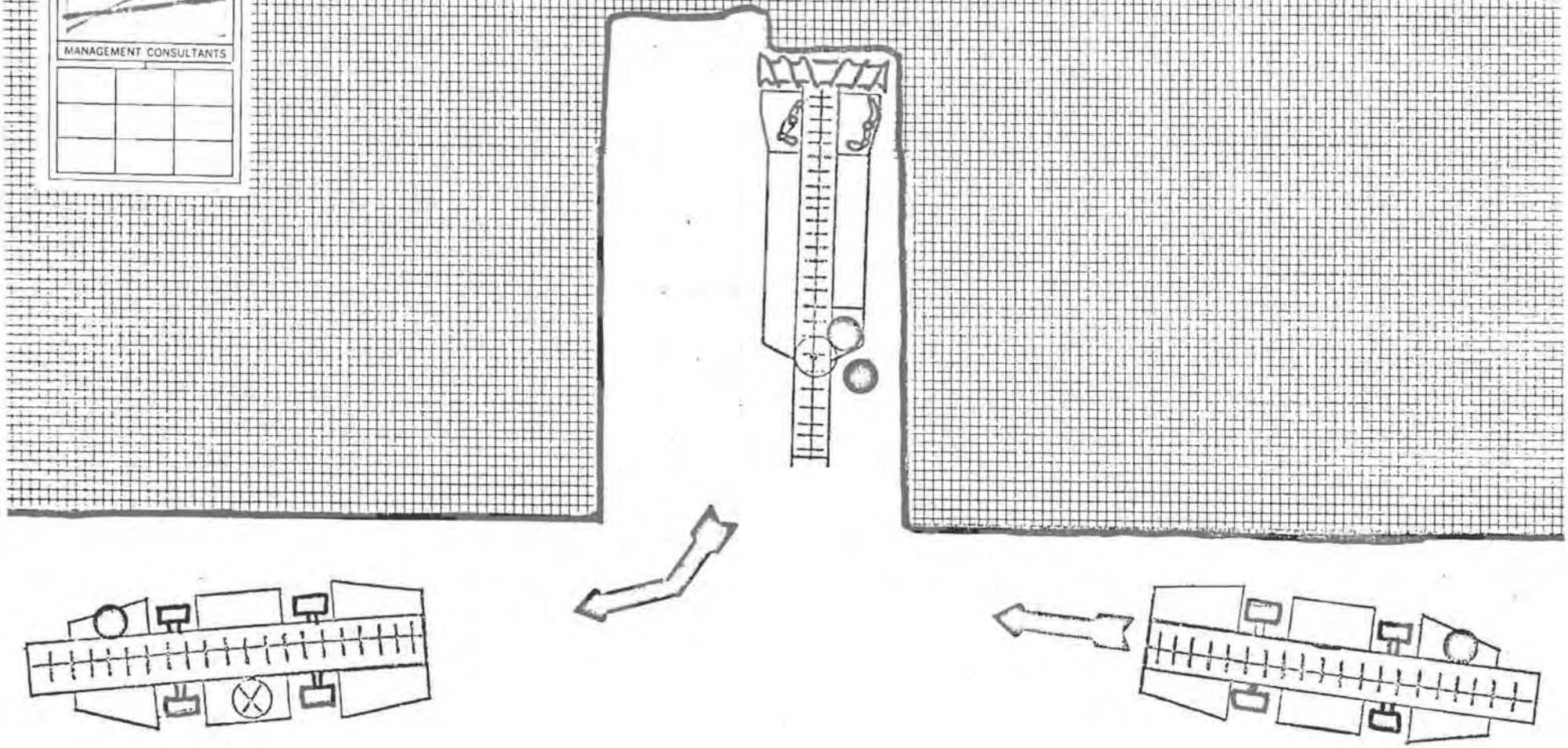
11 Mine and wait for #1 shuttle car 1.30



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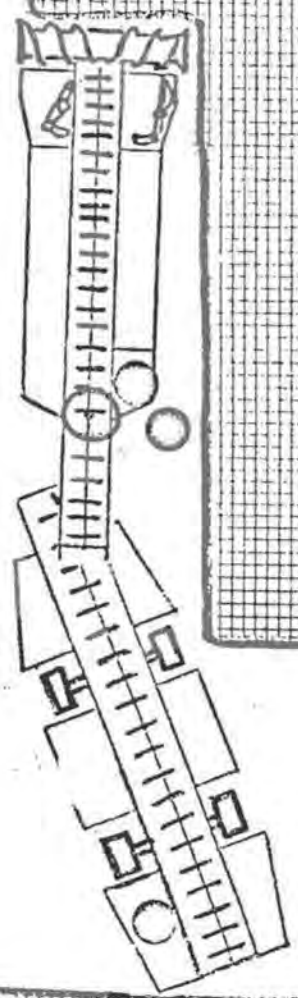
12 Mine and load #1 shuttle car 2.40



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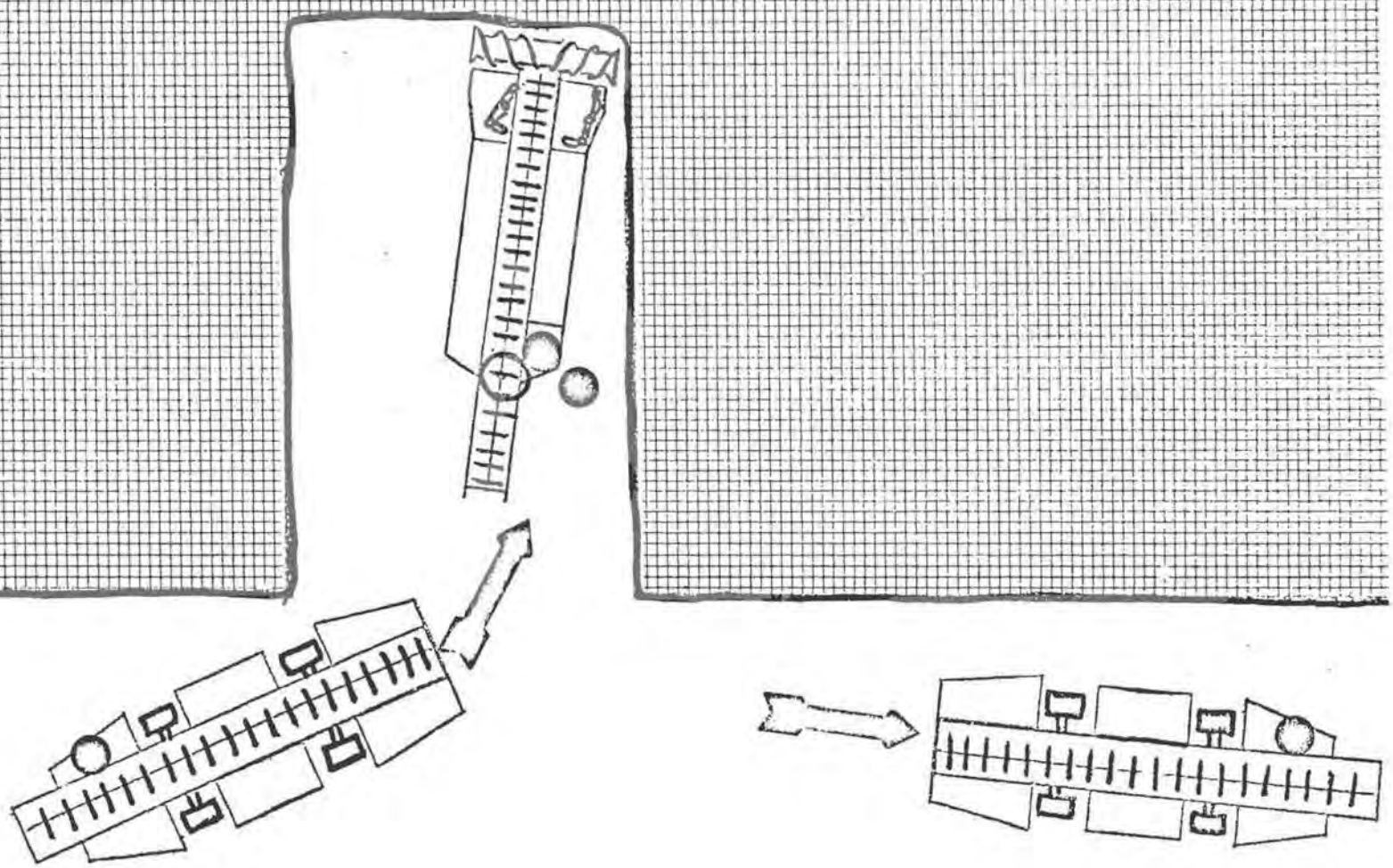
13 Mine and wait for #2 shuttle car 1.20



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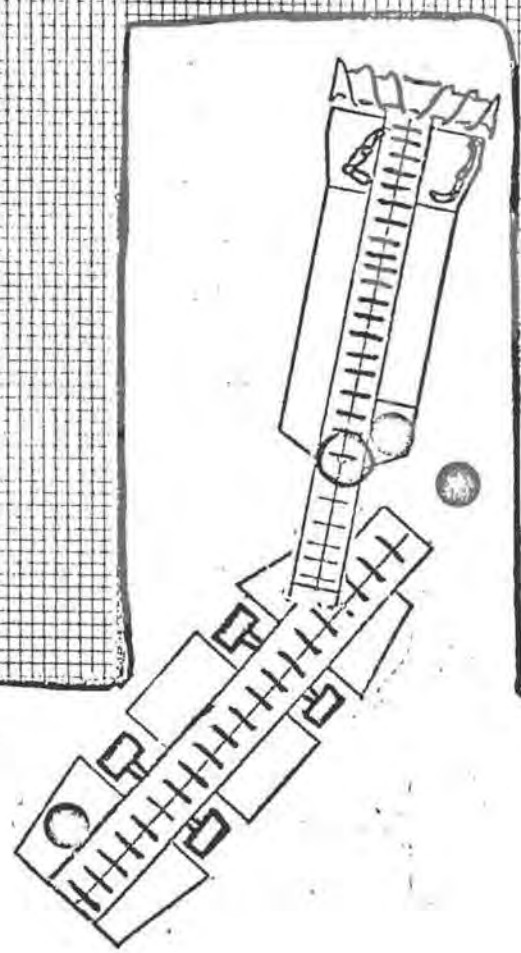
14 Mine and load #2 shuttle car 2.40



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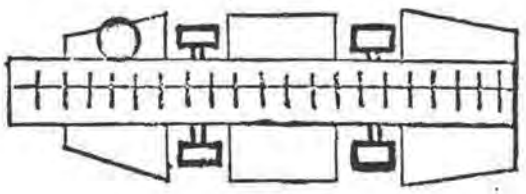
15 Position miner back .50



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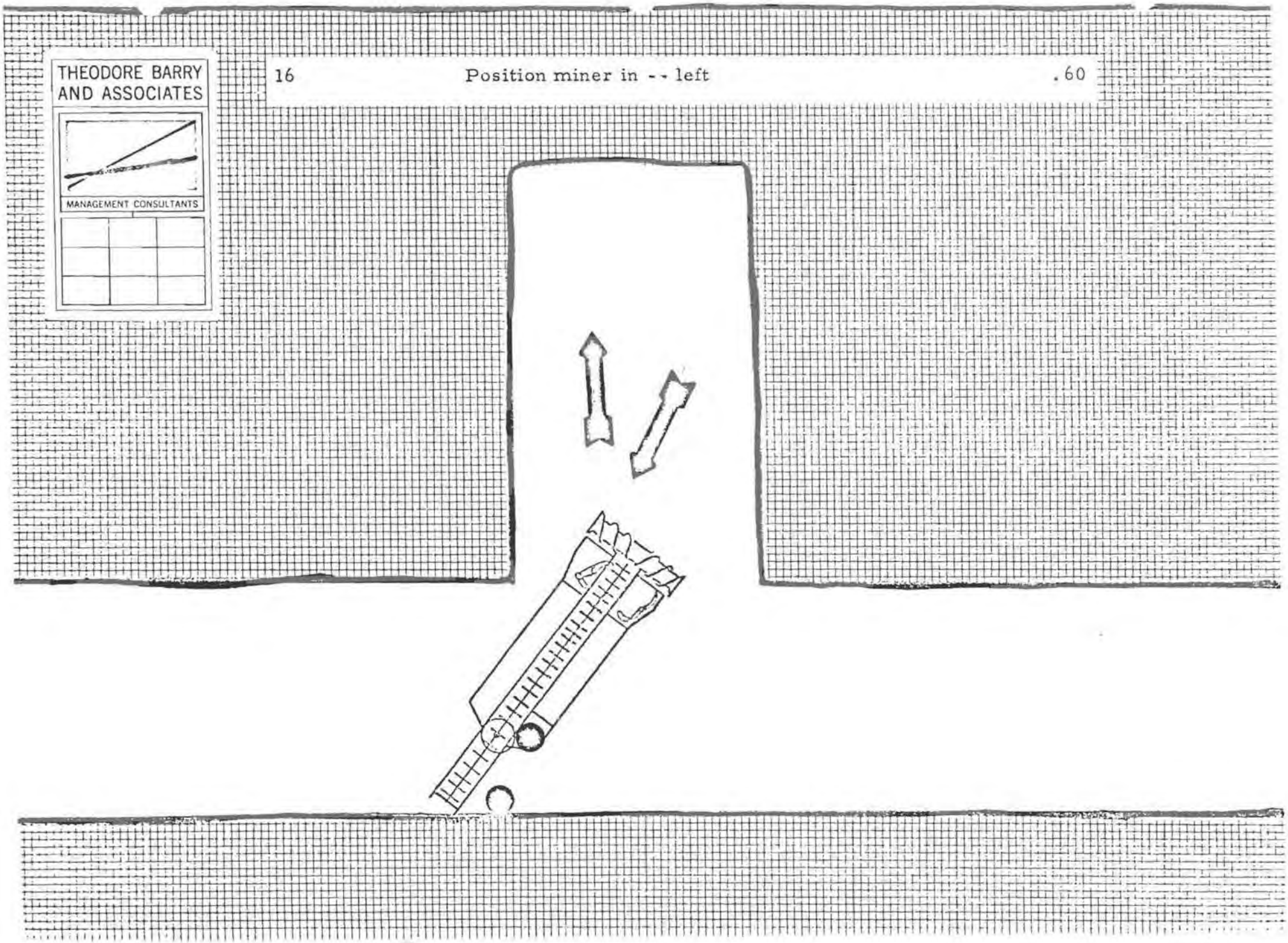
16 Position miner in -- left .60



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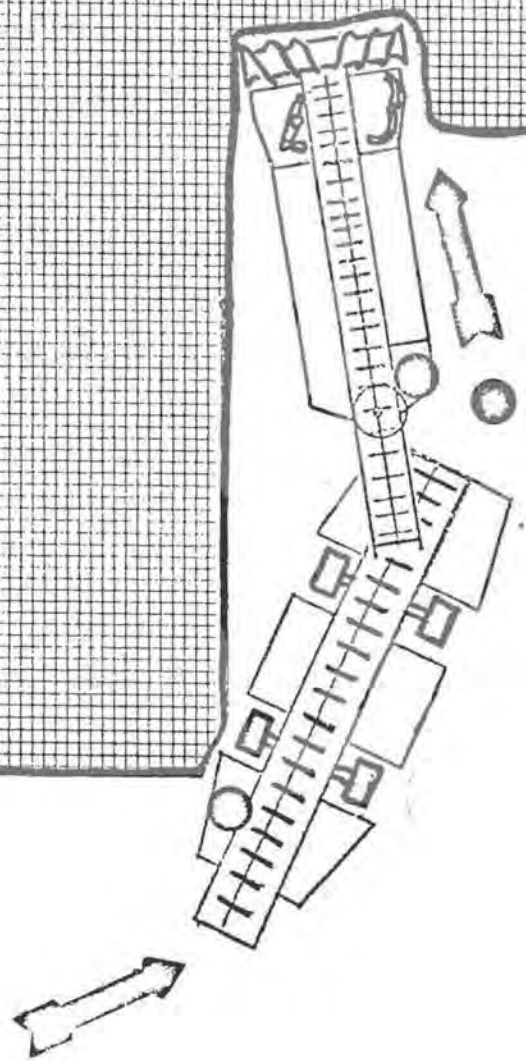
17

Mine and load #2 shuttle car

2.35



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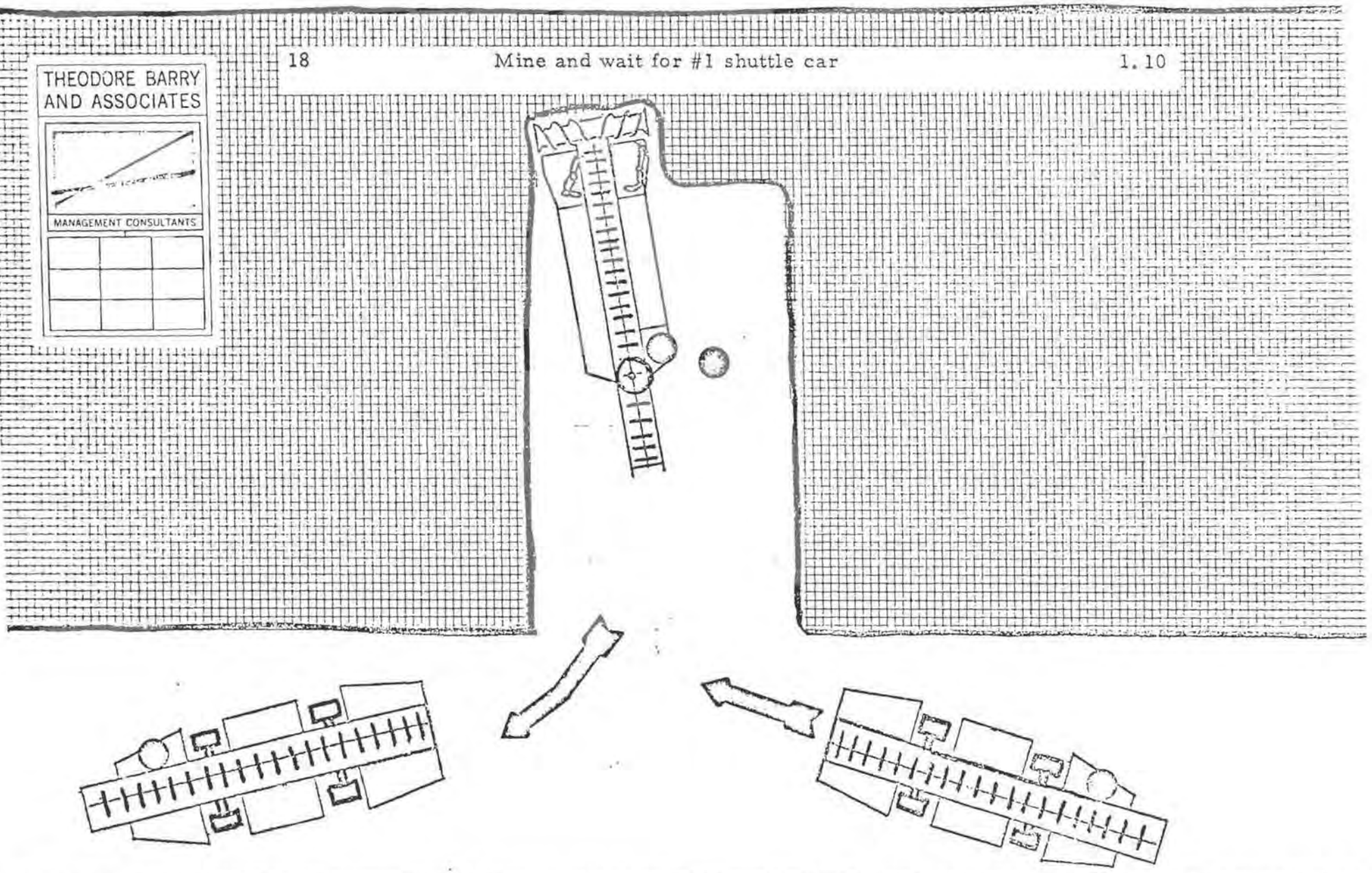
18 Mine and wait for #1 shuttle car 1.10



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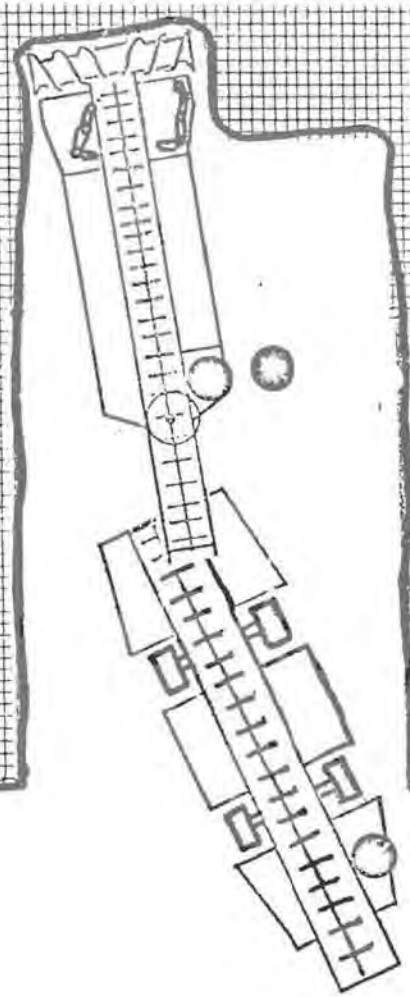
19 Mine and load #1 shuttle car 2.45



Mine and wait for #2 shuttle car

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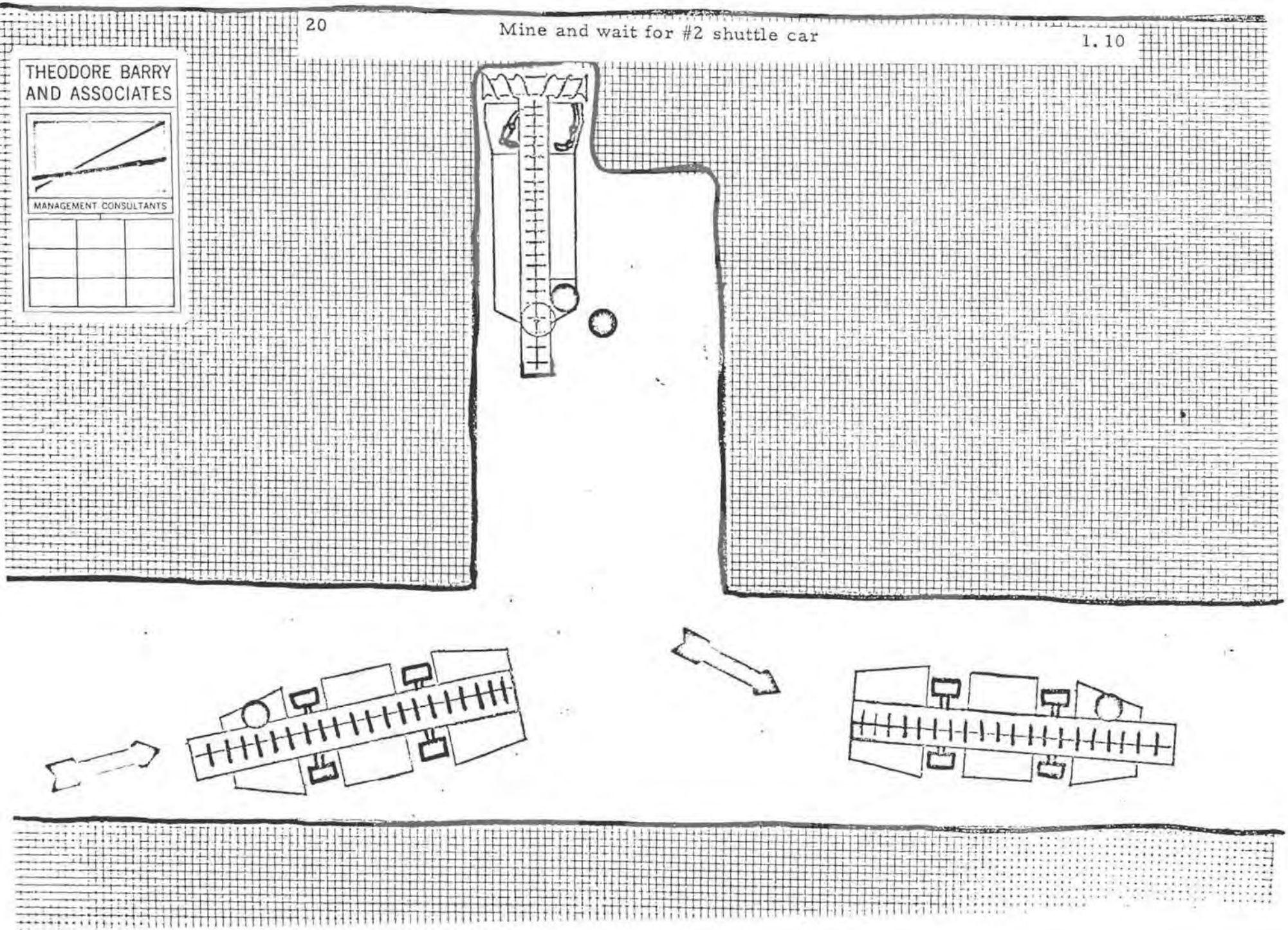

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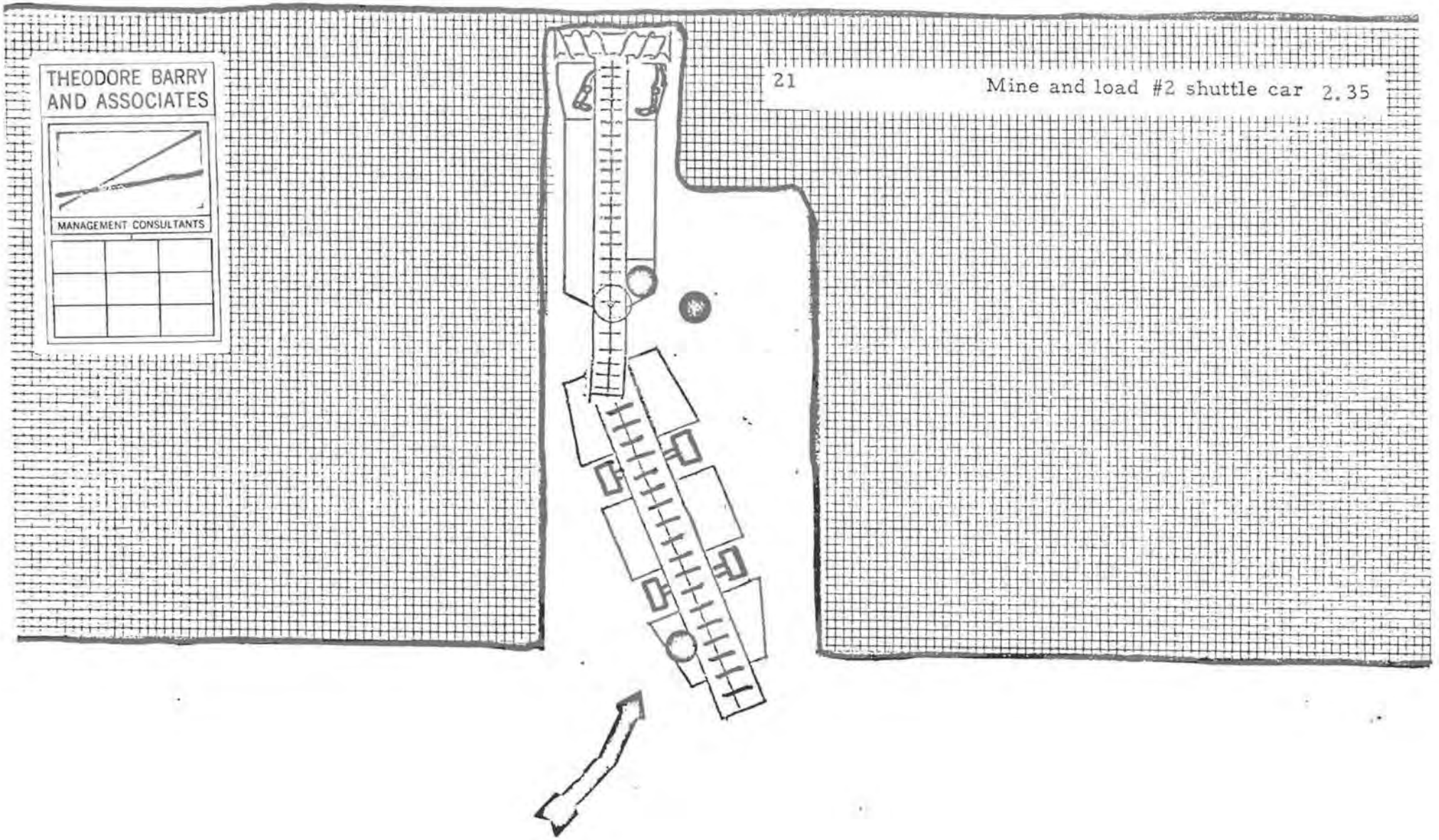
21 Mine and load #2 shuttle car 2.35



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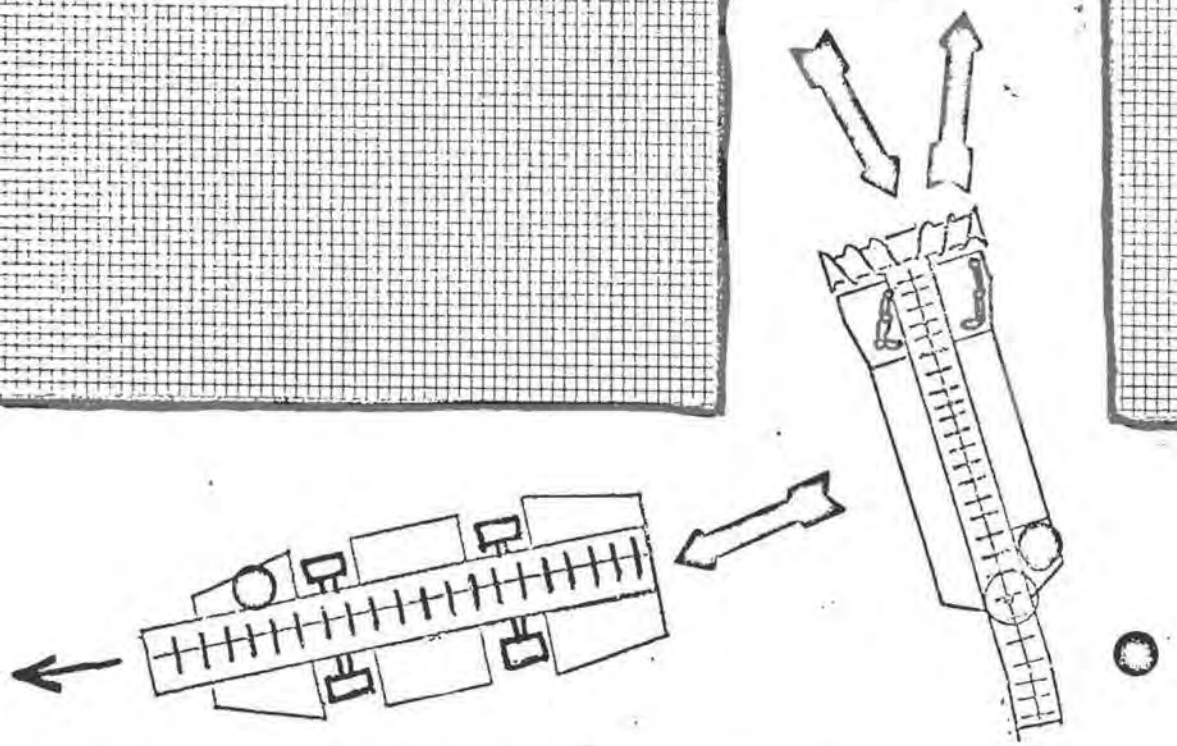
22 Position back and in -- right 1.10



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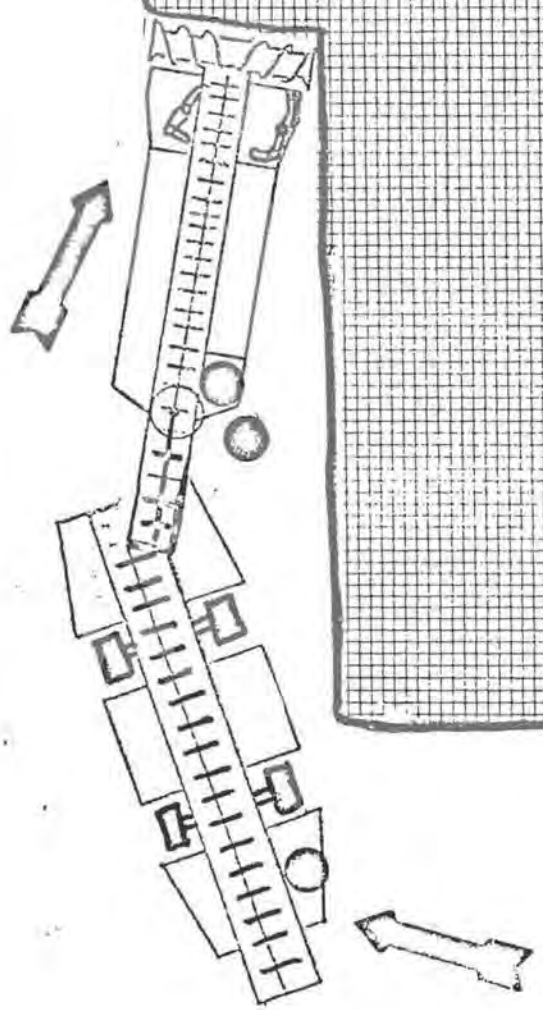
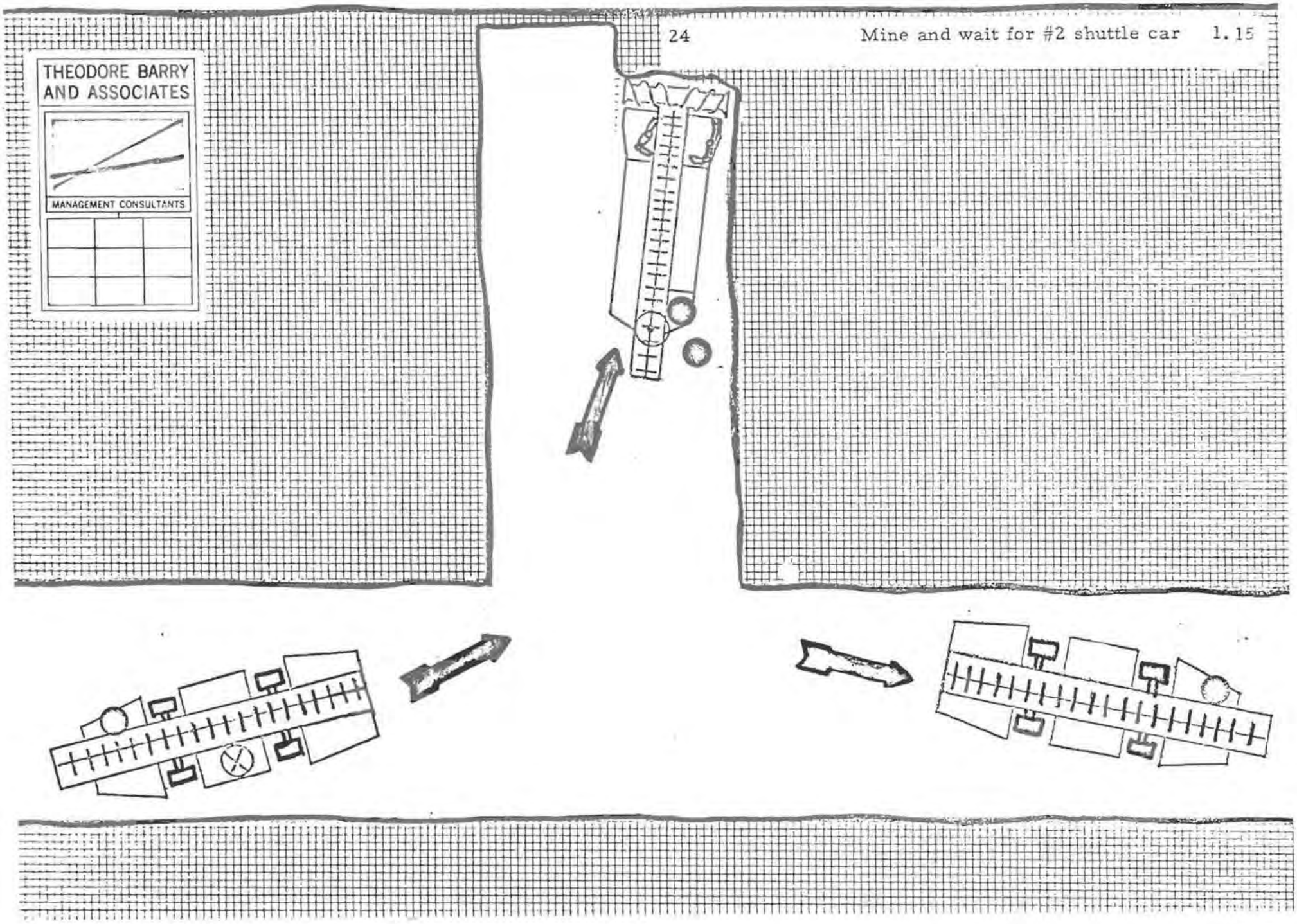
23 Mine and load #1 shuttle car 2.45

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24
Mine and wait for #2 shuttle car
1.15

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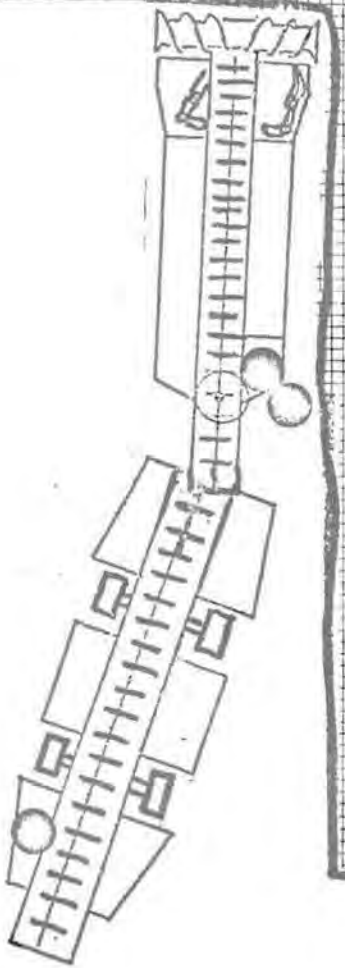

25 Mine and load #2 shuttle car 2.50

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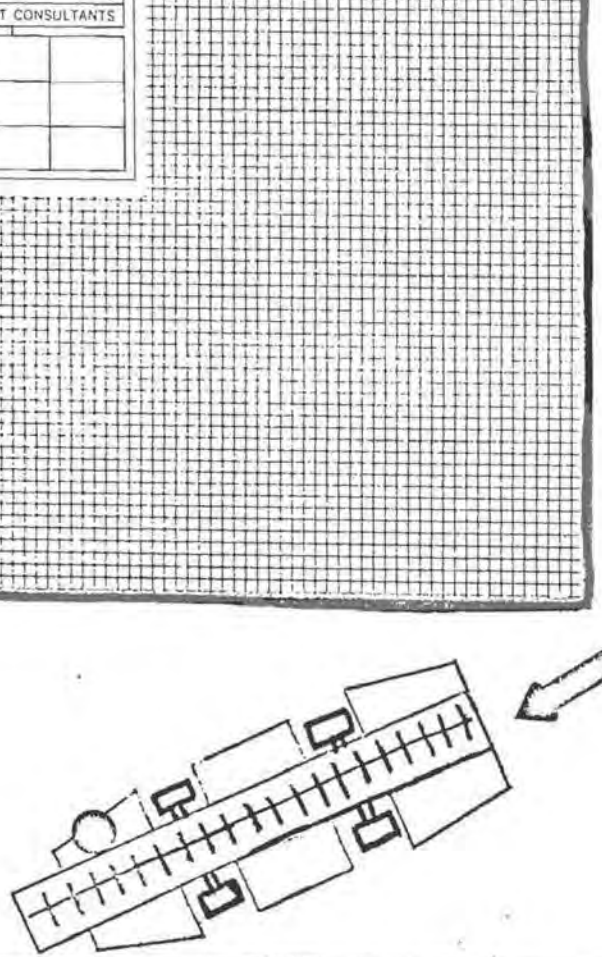
26 Position back and out of cut .70



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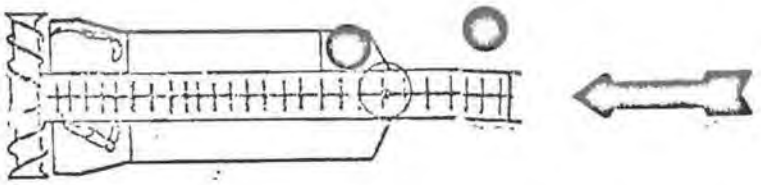
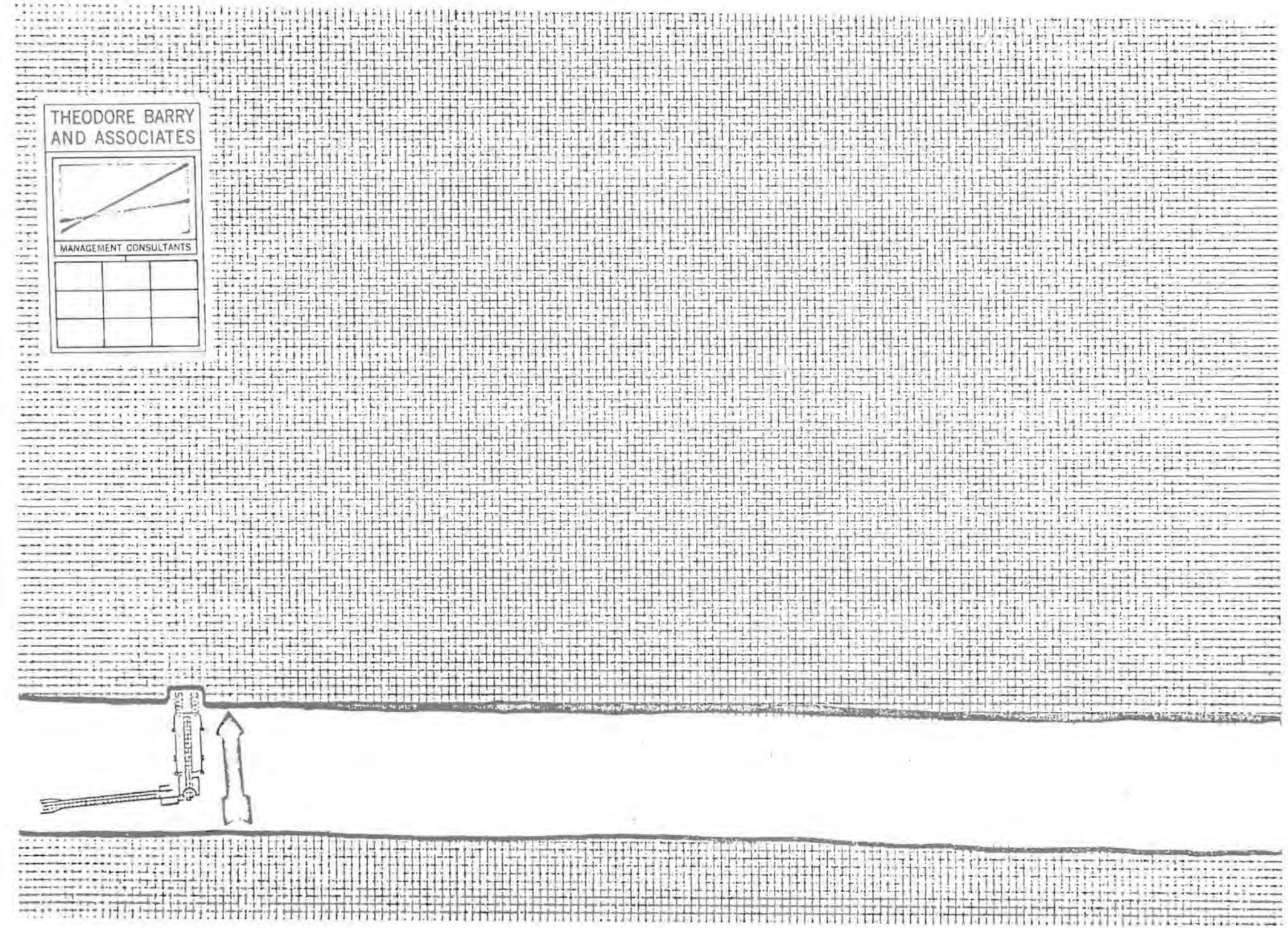
27 Tram to new face 3.45



AUGER MINING STYLE

- The following series of sketches illustrate the sequence of cuts taken when an Auger machine is used.
- The sketches are not to scale.
- This sequence has been developed to minimize the number of conveyor belt moves required.
- Only the bridge connected to the machine is shown.
- Some mines load from the bridge and universal conveyor to battery-operated haulage cars.
- If only belts are utilized, a series of conveyor belts carry the coal to the surface.
- The technique of cutting in, around, and back, as shown, is referred to as "legging".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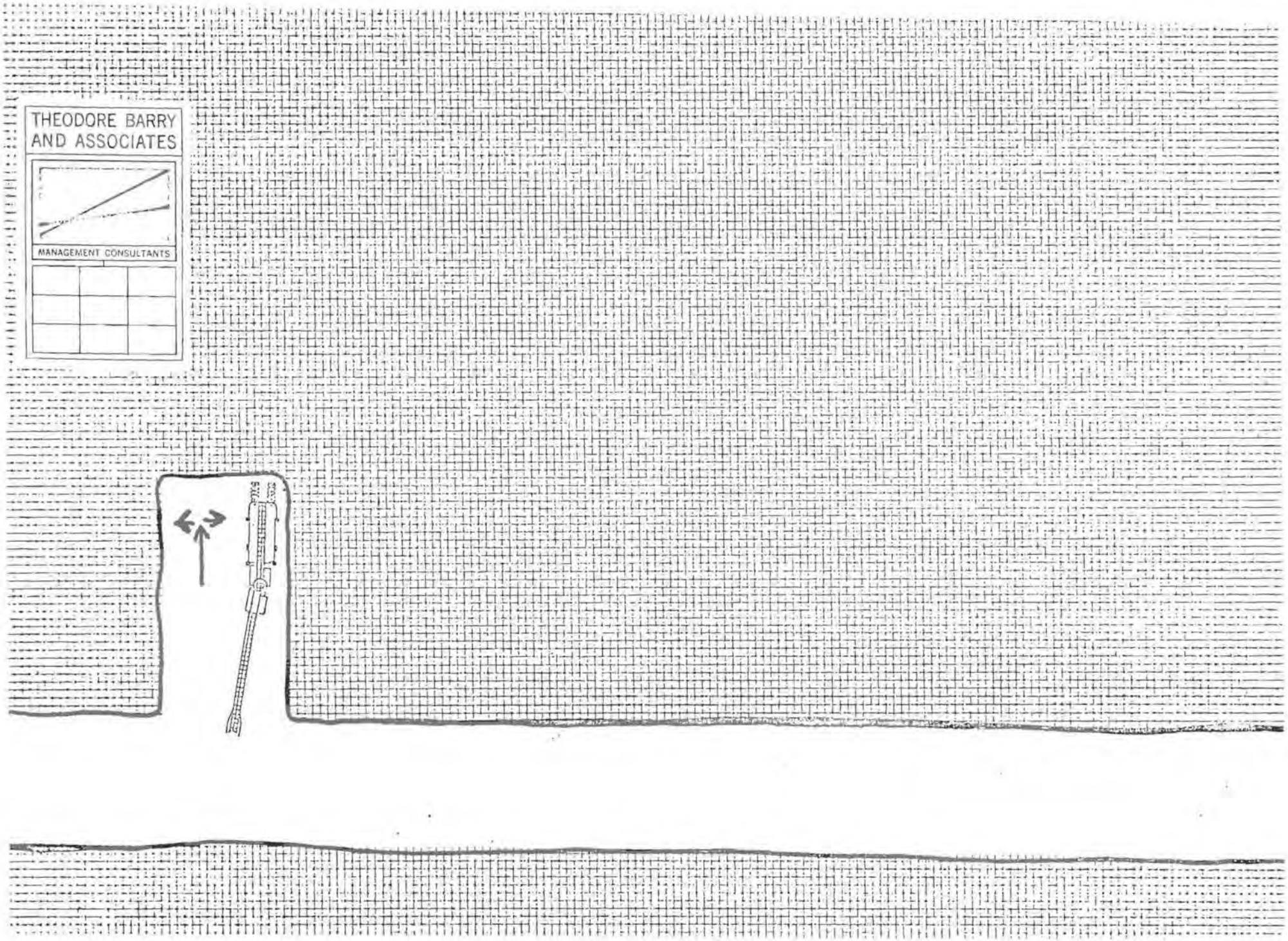

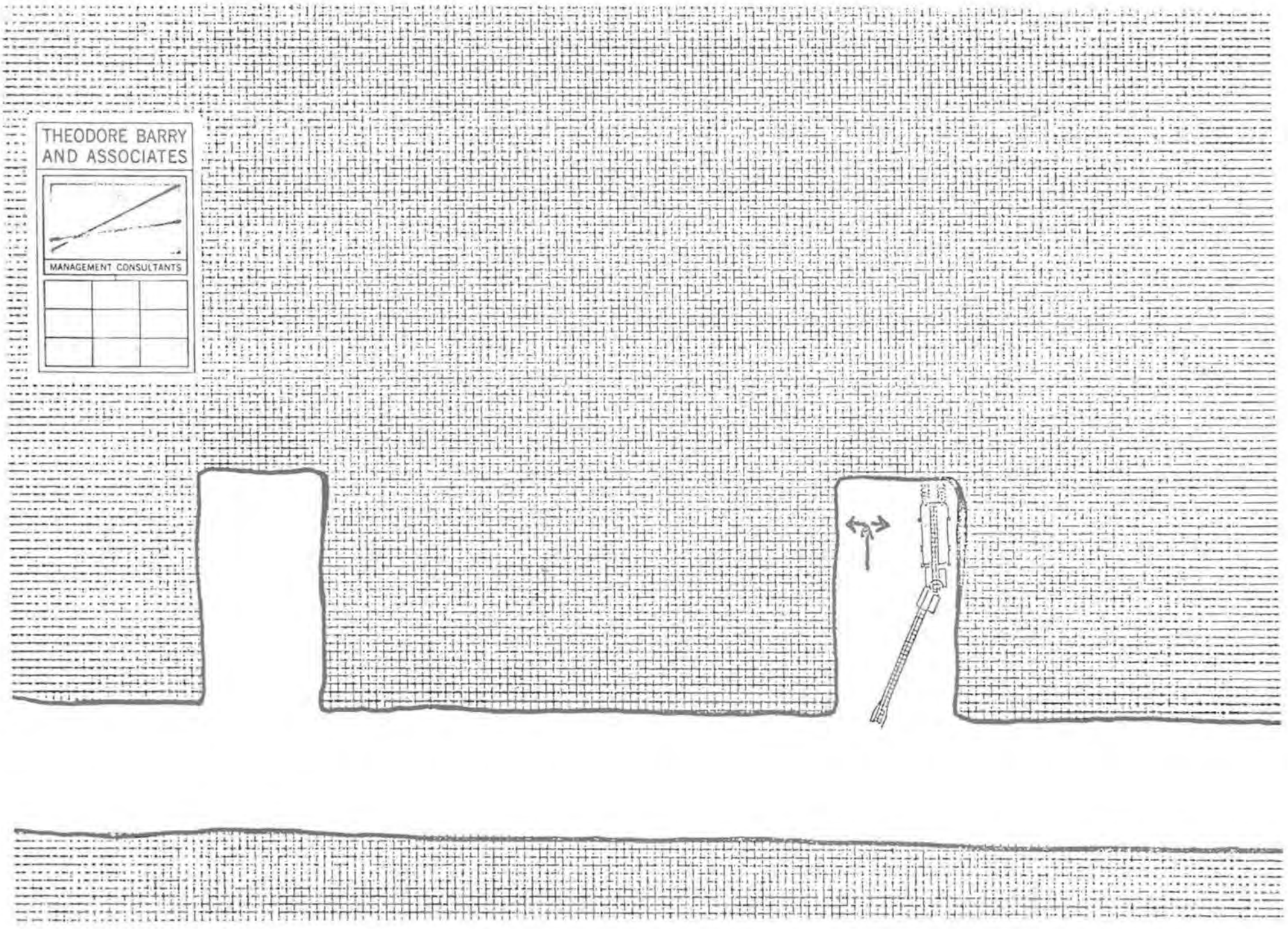
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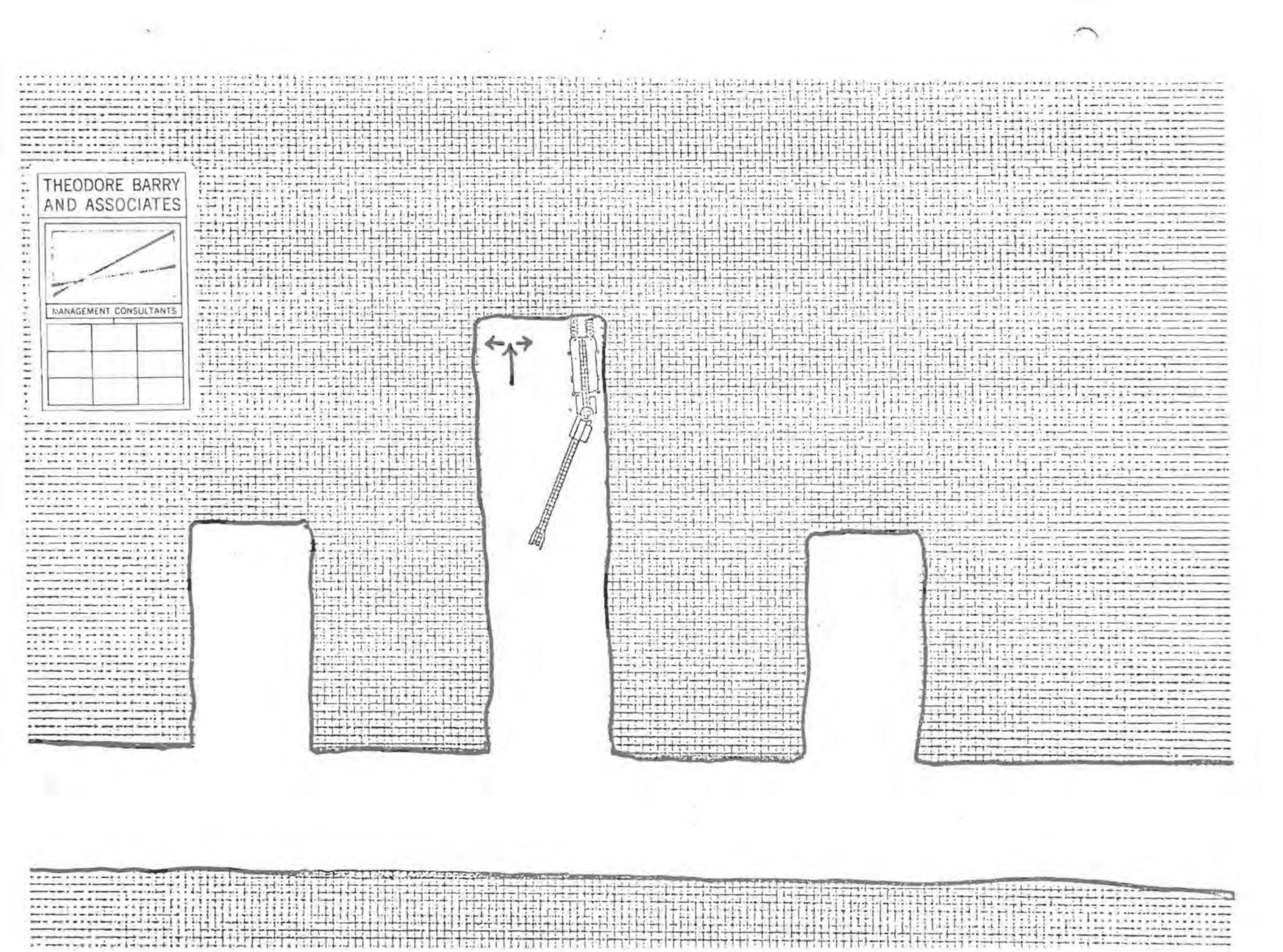
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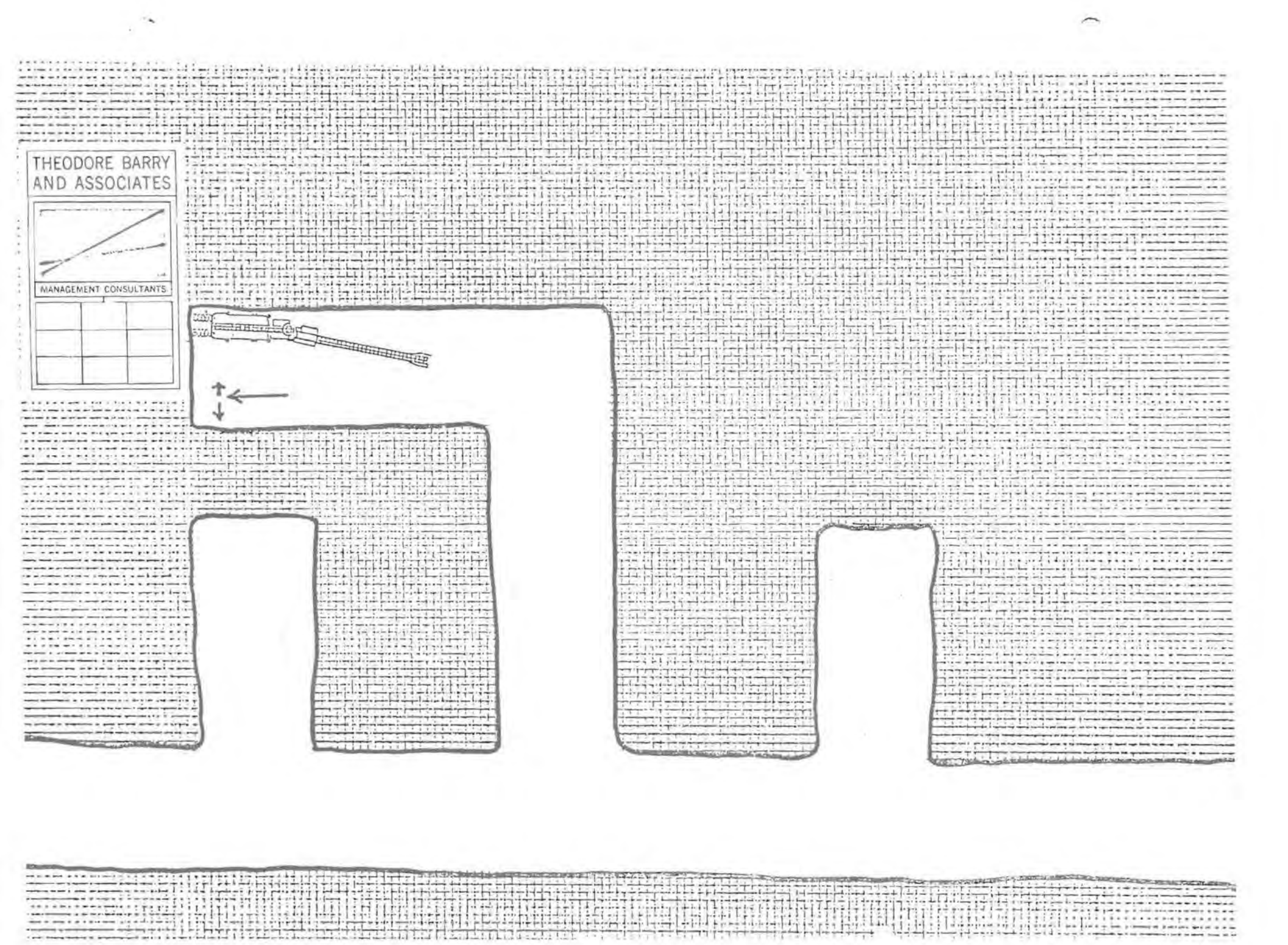
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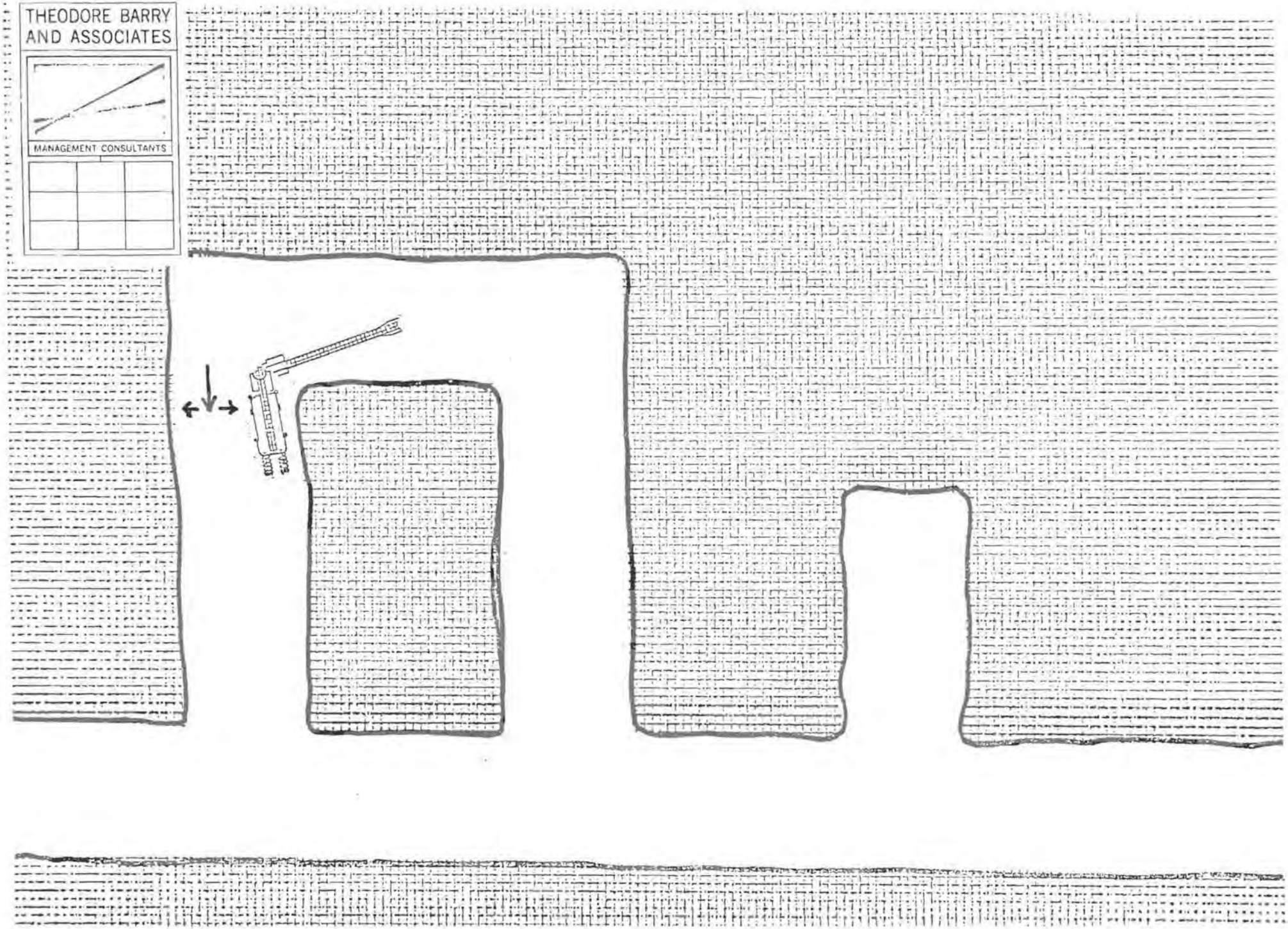

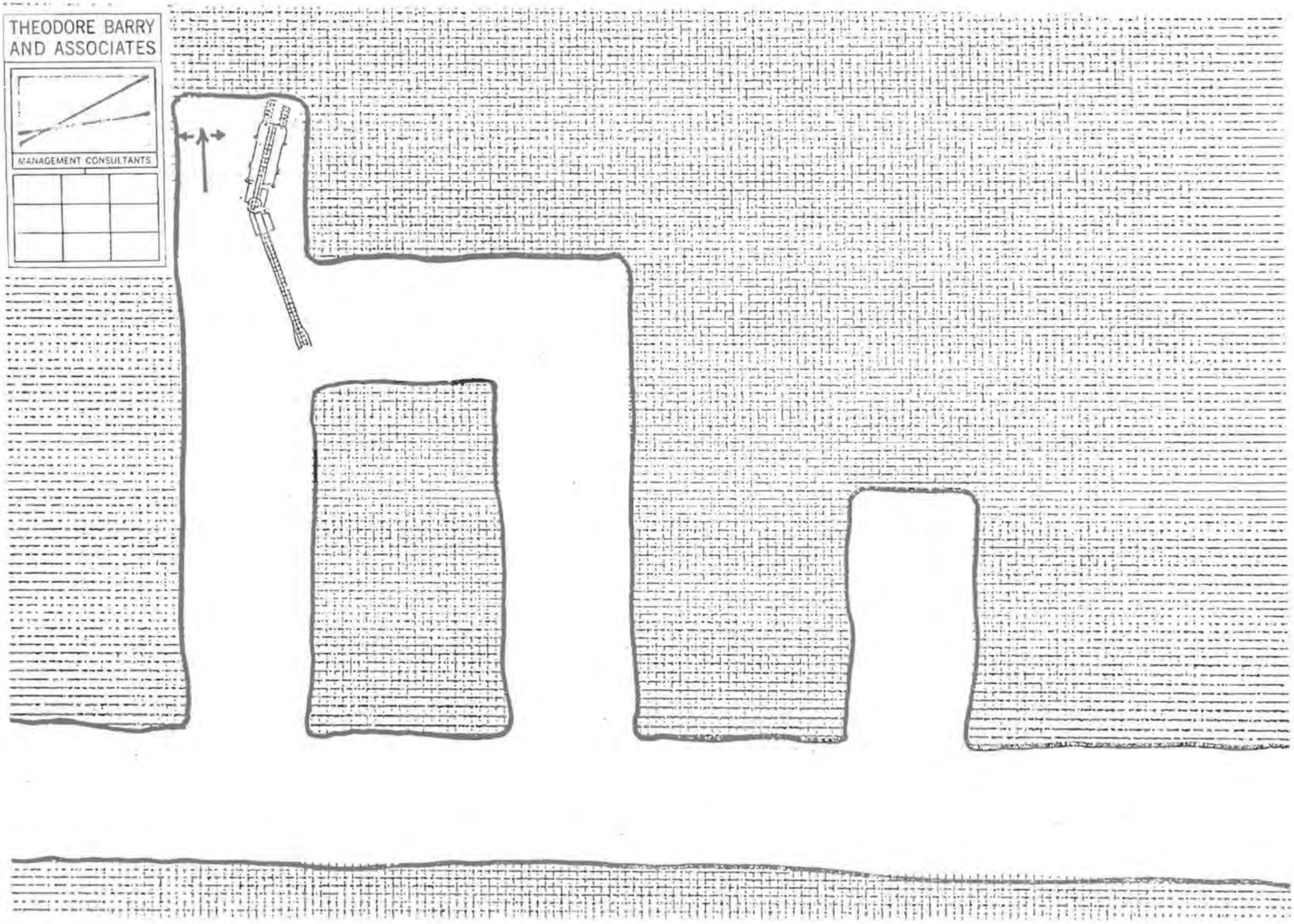
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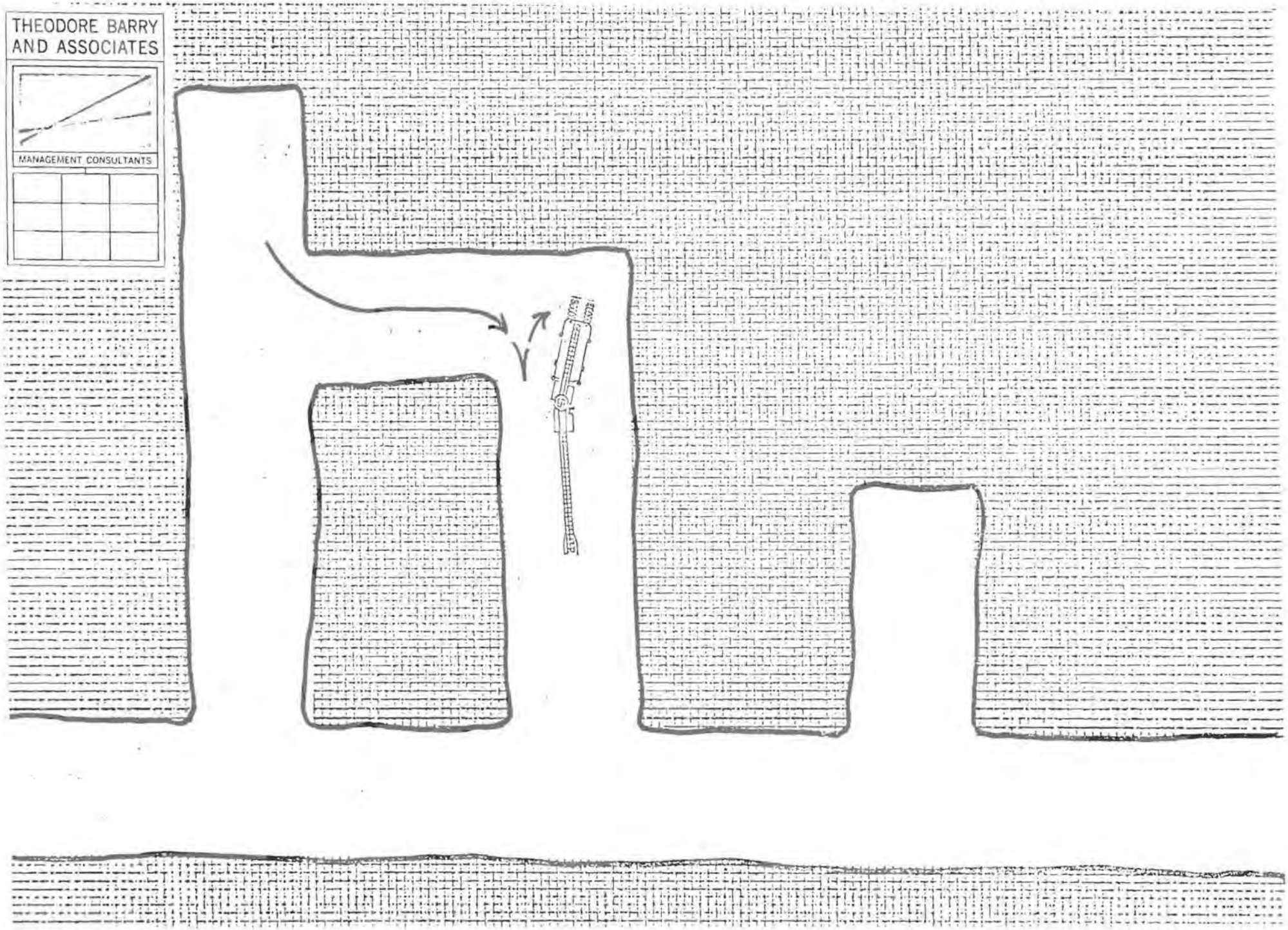

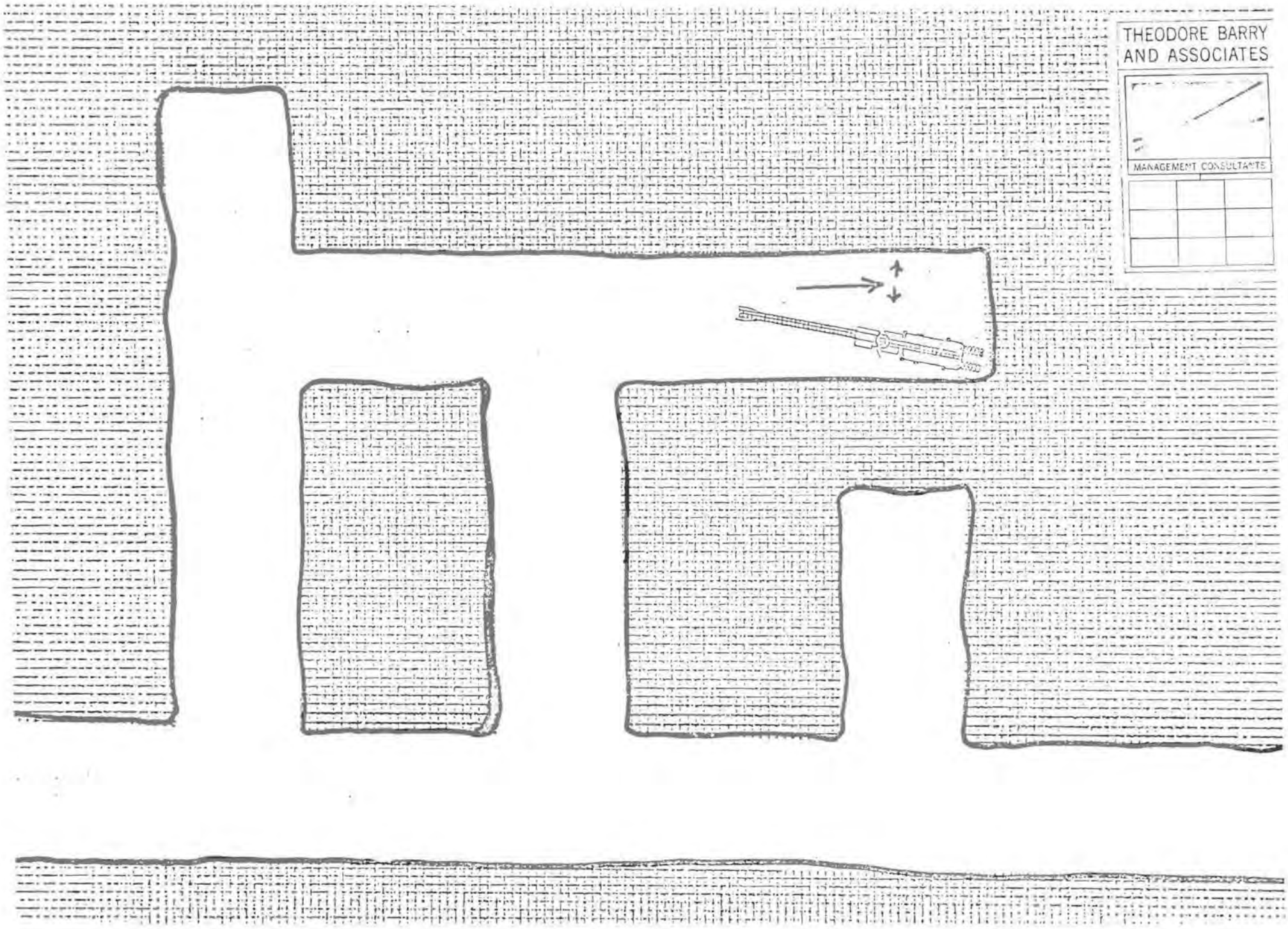
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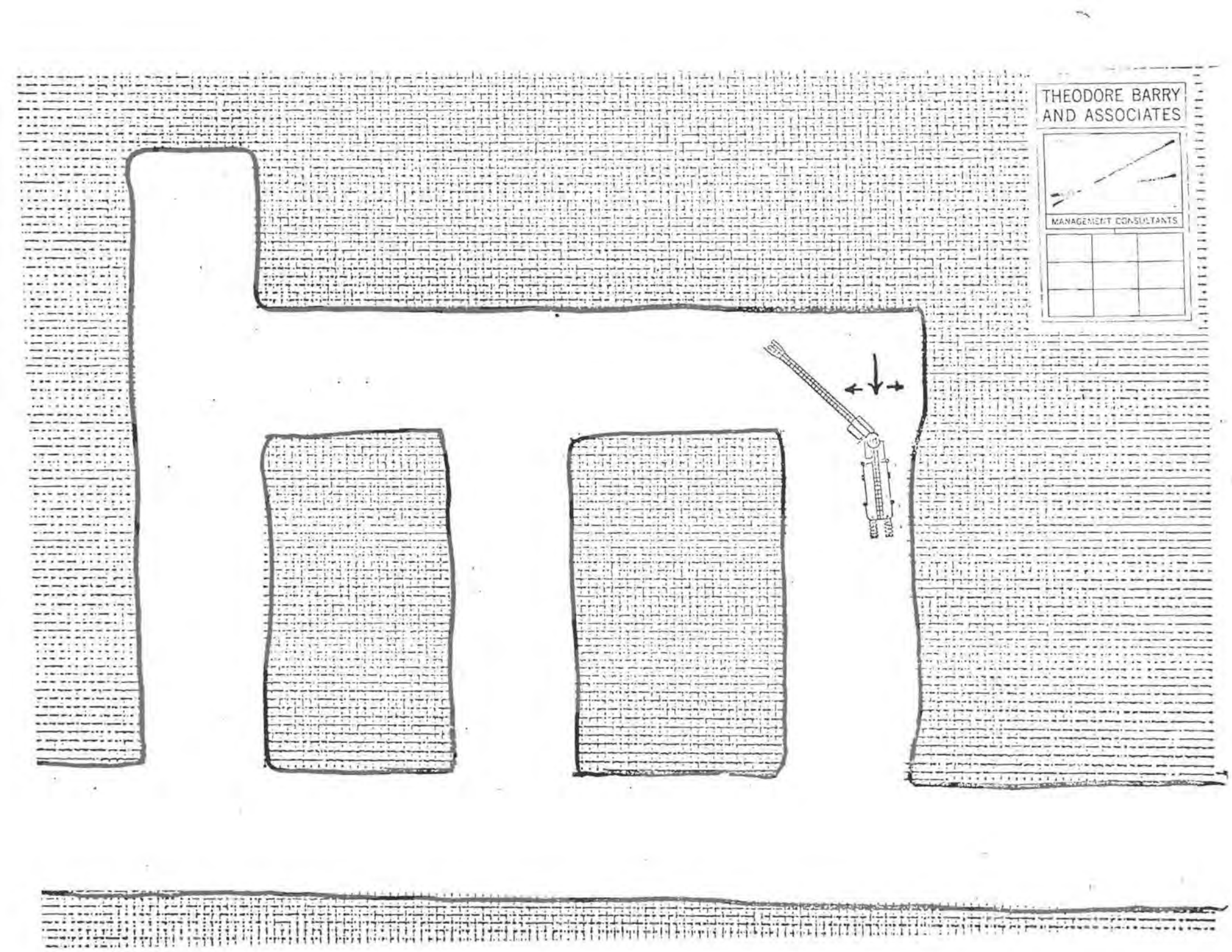
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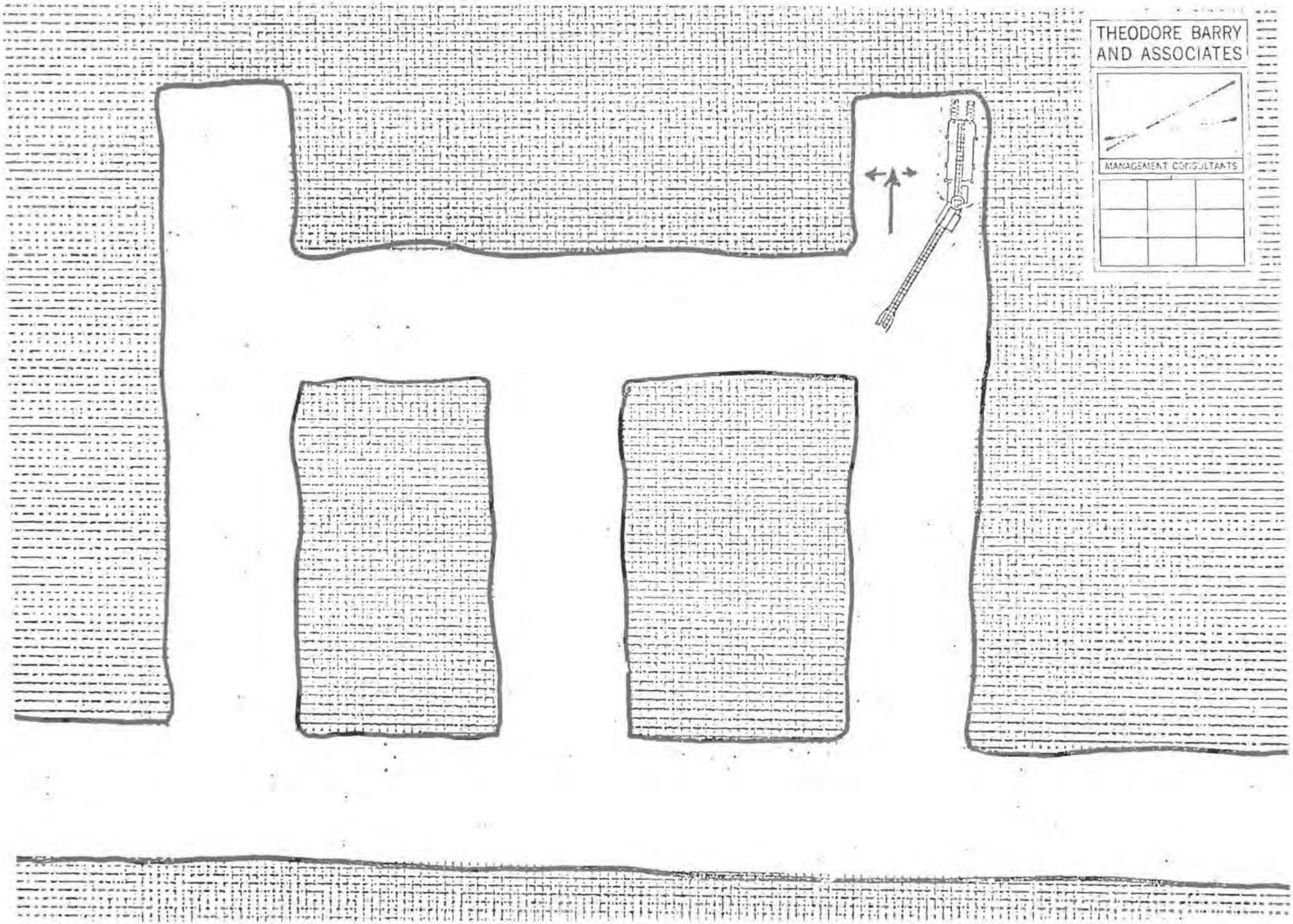
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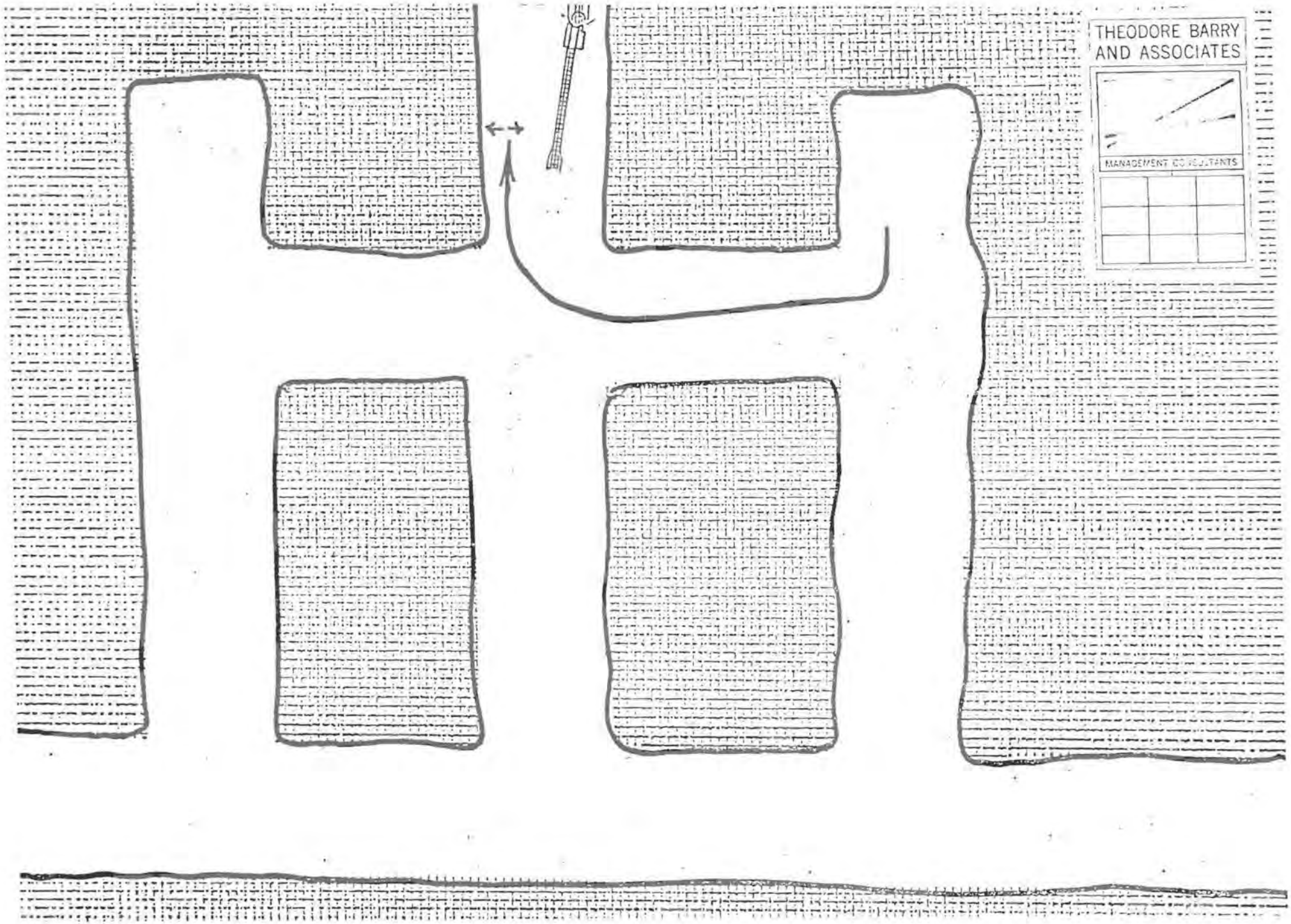
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AUGER BASIC OPERATIONS

- The following series of sketches show the location of the auger and its attached conveyor only.

- Note the large number of men and their required close proximity to the face and the equipment.

- "X" represents the equipment operator; "H" represents his helper; "T" represents timbermen; "L" represents hand loaders.

- The helpers are constantly setting jacks to winch the machine from position to position.

- One timberman constantly sets temporary supports on the left side of the machine as it moves right. Meanwhile, his counterpart removes the supports to the right of the machine. The process is reversed as the machine moves left.

- The loaders also perform the timber moving function and shovel loose coal onto the conveyor.

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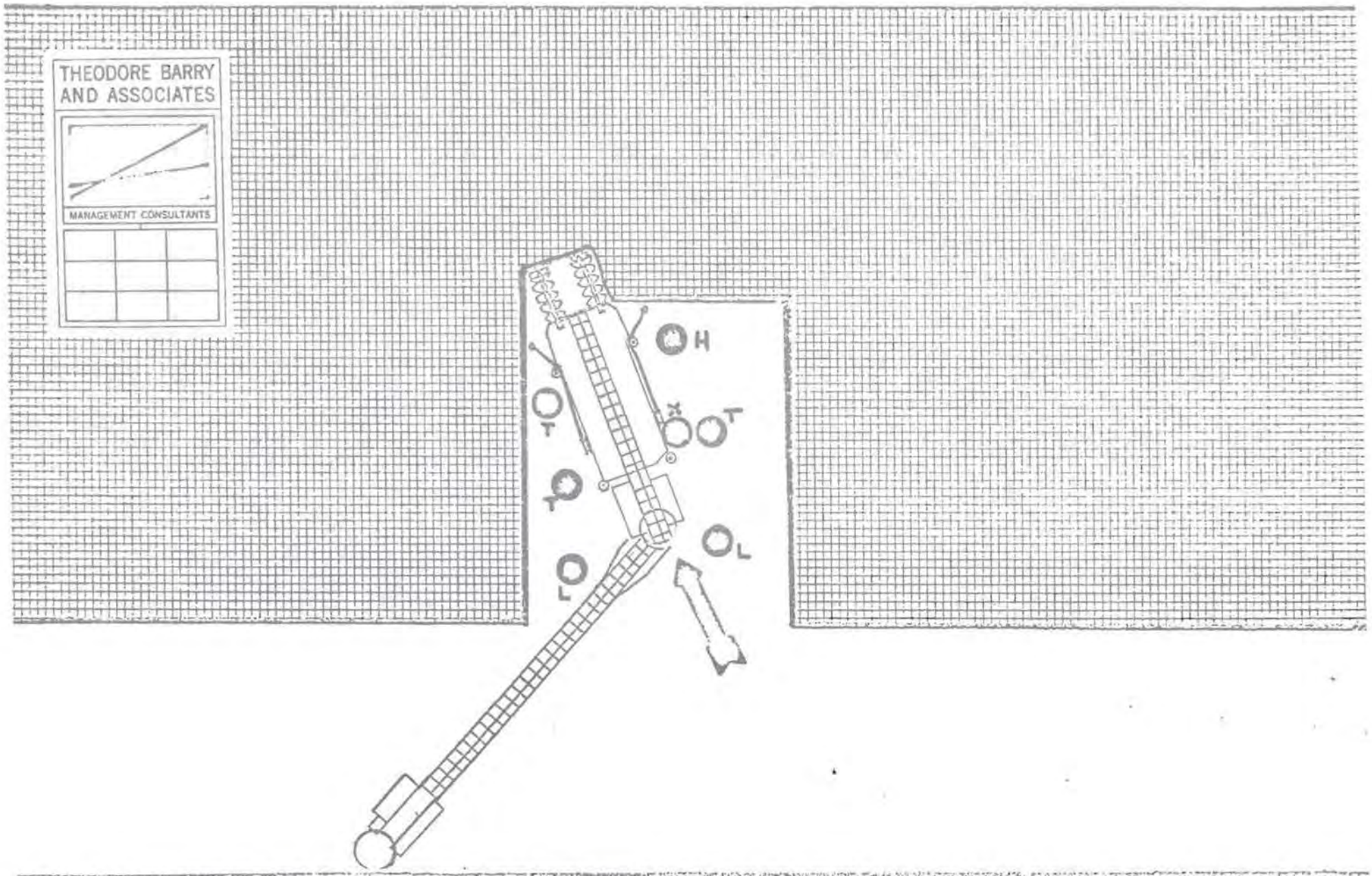

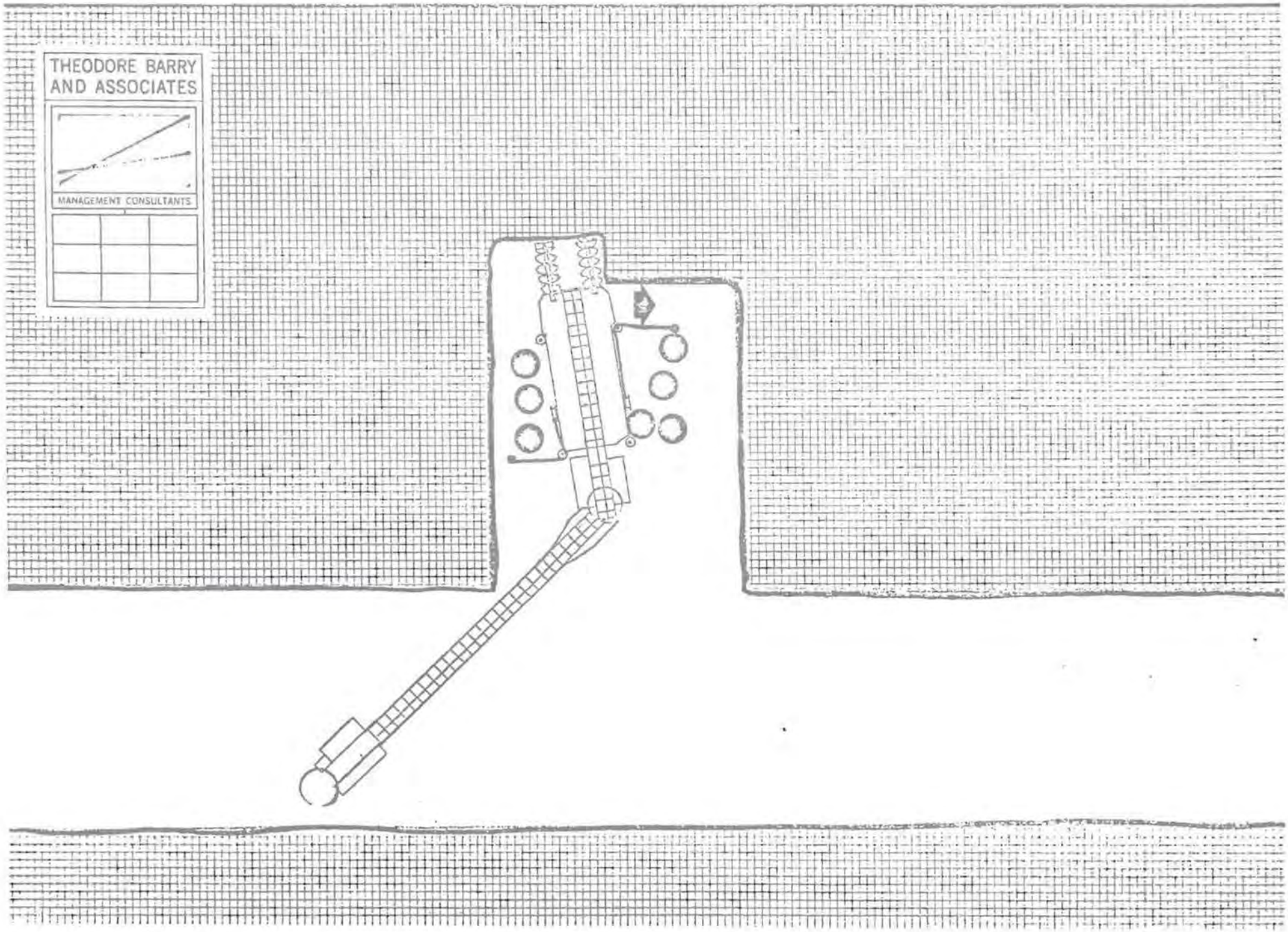
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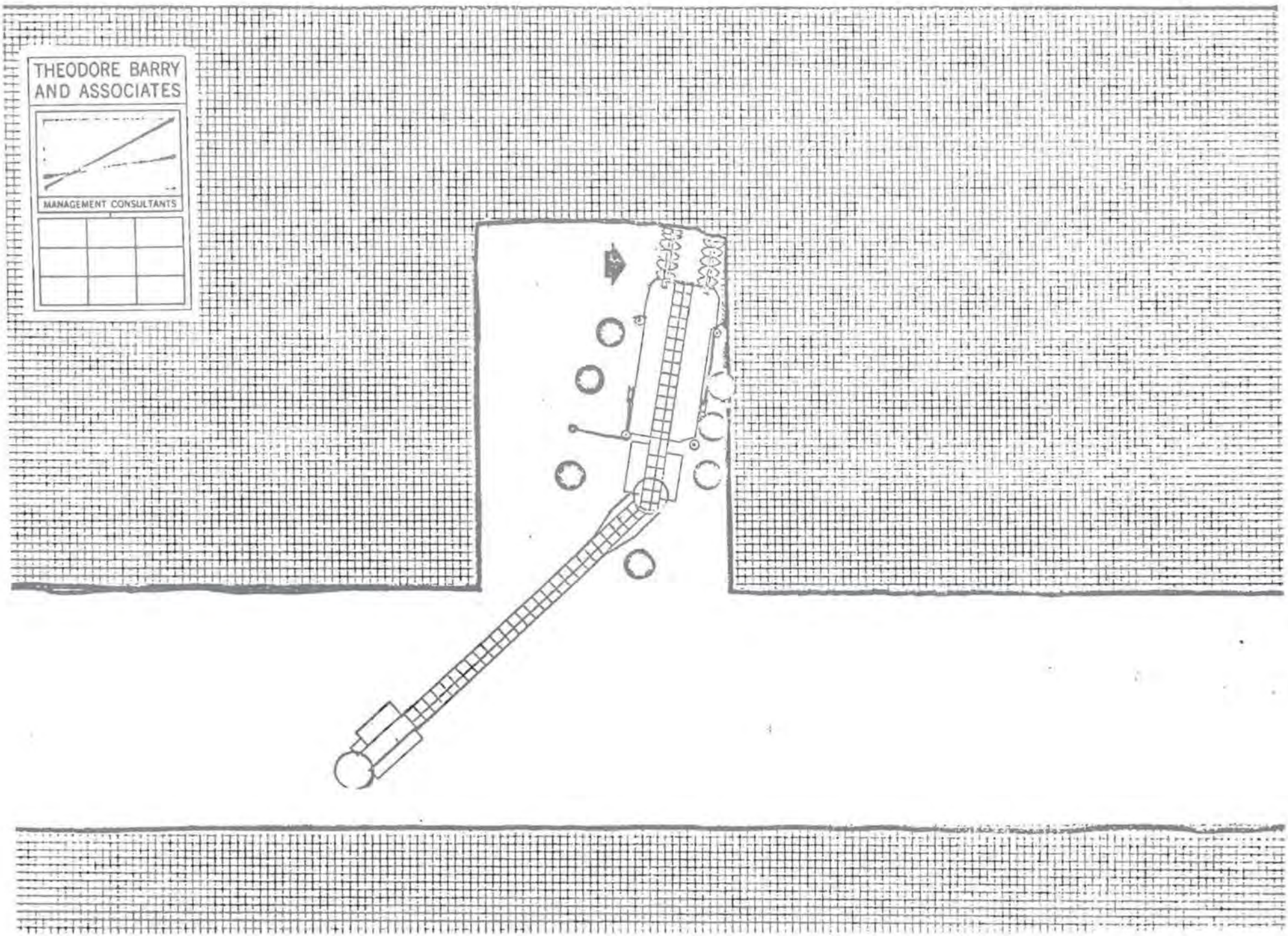
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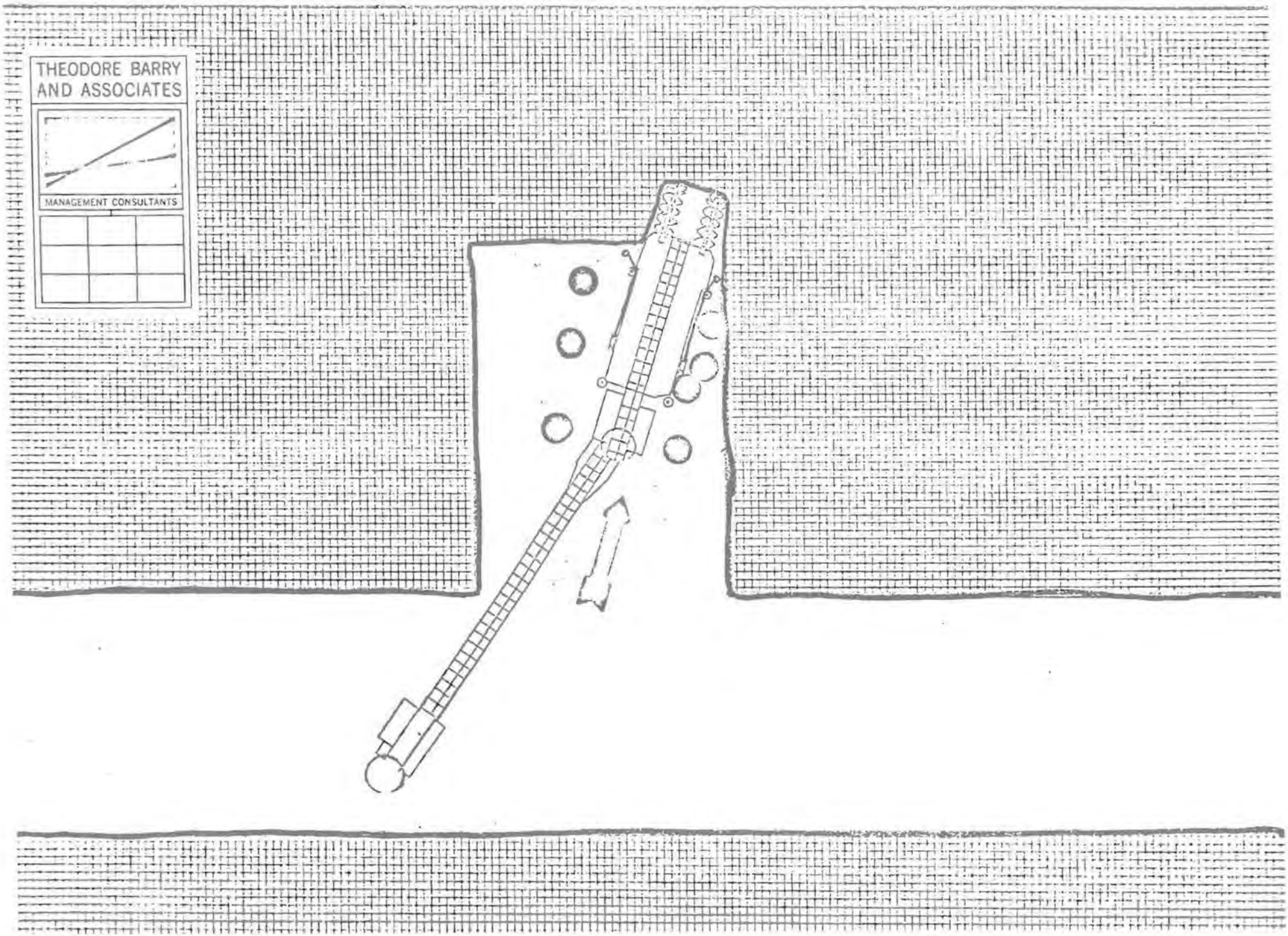
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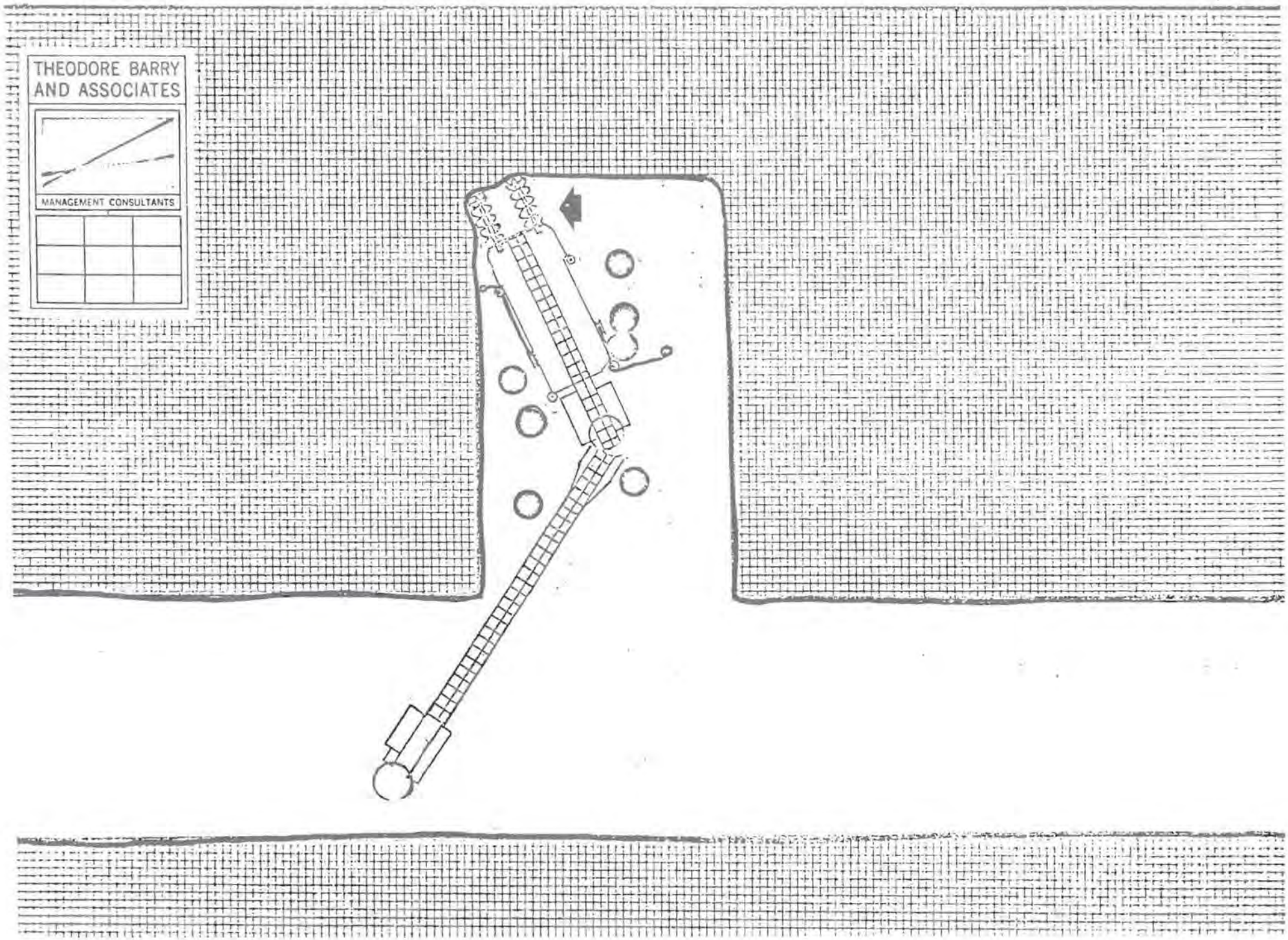
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CHAPTER 3

TYPICAL WORK CYCLE TIMES

This chapter presents work cycle times for the operations inherent to both continuous and conventional mining.

I. DESCRIPTION OF WORK CYCLE DATA

The work element cycle times recorded here are typical times, as opposed to average times. Work conditions, mine environment, mining equipment, lithology, and company operating policies varied so greatly over the 50-mine sample utilized in this study that average cycle times usually proved to be unrepresentative. TB & A consultants have relied upon their in-depth experience in observation of work cycle times at the face to modify average times which did not, in their best judgement, present truly representative or "typical" cycle times for each mine category.

The individual familiar with work cycle standards for various underground operations will also note that total cycle times in many of these work element breakdowns differ considerably from the normal industrial engineering time standards used to estimate such things as production capability. The major reason for these differences -- where they exist -- is that TB & A consultants included downtime, repair time, idle time, tramming time, and all other time elements which constitute the miner's normal routine. These elements were included since the miner may also be exposed to hazardous conditions at these times. In Category #1, for example, belt-clogging and bridge-unhinging were common production malfunctions observed by TB & A consultants in low coal, auger mines. We feel that these malfunctions were common enough during our observations to include them in our "typical" work element breakdown for Category #1, continuous mining.

In other words, the cycles recorded here are not ideal, but rather include the normal, day-to-day mistakes, malfunctions, accidents, and other observed factors which cause the operator to deviate from or exceed his theoretical standard.

An effect of the wide variation of observed work cycle times within a single category is to render the differences in work cycle times between categories less significant. For example, the range of recorded continuous mining cycles in Category #8 was much greater than the difference between the average total

cycle times for Category #4 and Category #8, which were nearly identical. In fact, in three cases, the same work element breakdowns are considered representative for two different categories: Categories 1 and 2, Categories 4 and 8, and Categories 5 and 9.

The ultimate effect of this variability is to suggest that any generalizations relating work element time differences to certain mine characteristics (e.g., seam height, mining style, etc.) must be made with caution. While the 40 to 50 mine sample was a major improvement over the original sample design of 18, it still allowed for detailed time observation in only 2-4 mines per category. (Full shift time-study observations were taken in 40 mines.) In order to give the reader a feel for the variability problem, the range of observed total cycle times is given in addition to the typical work element breakdown for each operation.

II. MINE CATEGORIES

Mines were categorized according to seam height, daily tonnage, and mining style in the following manner:

Seam Height	Daily Tonnage	Mining Style
< 3 Feet	under 200 Tons	Continuous
3 - 5 Feet	201 - 1,000 Tons	Conventional
> 3 Feet	over 1,000 Tons	

The various combinations of these categories result in 18 potential classifications (3 seam heights X 3 tonnage levels X 2 mining styles = 18 classifications). Seven of the 18 possible categories were considered irrelevant. For example, though it is conceivable that a conventional equipment operation in a <3-foot seam could produce more than 1,000 tons per day, there are probably very few such mines currently operating. The seven categories eliminated were:

1.	< 3 Feet	under 200 Tons	Continuous
2.	< 3 Feet	under 200 Tons	Conventional
3.	< 3 Feet	201-1,000 Tons	Conventional
4.	< 3 Feet	over 1,000 Tons	Conventional
5.	3-5 Feet	under 200 Tons	Continuous
6.	> 5 Feet	under 200 Tons	Continuous
7.	> 5 Feet	under 200 Tons	Conventional

Each of these 7 classifications represents a production category that does not significantly contribute either to the fatality problem or to coal production in the United States.

The remaining eleven categories are listed below:

Category		Description	
1.	< 3 Feet	201-1,000 Tons	Continuous
2.	< 3 Feet	over 1,000 Tons	Continuous
3.	3-5 Feet	under 200 Tons	Conventional
4.	3-5 Feet	201-1,000 Tons	Continuous
5.	3-5 Feet	201-1,000 Tons	Conventional
6.	3-5 Feet	over 1,000 Tons	Continuous
7.	3-5 Feet	over 1,000 Tons	Conventional
8.	> 5 Feet	201-1,000 Tons	Continuous
9.	> 5 Feet	201-1,000 Tons	Conventional
10.	> 5 Feet	over 1,000 Tons	Continuous
11.	> 5 Feet	over 1,000 Tons	Conventional

III. WORK ELEMENT ABBREVIATIONS AND DEFINITIONS

In the following tables, work element abbreviations are used in order to simplify the presentation of cycle times. The abbreviation key follows:

TIME STUDY ELEMENTS BY CODES

AE	Add extension	Add drill extension to roof bolter.
AJ	Away jack	Remove jack and put away or aside.
AP	Away prop or post	Remove temporary props or posts.
BC	Block cable	Block equipment cable on floor.
BF	Brush floor	Cut coal from floor with continuous miner.
BR	Brush roof	Clean coal from roof with continuous miner.
CB	Change bit	Replace worn bit(s) to continuous miner, undercutter or roof bolter.
CD	Change drill	Remove starter drill and insert finishing drill to roof bolter.
CL	Clean bit	Clean clogged roof bolter bit.
CR	Clean rib	Continuous miner clean rib; undercutter blade turned vertically to clean rib.
CM	Continuous Mining	Continuous mining or continuous miner.
CT	Carry timber	Carry timbers to working section.
CV	Conventional mining	Conventional mining style
CU	Clean up	Hand load coal with a shovel when equipment is not loading.
D	Delay	Normal or planned delay -- unavoidable.
DB	Dump to belt	Shuttle car unloading point.
DC	Dump to car	Shuttle car unloading point.
DE	Drill extension	Add extension to drill.
DF	Drill face	Drill holes into face to receive charges - specify rock or coal.
DR	Drill roof	Drill hole in roof to receive roof bolt.
DS	Dump to sump	Shuttle car unloading point.
EB	Empty dust box	Empty roof bolter dust collection box.
EX	Extend conveyor	Extend conveyor of continuous or auger miner.
EM	Electrical Maintenance	Repair cables, etc.
GR	Get Ready	Preparation prior to any operation.
HL	Hand load coal	Hand load coal with a shovel while equipment is loading.
HT	Hang tubing	Hang ventilation tubing from roof.
HU	Hookup	Attach charge fuse wires to each other and to the shooting wire.
HW	Hookup water hose	Attach water hose to equipment.
I	Idle	Operator is not performing any task.
IB	Insert and tighten roof bolt	Feed plate over bolt; insert bolt into roof hole and tighten.
IC	Insert and pack	Insert fuse into charge; insert charges into fall hole; pack hole with mud or water bags. Specify rock or coal.
IN	Inspect	Inspect mine conditions.
LS	Load shuttle	Load shuttle car with coal from loader.
ME	Move electrical cables	Move and hang cables at any time during the cycle; remove cables at end of cycle.
MF	Mark face holes	Mark face for locations of charge holes.

MM	Machine maintenance	Routine lubrication and random breakdown. Specify nature of maintenance.
MO	Methane monitor cut-out	> 2% methane shuts-off miner.
MR	Mark roof	Mark roof for proper roof bolt spacing.
MT	Methane test	Check face with methenometer for methane percentage.
MVL	Move left	Auger miner is winched to the left.
MVR	Move right	Auger miner is winched to the right.
NA	Norwood advance	Advancing auger miner.
OH	Off hose	Remove hose from equipment.
OW	Off water; on water	Turn off or on water supply to hose.
PE	Position equipment	Any equipment relocation other than tramming.
PF	General power failure	Mine electrical system fails.
PR	Pry loose	Pry face or wall; does not include scale roof.
RB	Roof bolt	Equal to IB.
RD	Rock dust	Broadcast rock dust manually.
RJ	Reset jack	Remove jack from one location and relocate elsewhere.
RK	Rework	Describe nature of rework.
RP	Remove post/jack	Remove post from one location and reset elsewhere.
RW	Recover wire	Shot fireman recovers wire after shooting coal.
SB	Set brattice	Set posts as necessary and hang brattice.
SC	Shoot coal	Detonate charges electrically.
SF	Sweep floor	Spread mound of coal at face with undercutter blade.
SJ	Set jack	Position and raise jack. Specify mechanical or hydraulic.
SL	Survey layout	Determine face and crosscut centers - plumb bob and tape measure.
SM	Sump	First undercutter blade penetration into face.
SP	Set props or posts	Set wooden props or posts.
SR	Scale roof	Remove loose rock from roof with pry bar.
SU	Sweep undercut	Clean coal from undercut face with undercutter blade.
TH	Test hole	Drill test hole into roof.
TI	Tram in	Move equipment from somewhere else to a working face - specify points.
TO	Tram out	Move equipment from a working face to somewhere else - specify points.
TQ	Torque roof bolt	Torque roof bolt with torque wrench.
TR	Test roof	Place one hand on unsecured roof; tap roof with a steel rod in other hand; listen and feel vibrations.
TS	Transport supplies	Carry supplies to the section or working face from elsewhere.
TV	Turn vertically	Turn undercutter blade to vertical position.
UC	Undercut	Sweep sumped undercutter blade back and forth at face.
UV	Undercut vertically	Cut face vertically.

IV. HAZARDOUS EXPOSURE

The work elements which expose the miner to unsupported roof conditions during a significant percentage of his time in the mine are noted by asterisks in the following tables as "hazardous exposure" time. It will be noted that hazardous exposure comprises a smaller percentage of any particular work cycle than the reader might have initially assumed. This fact seems to conflict with the widely accepted view of the constant environment of danger in which the typical miner operates.

There are several possible explanations for this apparent conflict:

1. It is not the normal work cycle that is hazardous, but rather deviations from the normal cycle which cause most accidents.

2. While some areas may be more hazardous than others, everyplace underground is really an area of "hazardous exposure"; i.e., there are no areas of non-hazardous exposure. The observation that a man is working for brief periods under either supported or unsupported roof is not as decisive a factor in accident analysis as initially thought.

3. TB & A consultants gathering time and work element data underground may have been subject to "observation warp" -- face crews working more carefully and more in accordance with "book" procedure than normal because of the presence of observers.

We believe that each of these possibilities may be true to some extent, and that the degree of significance of each corresponds to their order of listing above.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 1 DESCRIPTION <3 FEET/201-1000 TONS/CONTINUOUS

OPERATION CONTINUOUS MINING (AUGER): OPERATOR

TYPE OF EQUIPMENT WILCOX MARK 25 MINER

WORK ELEMENT		ELAPSED TIME	COMMENTS
GR		.35* Minutes	
SM	Auger Mining Subcycle (AMS)	1.75*	
MVR		7.16*	Machine mines across face @90° angle to coal.
SM		1.75*	Second sump not always necessary.
MVL		7.16*	
D/RJ		6.63*	Miner helpers reset winch jacks.
AMS		24.45*	
D/MM		27.50*	Bridge unhinges from universal conveyor accidently.
AMS		24.45*	
D/MM		26.60*	Wet coal clogs belt.
CU		3.15*	
PE		1.10*	
EX		14.05*	
TOTAL CYCLE		146.10 Minutes	

Notes: 1) It is artificial to define a cycle in Wilcox/Jeffries auger mining operations since there is no classic face-to-face rotation; a cycle was defined arbitrarily here as all operations occurring from one extension of the belt conveyor to the next.

2) Machine downtime and repair time is high in auger operations; production time constitutes about 3 hrs. of an 8-hour shift.

3) Typical mine in this category has roof supported only by posts, which are constantly removed and replaced in working area to allow for movement of miner/bridge/universal conveyor; moreover, during rooming operations in which the miner sweeps back and forth in wide arcs, 80 ft. spans of unsupported roof are not uncommon; for these reasons, TB&A consultants consider all operations in working area subject to hazardous exposure.

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 146.10 minutes, or 100 % of total cycle time.
- Observed total cycle range: 119.25 - 172.00 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 1 DESCRIPTION <3 FEET/201-1000 TONS/CONTINUOUS

OPERATION HELPER/JACK SETTERS/POST SETTERS

TYPE OF EQUIPMENT

WORK ELEMENT	ELAPSED TIME	COMMENTS
SP (15-20 Posts)	19.80* Minutes	1.10 Minutes/Post
RP (15-20 Posts)	6.85*	.38 Minutes/Post
RJ (4 Times)	26.52*	6.63 Minutes/2 Jacks
TS (8-9 Times)	12.30*	1.37 Minutes per trip; job consists mainly of bringing up more timbers for roof support.
I (15-18 Times)	23.00*	1.34 Minutes each time.
CU (15-20 Times)	42.00*	2.34 Minutes each time; shoveling loose coal; moving dislodged timbers.
EX	14.05*	
TOTAL CYCLE	144.52 Minutes	

Notes: 1) Usually, 4 men work in close physical relationship to the continuous miner; 2 of these men work forward -- near the face -- and are classified as miner helpers; 2 work toward the rear of the miner, primarily for the purpose of setting and removing posts. However, all perform essentially the same group of random tasks during the mining cycle, as outlined above: helpers move back to set timbers; timbermen move forward to help set jacks and clean-up, etc. Tasks are performed in no set sequence -- on an as-needed basis.

2) All work elements considered subject to hazardous exposure because of roof support situation described on previous page.

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 144.52 minutes, or 100 % of total cycle time.
- Observed total cycle range: 119.75 - 176.20 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 2 DESCRIPTION <3 FEET/>1000 TONS/CONTINUOUS

OPERATION CONTINUOUS MINING (AUGER); ALL OPERATIONS

TYPE OF EQUIPMENT WILCOX MARK 25 MINER

WORK ELEMENT	ELAPSED TIME	COMMENTS

Note: Typical cycles in this category are identical to those in Category #1; the only difference in this case is a greater number of working sections per mine, leading to higher daily tonnage.

- **Asterisk (*) denotes work element subject to hazardous exposure.**
- **Total hazardous exposure: minutes, or % of total cycle time.**
- **Observed total cycle range: minutes.**

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 3 DESCRIPTION 3-5 FEET/< 200 TONS/ CONVENTIONAL

OPERATION UNDERCUTTING (2 MEN)

TYPE OF EQUIPMENT JOY 11 RU

WORK ELEMENT	ELAPSED TIME	COMMENTS
TI	1.30 Minutes	Tram from previous face.
MT	.65	
SB	3.30	Operator and helper work together.
MM	1.10	Connect water.
SM	1.30	
UC	.52	
PE	.53	
UC	2.12	
PE	.53	
UC	2.12	
PE	.53	
UC	2.12	
SU	.65	
MM	1.10	Disconnect water.
I	1.45	Operator and helper rest before drilling face.
TOTAL CYCLE	19.32 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 0 minutes, or 0 % of total cycle time.
- Observed total cycle range: 11.70 - 22.75 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 3 DESCRIPTION 3-5 FEET/ <200 TONS/CONVENTIONAL

OPERATION FACE DRILLING (2 MEN)

TYPE OF EQUIPMENT 11 RU JOY DRILL (HAND DRILL OPERATING OFF CUTTER)

WORK ELEMENT	ELAPSED TIME	COMMENTS
GR	1.15 Minutes	
DF	.71*	One man supports drill about 1 foot from face; second man operates and guides drill; the man closest to face is about 2 feet under unsupported roof.
PE	.28	
DF	.71*	
PE	.28	
DF	.71*	
PE	.28	
DF	.71*	
PE	.28	
DF	.71*	
PE	.28	
DF	.71*	
CU	1.51	
TOTAL CYCLE	8.96 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 4.26 minutes, or 47 % of total cycle time.
- Observed total cycle range: 6.00-9.20 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 3 DESCRIPTION 3-5 FEET/ <200 TONS/CONVENTIONAL

OPERATION SHOOTING COAL (1 MAN)

TYPE OF EQUIPMENT

WORK ELEMENT	ELAPSED TIME	COMMENTS
GR	1.15 Minutes	
IC	1.36*	Fireman working right at face; about
IC	1.36*	3 feet in by last row of roof bolts.
IC	1.36*	
IC	1.36*	
IC	1.36*	
IC	1.36*	
HU	3.04	
D	4.65	Delay occurs while waiting for men to clear adjacent face area before shooting; 4-5 minute shooting delays are the rule rather than the exception.
SC	.60	
CU	.70	
RW	1.30	
TOTAL CYCLE	19.60 Minutes	Without delay, cycle time = 14.95

Notes: The inserting, packing, and hooking-up of charges are often accomplished by two men instead of one; this doubles hazardous exposure time, and does not decrease work cycle time significantly.

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 8.16 minutes, or 41.6 % of total cycle time.
- Observed total cycle range: 12.75 - 24.00 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 3 DESCRIPTION 3-5 FEET/ <200 TONS/ CONVENTIONAL

OPERATION LOADING (4 MEN)

TYPE OF EQUIPMENT JOY 14 BU LOADER (1); JOY 8 SC SHUTTLE (2)

WORK ELEMENT	ELAPSED TIME	COMMENTS
TI	1.20 Minutes	
SR	.60	Loader operator performs this function.
MT	.40	Loader operator performs this function.
PE	.84	
LS	1.35	
D	1.11	Delay occurs while loader waits for second shuttle.
LS	1.35	
D	1.11	
LS, PE, D (Load-position Subcycle (LPS))	1.35, .84, 1.11	
LPS	3.30	
LPS HL	3.30*	Helper shovels coal in front of loader at face; this occurs simultaneously with loading; he is under unsupported roof during this period.
MM	3.50	
LPS	3.30	
ME	1.73	Helper performs this function
LPS	3.30	
CU	.90	
LPS	3.30	
TO	1.60	
TOTAL CYCLE	35.49 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 3.30 minutes, or 9.3 % of total cycle time.
- Observed total cycle range: 27.16 - 41.50 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 3 DESCRIPTION 3-5 FEET/ <200 TONS/CONVENTIONAL

OPERATION ROOF BOLTING - 8 BOLT CYCLE (1 MAN)

TYPE OF EQUIPMENT GALIS 30-G

WORK ELEMENT		ELAPSED TIME	COMMENTS
TI		1.15 Minutes	. . Tram from previous face.
SJ		.75*	
SJ		.75*	
PE	Roof bolt Subcycle (RBS)	.55* (75%)	
DR		1.19* (75%)	
AE		.30* (75%)	
DR		1.05* (75%)	
IB		.10* (75%)	
Re-SJ		.65*	
RBS		3.19* (75%)	
RP		.45	
RBS		3.19* (75%)	
RP		.45*	
SJ		.75*	
SJ		.75*	
RBS		3.19* (75%)	
Re-SJ		.65*	
RBS		3.19* (75%)	
RP		.45	
RBS		3.19* (75%)	
RP		.45	
RBS		3.19* (75%)	
MM		.75* (75%)	. . Plugged drill.
EB		2.20* (50%)	
RBS		3.19* (75%)	
TO		1.25	. . Tram to next face.
TOTAL CYCLE		36.97 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 25.55 minutes, or 69.1 % of total cycle time.
- Observed total cycle range: 20.25 - 45.70 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 4 DESCRIPTION 3-5 FEET/201-1000 TONS/CONTINUOUS

OPERATION CONTINUOUS MINING (4 MEN)

TYPE OF EQUIPMENT LEE NORSE #26 (1); JOY 8 SC (2)

WORK ELEMENT		ELAPSED TIME	COMMENTS
TI		2.70 Minutes	
PE		1.03	
LS		1.50	
D		1.46	
LS	Load-position Subcycle (LPS)	1.50	
PE		1.03	
D		1.46	
LPS		3.99	
LPS		3.99	
LPS		3.99	
LPS		3.99	
MM		6.15	Operator and helper add oil to motor.
LPS		3.99	
LPS		3.99	
LPS		3.99	
LPS		3.99	
LPS		3.99	
LPS		3.99	
LPS		3.99	
LPS		3.99	
LPS		3.99	
LPS		3.99	
LPS		3.99	
BR		2.00	
BF		1.85	
SB		4.40*.	Helper and operator accomplish this task.
TO		3.50	
TOTAL CYCLE		84.44 Minutes	

- **Asterisk (*) denotes work element subject to hazardous exposure.**
- **Total hazardous exposure:** 4.40 **minutes, or** 5.2 **% of total cycle time.**
- **Observed total cycle range:** 53.20 - 87.40 **minutes.**

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 4 DESCRIPTION 3-5 FEET/201-1000 TONS/CONTINUOUS

OPERATION ROOF BOLTING - 16 BOLT CYCLE (1 MAN)

TYPE OF EQUIPMENT GALIS 50-C

WORK ELEMENT		ELAPSED TIME	COMMENTS
TI		1.15 Minutes	. . . . Tram to next face
TR		.70*	
SJ (3)		4.20*	
GR		4.50	
PE	Roof Bolting Subcycle (RBS)	.34	
DR		.60	
AE		.20*	
DR		.60	
AE		.20*	
DR		.42	
IB		.10*	
RJ		1.33	
RBS		3.79* (50%)	
RBS		3.79* (50%)	
RBS		3.79* (50%)	
EB		1.55	
RBS		3.79* (50%)	
RBS		3.79* (50%)	
RBS		3.79* (50%)	
RBS		3.79* (50%)	
MM		3.50	. . . . Grease machine
RBS		3.79* (50%)	
RBS		3.79* (50%)	
RBS		3.79* (50%)	
RBS		3.79* (50%)	
RBS		3.79* (50%)	
RBS		3.79* (50%)	
RBS		3.79* (50%)	
RBS		3.79* (50%)	
EB		2.00'	
TO		1.15	
TOTAL CYCLE		79.39 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 35.82 minutes, or 42.6 % of total cycle time.
- Observed total cycle range: 45.75 - 60.15 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 5 DESCRIPTION 3-5 FEET/201-1000 TONS/CONVENTIONAL

OPERATION UNDERCUTTING (2 MEN)

TYPE OF EQUIPMENT JOY 11 RU

WORK ELEMENT	ELAPSED TIME	COMMENTS
TI	1.00 Minutes	
MT	.50	
SB	1.90	. . . . . Operator and helper work together.
SM	1.56	
UC	.51	
PE	.43	
UC	1.41	
PE	.43	
UC	2.47	
PE	.43	
UC	2.47	
PE	.43	
UC	2.50	
SU	.93	
I	1.00	
TOTAL CYCLE	17.97 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 0 minutes, or 0 % of total cycle time.
- Observed total cycle range: 14.75 - 18.75 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 5 DESCRIPTION 3-5 FEET/201-1000 TONS/CONVENTIONAL

OPERATION FACE DRILLING (2 MEN)

TYPE OF EQUIPMENT JOY 11 RU FACE DRILL (HAND DRILL)

WORK ELEMENT	ELAPSED TIME	COMMENTS
GR	1.55 Minutes . .	Remove drill from undercutter and hook-up.
MT	.40	
PE	.25	
DF	1.10*	One man supports drill very close to face under unsupported roof; second man guides and operates drill under supported roof.
PE	.25	
DF	1.10*	
PE	.25	
DF	1.10*	
CU	.55	
TOTAL CYCLE	6.55 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 3.30 minutes, or 50.4 % of total cycle time.
- Observed total cycle range: 6.05 - 8.30 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 5 DESCRIPTION 3-5 FEET/201-1000 TONS/CONVENTIONAL

OPERATION SHOOTING COAL (1 MAN)

TYPE OF EQUIPMENT

WORK ELEMENT	ELAPSED TIME	COMMENTS
GR	1.85 Minutes . .	Prepare shot and packing materials.
IC	2.51* (75%) . .	Fireman is 2-3 feet under unsupported roof while working at face.
IC	2.51* (75%)	
IC	2.51* (75%)	
HU	3.35	
CU	.30	
I	2.10	Delay while other miners clear area.
SC	1.70	
RW	1.60	
TOTAL CYCLE	18.43 Minutes	

Notes: Inserting, packing and hooking-up of charges are often handled by two men, doubling hazardous exposure without significantly reducing work cycle time.

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 5.65 minutes, or 30.7 % of total cycle time.
- Observed total cycle range: 14.65 - 21.05 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 5 DESCRIPTION 3-5 FEET/201-1000 TONS/CONVENTIONAL

OPERATION LOADING (5 MEN)

TYPE OF EQUIPMENT JOY 14 BU (1); KERSEY 944 SHUTTLES (2)

WORK ELEMENT		ELAPSED TIME	COMMENTS
TI		1.20 Minutes	
TR		.40	
SR		.40	
PE	Position Load Subcycle (PLS)	.84	
LS		1.20	
D		1.15	Loader is idle while waiting for second shuttle car to return.
PLS		3.19	
PLS		3.19	
PLS		3.19	
PLS		3.19	
PLS		3.19	
BF		.84	
HL		1.95*	Helper shovels coal onto loader apron under unsupported roof.
PLS		3.19	
PLS		3.19	
MM		3.50	Helper and foreman add oil to loader motor.
PLS		3.19	
CU		.90	
I		1.30	Wait for coal to be shot in next face.
TO		1.60	
TOTAL CYCLE		40.80 Minutes	

- **Asterisk (*) denotes work element subject to hazardous exposure.**
- **Total hazardous exposure:** 1.95 **minutes, or** 4.8 **% of total cycle time.**
- **Observed total cycle range:** 24.00 - 57.50 **minutes.**

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 5 DESCRIPTION 3-5 FEET/201-1000 TONS/CONVENTIONAL

OPERATION ROOF BOLTING - 8 BOLT CYCLE (1 MAN)

TYPE OF EQUIPMENT ACME 70-35

WORK ELEMENT		ELAPSED TIME	COMMENTS
TI		.50 Minutes	
TS		1.40	Carry in supply of 30" roof bolts.
SR		.60*	
ME		3.00	
SP		.50*	Only using one temporary support.
PE	Roof Bolting Subcycle (RBS)	.31	
DR		1.28* (50%) . .	No drill extensions required.
RB		.35* (50%)	
RP/SP		.65*	Dislodge post and move it to new position.
RBS		1.94* (40%)	
RP/SP		.65*	
RBS		1.94* (40%) . .	About 40% of the total roof bolting subcycle is hazardous; i.e., about 50% of the drilling and bolting work elements is hazardous.
RP/SP		.65*	
RBS		1.94* (40%)	
RP/SP		.65*	
CB		2.90	
RBS		1.94* (40%)	
RP/SP		.65*	
RBS		1.94* (40%)	
RBS		1.94* (40%)	
RBS		1.94* (40%)	
EB		2.70* (50%)	
CU		.30	
TO		.50	
TOTAL CYCLE		31.17 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 11.95 minutes, or 38.3 % of total cycle time.
- Observed total cycle range: 21.90 - 37.25 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 6 DESCRIPTION 3-5 FEET/ >1000 TONS/CONTINUOUS

OPERATION CONTINUOUS MINING (4 MEN)

TYPE OF EQUIPMENT LEE NORSE 34 (1); JOY 18 SC (2)

WORK ELEMENT	ELAPSED TIME	COMMENTS
TI	3.15 Minutes	
MT	1.03	
GR	1.50	
HT	11.95	Ventilation tubing used instead of brattice in about 15% of total mine sample.
LS	2.05	
D	1.15	Miner is idle while waiting for second shuttle to return.
LS	2.05	
D	1.15	
PE } Position Load	1.69	
LS } Subcycle (PLS)	2.05	
D }	1.15	
PLS	4.89	
PLS	4.89	
PLS	4.89	
PLS	4.89	
PLS	4.89	
PLS	4.89	
BF	1.10	
CU	.85	
PLS	4.89	
PLS	4.89	
PLS	4.89	
PLS	4.89	
PLS	4.89	
PLS	4.89*. . . .	Miner is working at about 45° angle to face during last 2 or 3 shuttle car loads; even though the depth of the face cut does not exceed described limits, the angle of entry puts the operator under unsupported roof during these last cuts.
PLS	4.89*	
PLS	4.89*	
PLS	4.89*	
TO	2.05	
TOTAL CYCLE	106.27 Min.	

- **Asterisk (*) denotes work element subject to hazardous exposure.**
- **Total hazardous exposure: 19.56 minutes, or 18.5 % of total cycle time.**
- **Observed total cycle range: 50.75 - 125.70 minutes.**

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 6 DESCRIPTION 3-5 FEET/ >1000 TONS/CONTINUOUS

OPERATION CONTINUOUS MINING (3 MEN)

TYPE OF EQUIPMENT LEE NORSE CM 26H; WABCO B-26 (1)

WORK ELEMENT		ELAPSED TIME	COMMENTS
Note: This work element breakdown shows particular work element differences in a highly gassy mine; major differences are: 1) delays caused by methane monitor cut-out; 2) utilization of only one shuttle car because heavy brattice necessitated by high air volume; 3) no miner helper because of danger of methane ignition near face.			
TI		1.05 Minutes	
MT		.50	
GR		2.10	
PE	Position Load Subcycle (PLS)	.66	
LS		1.67	
MO		.78	"Red light" shuts down miner; miner does not operate until methane percentage drops below 1.0%.
LS		1.00	
D		2.99	Long delay because only 1 shuttle car is working.
PLS x 17 @ 7.10 = (17 additional cuts identical to the cut outlined above)		120.70	A "gassy" mine averages about one "red light" per cut, i.e., for an 18-cut cycle total red light time - 18 x .78 minutes = 14.0 minutes.
MT		.50	
BF		1.35	
MM		1.10	
MT		.50	
TO		1.40	
TOTAL CYCLE		136.30 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 0 minutes, or 0 % of total cycle time.
- Observed total cycle range: 89.30 - 145.45 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 6 DESCRIPTION 3-5 FEET/ > 1000 TONS/CONTINUOUS

OPERATION ROOF BOLTING - 16 BOLT CYCLE (2 MEN)

TYPE OF EQUIPMENT INGERSOLL-RAND # 32 STOPER

WORK ELEMENT		ELAPSED TIME	COMMENTS
GR		1.40 Minutes	
DR	Roof Bolting Subcycle (RBS)	.80	Operator releases stoper after initial entry into roof; stoper drives self into roof.
AE		.45*	
DR		.80	
AE		.45*	
DR		.80	
AE		.45*	
DR		.80	
IB		.63	
PE		.65	
RBS		5.83	
RBS		5.83* (25%)	
RBS		5.83* (25%)	
RBS		5.83* (25%)	
SJ		2.75* (80%) . .	Jacks are used only where operator feels roof requires it.
RBS		5.83* (25%)	
RBS		5.83* (25%)	
RBS		5.83* (25%)	
RBS		5.83* (25%)	
RBS		5.83* (25%)	
RBS		5.83* (25%)	
RP/SJ		3.65* (80%)	
RBS		5.83* (25%)	
RBS		5.83* (25%)	
RBS		5.83* (25%)	
RP		.90	
RBS		5.83* (25%)	
RBS		5.83* (25%)	

(Continued 2 Page)

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 26.87 minutes, or 25.3 % of total cycle time.
- Observed total cycle range: 95.30 - 123.50 minutes.

WORK ELEMENT	ELAPSED TIME	COMMENTS
(Continued)		
TS	2.10	
ME	.35	
CU	1.80	
TOTAL CYCLE	106.23 Minutes	

Notes: 1) Stoper type roof bolting was observed in less than 5% of the sample mines for this study.

2) Two stopers were often used per section instead of one, but without significant reduction in cycle time, which fell into the 95 - 130 minute range, regardless of the number of stopers used.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 7 DESCRIPTION 3-5 FEET/ >1000 TONS/CONVENTIONAL

OPERATION UNDERCUTTING (2MEN)

TYPE OF EQUIPMENT JOY 16 RB

WORK ELEMENT	ELAPSED TIME	COMMENTS
Note: The following work element breakdown represents a 2-face cycle.		
TI	.95 Minutes	
MT	.65	
SM	2.62	
PE	.45	
UC	1.56	
PE	.45	
UC	1.56	
PE	.45	
UC	1.56	
PE	.45	
UC	1.56	
SU	1.60	
PE	.45	
SM	2.62	Cutter begins second cut at right angles to first cut.
PE	.45	
UC	1.56	
PE	.45	
UC	1.56	
PE	.45	
UC	1.56	
PE	.45	
UC	1.56	
SU	1.60	
I	1.00	Operator and helper rest before face drilling
TOTAL CYCLE	27.57 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 0 minutes, or 0 % of total cycle time.
- Observed total cycle range: 13.70 - 32.35 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 7 DESCRIPTION 3-5 FEET/ >1000 TONS/CONVENTIONAL

OPERATION FACE DRILLING (2 MEN)

TYPE OF EQUIPMENT JOY 16 RB FACE DRILL (HAND DRILL)

WORK ELEMENT	ELAPSED TIME	COMMENTS
Note: The following work element breakdown represents a 2-face cycle.		
GR	3.10 Minutes	
MT	.90	
PE } Position Drill	.49	
DF } With Cycle (PDS)	1.12*.	One man supports drill very close to face under unsupported roof; second man guides and operates drill under supported roof.
PDS	1.61* (70%)	
PDS	1.61* (70%)	
PDS	1.61* (70%)	
PDS	1.61* (70%)	
PDS	1.61* (70%) . . .	Men begin drilling on second face at right angles to first face.
PDS	1.61* (70%)	
PDS	1.61* (70%)	
PDS	1.61* (70%)	
PDS	1.61* (70%)	
TO	.70	
TOTAL CYCLE	20.80 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 11.20 minutes, or 53.8 % of total cycle time.
- Observed total cycle range: 17.20 - 27.10 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 7 DESCRIPTION 3-5 FEET/ >1000 TONS/CONVENTIONAL

OPERATION SHOOTING COAL (1 MAN)

TYPE OF EQUIPMENT

WORK ELEMENT	ELAPSED TIME	COMMENTS
Note: The following work element breakdown represents a 2-face cycle.		
GR	1.95 Minutes	
MT	.50	
IC	1.90* (40%)	
IC	1.90* (40%)	
IC	1.90* (40%)	
IC	1.90* (40%)	
IC	1.90* (40%)	
IC	1.90* (40%)	
IC	1.90* (40%)	
IC	1.90* (40%)	
IC	1.90* (40%)	
IC	1.90* (40%)	
HU	5.80	
I	2.50	
MT	.50	
SC	.10	
RW	1.30	
TOTAL CYCLE	31.65 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 7.60 minutes, or 24.0 % of total cycle time.
- Observed total cycle range: 22.05 - 38.20 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 7 DESCRIPTION 3-5 FEET/ >1000 TONS/CONVENTIONAL

OPERATION LOADING (4 MEN)

TYPE OF EQUIPMENT JOY 14 BU-10 (1); JOY 8 SC (2)

WORK ELEMENT		ELAPSED TIME	COMMENTS
Note: The following work element breakdown represents a 2-face cycle.			
TI		1.90 Minutes	
PE	Position Load Subcycle (PLS)	.52	
LS		1.54	
D		1.45	Loader is idle while waiting for second shuttle.
PLS		3.51	
PLS		3.51	
PLS		3.51	
PLS		3.51	
PLS		3.51	
PLS		3.51	
PLS		3.51	
PLS		3.51	
PLS		3.51	
PLS		3.51	
PLS		3.51	
BF		2.20	
PLS		3.51	
MM		9.50	Operator, helpers and foreman add oil to loader.
PLS		3.51	
PLS		3.51*	Loader angle puts operator under unsupported roof.
PLS		3.51*	
SP/SB		13.40*	Helper accomplishes these tasks; operator helps but stays under supported roof.
TO		2.60	
TOTAL CYCLE		85.76 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 20.42 minutes, or 23.8 % of total cycle time.
- Observed total cycle range: 22.10 - 96.50 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 7 DESCRIPTION 3-5 FEET/ >1000 TONS/CONVENTIONAL

OPERATION ROOF BOLTING - 8 BOLTS PER CYCLE (2 MEN)

TYPE OF EQUIPMENT GALIS 30-C

WORK ELEMENT		ELAPSED TIME	COMMENTS
TI		2.30 Minutes	
GR		2.50	
SP		2.67*	
PE	Roof Bolting Subcycle (RBS)	.80	
DR		2.13	
IB		.25	
RBS		3.18	
RBS		3.18	
RP/SP		2.97*	
RBS		3.18	
RBS		3.18	
RBS		3.18	
RP/SP		2.97*	
RBS		3.18	
RBS		3.18	
LB		2.10* (50%)	
ME		2.57	
TO		1.05	
TOTAL CYCLE		44.57 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 9.66 minutes, or 21.7 % of total cycle time.
- Observed total cycle range: 23.30 - 60.15 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 8 DESCRIPTION > 5 FEET/201-1000 TONS/ CONTINUOUS

OPERATION CONTINUOUS MINING (3 MEN)

TYPE OF EQUIPMENT LEE NORSE CM32 (1); JEFFREY MT 66 (2)

WORK ELEMENT		ELAPSED TIME	COMMENTS
TI		3.75 Minutes	
SR		.90	
SJ		1.05	
SB		.75	. . . . . Continuous miner operator sets brattice.
PE, LS, D	Position Load Subcycle (PLS)	.69, .87, 1.04	. . . . . Delay while miner waits for second shuttle.
PLS		2.60	
PLS		2.60	
PLS		2.60	
PLS		2.60	
PLS		2.60	
PLS		2.60	
PLS		2.60	
PLS		2.60	
PLS		2.60	
PLS		2.60	
PLS		2.60	
PE		.69	
LS		.87	
HL/PE		2.74* (75%)	. . . Miner operator moves to front of mine and hand shovels coal under unsupported roof.
LS		.87	
HL/PE		2.74* (75%)	
LS		.87	
HL/PE		2.74* (75%)	
LS		.87	
HL/PE		2.74* (75%)	
LS		.87	
PLS		2.60	
PLS		2.60	
PLS		2.60	
TO		2.50 = TOTAL CYCLE 61.35 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 8.24 minutes, or 13.4 % of total cycle time.
- Observed total cycle range: 39.80 - 66.05 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 8 DESCRIPTION >5 FEET/201-1000 TONS/CONTINUOUS

OPERATION ROOF BOLTING - 16 BOLT CYCLE (1 MAN)

TYPE OF EQUIPMENT GALIS - 50-C

WORK ELEMENT	ELAPSED TIME	COMMENTS

Note: Typical roof bolting cycle in this category identical to roof bolting cycle in Category #4.

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: minutes, or % of total cycle time.
- Observed total cycle range: minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 9 DESCRIPTION >5 FEET/201-1000 TONS/CONVENTIONAL

OPERATION ALL OPERATIONS

TYPE OF EQUIPMENT SAME AS CATEGORY # 5

WORK ELEMENT	ELAPSED TIME	COMMENTS

Note: Typical cycles in Category #9 all identical to those in Category #5.

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: minutes, or % of total cycle time.
- Observed total cycle range: minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 10 DESCRIPTION ≥5 FEET/ ≥1000 TONS/CONTINUOUS

OPERATION CONTINUOUS MINING (4 MEN)

TYPE OF EQUIPMENT LEE NORSE 38-H (1); JOY 10SC (2)

WORK ELEMENT		ELAPSED TIME	COMMENTS
TI		2.80 Minutes	
TR		.80*	
SB		3.00*	Operator and helper set brattice.
PE	Position Load Subcycle (PLS)	.66	
LS		3.77	
D		1.07	Delay while miner waits for second shuttle.
PLS		5.50	
PLS		5.50	
PLS		5.50	
PLS		5.50	
PLS		5.50	
PLS		5.50	
PLS		5.50	
PLS		5.50	
PLS		5.50	
PLS		5.50	
PLS		5.50	
PLS		5.50	
PLS		5.50* (80%) . . .	Miner is working at about 45° angle to the face during last three or four shuttle car loads; even though the depth of the face cut does not exceed prescribed limits, the angle of entry puts the operator under unsupported roof during these last cuts.
PLS		5.50* (80%)	
PLS		5.50* (80%)	
PLS		5.50* (80%)	
TO		2.20	
TOTAL CYCLE		102.30 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 21.40 minutes, or 20.9 % of total cycle time.
- Observed total cycle range: 68.19 - 114.40 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 10 DESCRIPTION >5 FEET/ >1000 TONS/CONTINUOUS

OPERATION ROOF BOLTING - 20 BOLT CYCLE

TYPE OF EQUIPMENT T-2 CARRYALL TRUCK w/2 INGERSOLL-RAND STOPERS

WORK ELEMENT		ELAPSED TIME	COMMENTS
TI		1.33 Minutes	
SR		.65*	Operator moves under unsupported roof to scale prior to setting jacks.
MR		1.10*	
GR		1.25	
SJ		3.29*	
SJ		3.29*	
SJ		3.29*	
PE	Roof Bolting Subcycle (RBS)	.39	Roof bolter operates entirely under temporary supports; i.e., no hazardous exposure.
DR		1.00	
AE		.25	
DR		1.00	
AE		.25	
DR		1.00	
AE		.25	
DR		1.00	
IB		.10	
RBS		5.24	
RBS		5.24	
RBS		5.24	
RP/SJ		1.60* (40%)	
RBS x 4 @ 5.24 =		20.96	
RP/SJ		1.60* (40%)	
RBS x 4 @ 5.24 =		20.96	
RP/SJ		1.60* (40%)	
RBS x 4 @ 5.24 =		20.96	
ME		4.40	
RP		1.00	
RBS x 4 @ 5.24 =		20.96	
HT		1.95	
TO		1.33	
TOTAL CYCLE		132.48 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 13.54 minutes, or 10.2 % of total cycle time.
- Observed total cycle range: 112.16 - 140.61 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 11 DESCRIPTION >5 FEET/ >1000 TONS/CONVENTIONAL

OPERATION UNDERCUTTING (2 MEN)

TYPE OF EQUIPMENT JOY 16 RB

WORK ELEMENT	ELAPSED TIME	COMMENTS
TI	4.05	
SL	2.70	
PE	.48	
SM	1.43	
UC	.40	
PE	.20	
UC	1.50	
PE	.20	
UC	1.30	
PE	.28	
UC	2.00	
PE	.20	
UC	2.00	
SU	.80	
I	1.00	Operator and helper rest while waiting for end roof bolting operation in next face.
TOTAL CYCLE	18.54 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 0 minutes, or 0 % of total cycle time.
- Observed total cycle range: 17.15 - 29.50 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 11 DESCRIPTION >5 FEET/ >1000 TONS/CONVENTIONAL

OPERATION FACE DRILLING (1 MAN)

TYPE OF EQUIPMENT LONG AIRDOX FACE DRILL

WORK ELEMENT	ELAPSED TIME	COMMENTS
TI	1.70 Minutes	
GR	1.25	
SL	1.25	
MF	1.50*	Operator marks face under unsupported roof; the marks appear to be used only in an approximate way; with this stable drilling platform (i.e. self-propelled drill) face could most likely be drilled without marking.
MT	.30	
PE	.35	
DF	.80	
PE	.35	
DF	.80	
PE	.35	
DF	.80	
PE	.35	
DF	.80	
PE	.35	
DF	.80	
PE	.35	
DF	.80	
PE	.35	
TO	.65	
TOTAL CYCLE	13.90 Minutes	

Notes: Hazardous exposure time during face drilling is greatly reduced by the use of self-propelled face drill instead of a hand drill operating off undercutter (for a comparison, see Face Drilling Categories 3, 5 and 9).

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 1.50 minutes, or 10.8 % of total cycle time.
- Observed total cycle range: 4.30 - 19.80 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 11 DESCRIPTION >5 FEET/ >1000 TONS/CONVENTIONAL

OPERATION SHOOTING COAL (1 MAN)

TYPE OF EQUIPMENT

WORK ELEMENT	ELAPSED TIME	COMMENTS
GR	1.45 Minutes	
IC	.84*	
IC	.84*	
IC	.84*	
IC	.84*	
IC	.84*	
IC	.84*	
HU	3.48	
I	3.65	
SC	.20	
RW	1.75	
TOTAL CYCLE	15.57 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 5.04 minutes, or 32.4 % of total cycle time.
- Observed total cycle range: 9.10 - 48.20 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 11 DESCRIPTION > 5 FEET/ >1000 TONS/CONVENTIONAL

OPERATION LOADING (3 MEN)

TYPE OF EQUIPMENT GOODMAN 1-21 (1); NATIONAL MINE 3 1/2 TON SC (2)

WORK ELEMENT		ELAPSED TIME	COMMENTS
TI		1.90 Minutes	
MT		.95	
PE	Position Load Subcycle (PLS)	.51	
LS		.90	
D		1.50	
PLS		2.91	
PE		.51	
LS		.90	
HL		1.12*	Operator and helper hand load coal and clean up under unsupported roof.
D		.50	
PLS		2.91	
PLS		2.91	
PE		.51	
LS		.90	
HL		1.12*	
D		.50	
PLS		2.91	
PE		.51	
LS		.90	
HL		1.12*	
D		.50	
PLS		2.91	
PLS		2.91	
PLS		2.91	
CU		1.58	
TO		1.90	
TOTAL CYCLE		38.70 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 3.36 minutes, or 8.7 % of total cycle time.
- Observed total cycle range: 25.15 - 66.25 minutes.

TYPICAL CYCLE: WORK-ELEMENT BREAKDOWN

CATEGORY 11 DESCRIPTION >5 FEET/ >1000 TONS/CONVENTIONAL

OPERATION ROOF BOLTING - 8 BOLT CYCLE (2 MEN)

TYPE OF EQUIPMENT GALIS E-24

WORK ELEMENT		ELAPSED TIME	COMMENTS
TI		.90 Minutes	
TR		.30	
MT		.55	
SJ		.62*	
SJ		.62*	
SJ		.62*	
PE	Roof Bolting Subcycle (RBS)	.37	
DR		.90	
AE		.24	
DR		.90	
IB		.40	
RBS		2.81	
RP/SJ		.95*	
RBS		2.81	
RBS		2.81	
RP/SJ		.95*	
RBS		2.81	
RBS		2.81	
RP/SJ		.95*	
RBS		2.81	
RBS		2.81	
EB		1.10	
MM		.50	
TO		1.80	
TOTAL CYCLE		32.34 Minutes	

- Asterisk (*) denotes work element subject to hazardous exposure.
- Total hazardous exposure: 4.71 minutes, or 14.6 % of total cycle time.
- Observed total cycle range: 27.76 - 38.90 minutes.

STANDARD TIME DATA

CATEGORY 1 MINE STYLE CT OPERATION AUGER MINING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Get Ready	0.50 Minutes	0.11
Sump	1.90	0.40
Move Left	6.10	1.55
Move Right	8.30	1.70
Reset Jacks	7.50	1.50
Machine Maintenance	31.00	7.15
Extend Conveyor	15.00	2.05
Position Equipment	1.30	0.20
Clean-Up	4.05	0.55
Methane Test	1.00	0.20
Survey Layout	0.75	0.15

STANDARD TIME DATA

CATEGORY 2 MINE STYLE CT OPERATION AUGER MINING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Get Ready	0.50 Minutes	0.11
Sump	1.90	0.40
Move Left	6.10	1.55
Move Right	8.30	1.70
Reset Jacks	7.50	1.50
Machine Maintenance	31.00	7.15
Extend Conveyor	15.00	2.05
Position Equipment	1.30	0.20
Clean-Up	4.05	0.55
Methane Test	1.00	0.20
Survey Layout	0.75	0.15

STANDARD TIME DATA

CATEGORY 3 MINE STYLE CV OPERATION UNDERCUTTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Machine Maintenance	1.10 Minutes	0
Undercutter Tram -- Non-Specified	2.46	1.06
Set Brattice	5.30	0
Away Anchor Jack	0.70	0.10
Undercut	2.18	1.46
Position Equipment	0.50	0.13

STANDARD TIME DATA

CATEGORY 3 MINE STYLE CV OPERATION SHOOT COAL

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Shoot Coal	0.60 Minutes	0
Lay Out Charges	2.33	1.17
Insert Charges (4 Charges + 4 Packs)	5.23	0.22
Pickup Supplies	0.75	0.05
Hook-Up	3.70	0.45
Recover Wire	1.30	0
Unnecessary Delay	6.83	5.67

STANDARD TIME DATA

CATEGORY 3 MINE STYLE CV OPERATION DRILL FACE

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Get Ready	1.20 Minutes	0.18
Away Face Drill	1.43	0.59
Drill Face Hole	0.78	0.13
Position Equipment	0.26	0.06

STANDARD TIME DATA

CATEGORY 3 MINE STYLE CV OPERATION LOADING -- BATTERY LOADER/ SCOOPER W/2 TON SCOOP (2)

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Unnecessary Delay	17.00 Minutes	0
Raise Scoop/Travel/Dump/Return	2.41	1.08
Load Scoop	2.48	1.69

STANDARD TIME DATA

CATEGORY 3 MINE STYLE CV OPERATION ROOF BOLTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Tram -- Non-Specified	2.45 Minutes	1.97
Set Jack	0.94	0.48
Prepare To Roof Bolt -- Get Supplies	3.30	0
Roof Bolting (36" Bolt/1 Man)	0.56	0.09
Position Equipment	0.47	0.26
Machine Maintenance	0.50	0
Drill Hole	1.90	0.59
Reset Jack	0.60	0.05
Unnecessary Delay	0.63	0.35
Away Jack	0.37	0.07
Empty Dust Box	2.20	0

STANDARD TIME DATA

CATEGORY 4 MINE STYLE CT OPERATION CONTINUOUS MINING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Tram -- Non-Specified	7.73 Minutes	4.08
Machine Maintenance	5.75	2.30
Brush Floor	8.00	4.40
Set Brattice	6.40	0
Position Equipment (During Load)	1.08	0.12
Position Equipment (Between Loads)	1.03	0.52
Unnecessary Delay	0.45	0
Brush Roof	2.85	0
Methane Test	2.30	0
Wait For Shuttle To Return	1.33	1.35
Load 4 Ton Shuttle	1.75	0.24
Load 2 Ton Shuttle	1.12	0.63
Continuous Mine (1771 Cu. Ft.)	0.73	0.35
Continuous Mine And Load (Simult.)	4.19	1.79

STANDARD TIME DATA

CATEGORY 4 MINE STYLE CT OPERATION ROOF BOLTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Roof Bolt w/Header	0.58 Minutes	0.19
Reset Jack	1.33	0.29
Test Roof	0.70	0
Tram -- Non-Specified	1.83	0.74
Remove Jack	0.27	0.04
Set Jack	1.11	0.08
Roof Bolt	0.42	0.14
Position Equipment	0.37	0.13
Empty Dust Box	3.45	0.11
Drill -- 30" Hole	1.62	0.45
Get Ready	5.18	0.67
Machine Maintenance	9.00	0
Block Cables	2.48	0.22

STANDARD TIME DATA

CATEGORY 5 MINE STYLE CV OPERATION UNDERCUTTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Chain Blade	0.60 Minutes	0
Unchain Blade	0.50	0
Set Anchor Jack	1.53	1.20
Set Brattice	29.70	0
Set Post	0.48	0.13
Set Jack	0.50	0
Necessary Delay	0.56	0.14
Hang Electric Cable	2.40	0.50
Undercut	2.90	1.86
Position Equipment	0.40	0.08
Sweep Floor	0.73	0.17
Change Bits	4.10	0
Tram -- Non -Specified	2.24	0.79

STANDARD TIME DATA

CATEGORY 5 MINE STYLE CV OPERATION DRILL FACE

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Methane Test	0.40 Minutes	0
Away Drill Equipment	0.98	0.13
Drill (9" Hole)	1.35	0.11
Drill (8" Hole)	1.09	0.46
Position Equipment	0.39	0.17
Prepare To Drill Face	1.40	0.66

STANDARD TIME DATA

CATEGORY 5 MINE STYLE CV OPERATION SHOOT COAL

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Take Cover And Shoot Coal	2.06 Minutes	0.69
Recover Wire	1.80	0.59
Necessary Delay	0.50	0
Hook-Up (3 Holes)	3.98	2.11
Insert Charges (5 Charges/Hole)	2.35	0.93
Prepare To Insert Charges	2.04	0.29
Carry Supplies To Face	1.13	1.02

STANDARD TIME DATA

CATEGORY 5 MINE STYLE CV OPERATION LOADING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Tram -- #2 Break - #4 Face	3.60 Minutes	0
Tram -- Unspecified	0.78	0.34
Remove Post	0.30	0
Machine Maintenance	3.50	2.00
Away Tools	0.90	0
Unnecessary Delay	1.42	1.03
Scale Roof	0.60	0
Hand Load	2.01	0.59
Hang/Remove Electric Cable	1.40	1.06
Reset Post	1.10	0
Load -- 2 1/2 Ton Shuttle	1.43	0.70
Inspect Roof	0.40	0
Transport Supplies	6.37	1.65
Necessary Delay	1.82	1.64
Position Equipment	0.89	0.49

STANDARD TIME DATA

CATEGORY 5 MINE STYLE CV OPERATION TIMBER

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Inspect Roof/Away Tools	2.60 Minutes	0
Set Post	0.33	0.02
Saw Post	1.60	0.10
Get Posts	0.50	0

STANDARD TIME DATA

CATEGORY 5 MINE STYLE CV OPERATION ROOF BOLTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Inspect Roof	0.25 Minutes	0
Wait For Torquing	4.30	0
Empty Dust Box	3.78	0.92
Replace Bad Roof Bolts	3.65	0
Drill Hole For Brattice Hook	1.03	0.07
Test Roof	0.40	0
Get Roof Bolts	1.51	0.42
Tram -- Non-Specified	0.88	0.42
Necessary Delay	1.78	0.97
Hang Electric Cable	1.74	1.16
Away Tools	0.30	0
Scale Roof	0.60	0
Change Bits	2.90	0
Roof Bolt (36" Bolt)	0.45	0
Roof Bolt (30" Bolt)	0.35	0
Roof Bolt (24" Bolt)	0.48	0.23
Drill (36" Hole)	2.85	0
Drill (30" Hole)	1.53	0.27
Drill (24" Hole)	1.69	0.99
Position Equipment	0.44	0.32
Reset Jack	0.90	0.05
Remove Posts	0.31	0.21
Reset Posts	0.43	0.23
Set Posts	0.42	0.12

STANDARD TIME DATA

CATEGORY 6 MINE STYLE CT OPERATION CONTINUOUS MINING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Check Face	4.35 Minutes	0
Hang Vent. Tubing	11.95	0
Clean Rib	1.75	0
Clean-Up	0.85	0
Scale Roof	1.00	0
Change Bits	17.20	0
Methane Test	1.02	0.73
Machine Maintenance	9.08	5.64
Brush Floor	1.20	0.22
Set Brattice	1.26	0.68
Position Equipment (2 Shuttles)	1.16	0.78
Wait For Shuttle (2 Shuttles)	0.93	0.41
Get Ready	5.10	3.24
Load (2 Shuttles)	2.47	1.17
Load (1 Shuttle)	2.34	1.57
Position Equipment (1 Shuttle)	0.96	0.44
Wait For Shuttle (1 Shuttle)	2.05	1.42
Survey Layout	5.00	0
Tram -- Non-Specified	7.29	4.25
Hang Electric Cable	1.35	1.05

STANDARD TIME DATA

CATEGORY 6 MINE STYLE CT OPERATION PILLARING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Survey Layout	0.30 Minutes	2.50
Get Ready	6.10	0
Advance Into New Cut	0.44	0.20
Withdraw For New Cut	0.46	0.19
Continuous Mine	1.62	0.75

STANDARD TIME DATA

CATEGORY 6 MINE STYLE CT OPERATION ROOF BOLTING (STOPERS)

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Necessary Delay	0.25 Minutes	0
Resupply	5.95	0
Set Posts	1.91	0.60
Transport Posts	0.65	0.24
Hang Electric Cables	0.35	0
Transport Headers	2.10	0
Cut Board (Header)	0.60	0
Unnecessary Delay	0.50	0
Tram Out -- Non-Specified	5.27	3.24
Clean Rib	2.00	0
Torque Bolt	0.40	0
Clean-Up	4.62	1.17
Position Equipment	1.03	0.90
Insert And Tighten Bolt (30" Hole)	0.50	0.26
Roof Bolt (60" Hole)	0.48	0.21
Insert Bolt (60" Hole)	0.50	0.29
Change Drill (60" Hole)	0.22	0.11
Drill W/Stoper (60" Hole)	0.72	0.41
Drill W/Stoper (60" Hole)	0.50	0.29
Drill W/Stoper (30" Hole)	4.42	1.05
Reset Jacks	1.01	0.90
Set Jacks	2.03	0.90
Get Ready	6.35	0.75
Change Drill (60" Hole)	0.47	0.53

STANDARD TIME DATA

CATEGORY 6 MINE STYLE CT OPERATION SHUTTLE CAR

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Travel Empty -- Belt to Loader	0.49 Minutes	0.12
Travel Loaded -- Loader to Belt	0.35	0.04
Dump to Belt	0.64	0.08

STANDARD TIME DATA

CATEGORY 7 MINE STYLE CV OPERATION UNDERCUTTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Position Equipment	0.35 Minutes	0.22
Survey Layout	0.75	0
Machine Maintenance	1.60	0
Get Ready	5.30	0
Sweep Undercut	1.30	0.22
Methane Test	0.70	0.05
Undercut	2.06	1.84
Sump	2.32	0.73
Tram -- Non-Specified	1.37	0.54

STANDARD TIME DATA

CATEGORY 7 MINE STYLE CV OPERATION FACE DRILL

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Methane Test	0.90 Minutes	0
Empty Dust Box	1.00	0
Away Jack	1.50	0
Break Face	2.00	0
Get Ready	9.10	0
Position Equipment	1.00	0.39
Drill Coal	1.22	0.39
Drill Rock	23.10	3.15

STANDARD TIME DATA

CATEGORY 7 MINE STYLE CV OPERATION SHOOT COAL

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Inspect	2.15 Minutes	0
Set Brattice	5.60	0
Shoot Coal	0.13	0.02
Hookup	0.41	0.03
Move to Next Hole	0.34	0.16
Insert Charge - Partial	1.03	0.31
Insert Charge - Complete	1.61	0.22
Methane Test	0.50	0.10
Get Ready	2.37	0.56

STANDARD TIME DATA

CATEGORY 7 MINE STYLE CV OPERATION LOADING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Shuttle Dump to Belt	0.69 Minutes	0.26
Machine Maintenance	5.06	3.17
Set Brattice	0.35	0
Set Jack	1.43	0
Inspect	2.15	0
Hand Pry Face	1.05	0.57
Brush Floor	1.12	0.79
Cable Splice Repair	29.50	3.92
Get Ready	10.50	6.00
Load Shuttle (1 Shuttle)	1.14	0.72
Position Equipment (1 Shuttle)	0.39	0.54
Wait For Shuttle (2 Shuttles)	1.23	1.43
Load Shuttle (2 Shuttles)	0.99	0.76
Position Equipment (2 Shuttles)	0.74	0.56
Tram -- Non-Specified	2.35	1.48
Wait For Shuttle (1 Shuttle)	2.13	1.37

STANDARD TIME DATA

CATEGORY 7 MINE STYLE CV OPERATION ROOF BOLTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Position Equipment (24" Hole)	0.80 Minutes	0.29
Roof Bolt (24" Hole)	0.25	0.07
Drill	2.13	1.14
Away Jack	1.00	0
Electrical Maintenance	6.45	0
Machine Maintenance	4.58	4.07
Scale Face	9.65	6.15
Drill (60" Hole)	3.78	0.90
Scale Roof	2.03	0.87
Replace Loose Bolts	24.10	0
Set Post	1.65	1.10
Roof Bolt (60" Hole)	0.48	0.60
Change Drill (60" Hole)	0.36	0.23
Drill (60" Hole)	0.56	0.35
Get Ready	6.11	4.74
Position Equipment	0.52	0.36
Necessary Delay	0.64	0.57
Test Roof	1.03	0.66
Tram -- Non-Specified	1.32	0.63

STANDARD TIME DATA

CATEGORY 8 MINE STYLE CT OPERATION CONTINUOUS MINING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Load Shuttle (1 Shuttle)	2.79 Minutes	0.79
Position Equipment (1 Shuttle)	1.00	0.40
Wait For Shuttle (1 Shuttle)	1.48	0.44
Hand Load (2 Shuttles)	2.33	1.76
Load Shuttle (2 Shuttles)	1.02	0.28
Wait For Shuttle (2 Shuttles)	0.86	0.62
Position Equipment (2 Shuttles)	0.81	0.46
Machine Maintenance	0.50	0.10
Inspect Face	0.55	0
Set Jack	0.93	0.12
Tram -- Non-Specified	4.22	1.58
Scale Roof	0.90	0
Set Brattice	0.69	0.21

STANDARD TIME DATA

CATEGORY 8 MINE STYLE CT OPERATION ROOF BOLTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Scale Face	0.40 Minutes	0
Away Jack	0.25	0
Drill Thru Header	0.43	0.07
Drill 66" Hole	3.57	0.25
Roof Bolt	0.73	0.15
Lift 10' Header And Roof Bolt	1.66	0.81
Drill 96" Hole	3.78	1.03
Position Equipment	0.73	0.63
Tram -- Non-Specified	3.55	0
Set Brattice	0.30	0
Set Jack	1.98	1.01
Reset Jack	1.35	0
Drill 60" Hole - Stoper	0.62	0.26
Drill 60" Hole - Stoper	0.28	0.09
Position Stoper	0.53	0.25
Necessary Delay - Stoper	2.12	1.00
Hang Electric Cables - Stoper	0.50	0

STANDARD TIME DATA

CATEGORY 9 MINE STYLE CV OPERATION UNDERCUTTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Chain Blade	0.60 Minutes	0
Unchain Blade	0.50	0
Set Anchor Jack	1.53	1.20
Set Brattice	29.70	0
Set Post	0.48	0.13
Set Jack	0.50	0
Necessary Delay	0.56	0.14
Hang Electric Cable	2.40	0.50
Undercut	2.90	1.86
Position Equipment	0.40	0.08
Sweep Floor	0.73	0.17
Change Bits	4.10	0
Tram -- Non-Specified	2.24	0.79

STANDARD TIME DATA

CATEGORY 9 MINE STYLE CY OPERATION DRILL FACE

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Methane Test	0.40 Minutes	0
Away Drill Equipment	0.98	0.13
Drill (9" Hole)	1.35	0.11
Drill (8" Hole)	1.09	0.46
Position Equipment	0.39	0.17
Prepare To Drill Face	1.40	0.66

STANDARD TIME DATA

CATEGORY 9 MINE STYLE CV OPERATION SHOOT COAL

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Take Cover And Shoot Coal	2.06 Minutes	0.69
Recover Wire	1.80	0.59
Necessary Delay	0.50	0
Hook-Up (3 Holes)	3.98	2.11
Insert Charges (5 Charges/Hole)	2.35	0.93
Prepare To Insert Charges	2.04	0.29
Carry Supplies To Face	1.13	1.02

STANDARD TIME DATA

CATEGORY 9 MINE STYLE CV OPERATION LOADING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Tram -- #2 Break - #4 Face	3.60 Minutes	0
Tram -- Unspecified	0.78	0.34
Remove Post	0.30	0
Machine Maintenance	3.50	2.00
Away Tools	0.90	0
Unnecessary Delay	1.42	1.03
Scale Roof	0.60	0
Hand Load	2.01	0.59
Hang/Remove Electric Cable	1.40	1.06
Reset Post	1.10	0
Load -- 2 1/2 Ton Shuttle	1.43	0.70
Inspect Roof	0.40	0
Transport Supplies	6.37	1.65
Necessary Delay	1.82	1.64
Position Equipment	0.89	0.49

STANDARD TIME DATA

CATEGORY 9 MINE STYLE CV OPERATION TIMBER

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Inspect Roof/Away Tools	2.60 Minutes	0
Set Post	0.33	0.02
Saw Post	1.60	0.10
Get Posts	0.50	0

STANDARD TIME DATA

CATEGORY 9 MINE STYLE CV OPERATION ROOF BOLTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Inspect Roof	0.25 Minutes	0
Wait For Torquing	4.30	0
Empty Dust Box	3.78	0.92
Replace Bad Roof Bolts	3.65	0
Drill Hole For Brattice Hook	1.03	0.07
Test Roof	0.40	0
Get Roof Bolts	1.51	0.42
Tram -- Non-Specified	0.88	0.42
Necessary Delay	1.78	0.97
Hang Electric Cable	1.74	1.16
Away Tools	0.30	0
Scale Roof	0.60	0
Change Bits	2.90	0
Roof Bolt (36" Bolt)	0.45	0
Roof Bolt (30" Bolt)	0.35	0
Roof Bolt (24" Bolt)	0.48	0.23
Drill (36" Hole)	2.85	0
Drill (30" Hole)	1.53	0.27
Drill (24" Hole)	1.69	0.99
Position Equipment	0.44	0.32
Reset Jack	0.90	0.05
Remove Posts	0.31	0.21
Reset Posts	0.43	0.23
Set Posts	0.42	0.12

STANDARD TIME DATA

CATEGORY 10 MINE STYLE CT OPERATION SET TIMBERS

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Load Timbers	2.35 Minutes	1.21
Set Timber	0.85	0
Survey Layout	0.65	0
Clear Entry	1.30	0
Examine Roof	1.90	0
Transport Supplies	2.99	3.41
Get Ready	1.85	0
Position Equipment	1.05	0
Set Jacks	3.34	2.50
Set Pulley	1.45	0
Clean Rib	2.75	2.01
Clean-Up	1.70	0
Measure Roof	2.50	0
Cut Timber	1.45	0.59
Unnecessary Delay	4.55	0
Set Posts	3.85	0.27
Necessary Delay	1.30	0

STANDARD TIME DATA

CATEGORY 10 MINE STYLE CT OPERATION ROOF BOLTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Tram -- Non-Specified (Stopers)	2.29 Minutes	0.99
Hang Electrical Cables (Stopers)	4.40	0
Necessary Delay (Stoper)	1.67	1.28
Position Equipment (Stoper)	0.33	0.20
Set Jack	2.95	1.73
Drill 60" Hole (Stoper)	1.67	0.57
Change Drill - 60" Hole (Stoper)	0.91	0.53
Insert Bolt - 60" Hole (Stoper)	0.95	0.62
Roof Bolt - 60" Hole (Stoper)	0.71	0.40
Drill 60" Hole (Stoper)	1.31	0.82
Remove Jack	1.60	0.85
Mark Roof	1.10	0
Get Ready	1.25	0.75
Hang Vent. Tubing	4.18	2.22
Clean-Up (Stopers)	3.20	0

STANDARD TIME DATA

CATEGORY 10 MINE STYLE CT OPERATION CONTINUOUS MINING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Tram -- Non-Specified	2.97 Minutes	1.33
Wait For Shuttle (2 Shuttles)	1.40	0.95
Continuous Mine (2 Shuttles)	2.02	1.10
Position Equipment	1.09	0.34
Unnecessary Delay	1.15	0
Secure Brattice	3.48	1.71
Check Roof	0.80	0
Machine Maintenance	4.75	6.38

STANDARD TIME DATA

CATEGORY 11 MINE STYLE CV OPERATION UNDERCUTTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Tram -- Specified -- Face - Same Int	0.83 Minutes	0.37
Tram -- Specified -- #1 Face - #5 Face	6.10	0
#5 Face - #4 Face	2.00	0
Clean Rib	12.05	1.38
Tram -- Non-Specified	2.56	1.97
Clean-Up	1.20	0
Sweep Floor	0.50	0
Sump	2.05	0.15
Position Equipment	0.62	0.43
Sweep Undercut	0.63	0.34
Get Ready	0.40	0.10
Machine Maintenance	1.55	0.05
Hook Up Water	0.50	0.14
Turn Cutter Bar Vertically	0.90	0.10
Vertically Cut Face Center -- 12" Rock	4.39	3.20
Position Equip. w/Cutter Bar Vertical	0.50	0
Shear Rt. Rib (Bar Vertical)	4.05	2.12
Off Water & Hose	0.70	0.14
Rewind Water Hose	1.43	0.52
Hang Electrical Cable	0.80	0.40
Change Bit (Per Bit)	0.08	0
Undercut	10.64	3.10

STANDARD TIME DATA

CATEGORY 11 MINE STYLE CV OPERATION FACE DRILLING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Survey Layout	1.13 Minutes	0.12
Mark Face	1.00	0.50
Methane Test	0.25	0.05
Get Ready (Long Airdox)	1.20	0
Drill Coal -- Long Airdox (L.A.)	0.77	0.15
Tram -- Non-Specified (L.A.)	1.44	0.57
Tram - Specified #3 Int. - #1 Face	1.70	0
Tram - Specified #1 Face - #1 Int.	0.65	0
Tram - Specified #4 Int. - #4 Face	0.48	0.02
Position Equip (Long Airdox)	0.33	0.18
Drill Rock (L.A.)	0.95	0.48
Machine Maintenance (L.A.)	2.55	1.85
Change Bit (L.A.)	0.65	0
Clean Bit (L.A.)	0.90	0.55
Disconnect Hose (L.A.)	0.50	0
Set Jack (L.A.)	0.80	0
Drill Face (Hand Drill)	1.10	0.87
Position Equipment (Hand Drill)	0.29	0.37
Tram -- Non-Specified (Hand Drill)	2.25	0.70
Change Bit (Hand Drill)	0.45	0

STANDARD TIME DATA

CATEGORY 11 MINE STYLE CV OPERATION SHOOTING COAL

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Hook-Up	3.27 Minutes	1.02
Insert Charge (4" rock/3" coal)	1.09	0
Insert Charge (4" coal)	0.84	0.08
Insert Charge (4" coal)	0.81	0
Insert Charge (5" rock/2" coal)	1.22	1.26
Recover Wire	1.39	0.29
Shoot Coal	0.22	0.04
Fill Dummies w/Water	0.20	0
Re-Supply At Face	2.98	3.23
Away Supplies From Face	1.00	0
Misfire (Unnecessary Delay)	2.25	0
Methane Test	0.45	0.10
Insert Charge & Hook-Up	1.50	0.03

STANDARD TIME DATA

CATEGORY 11 MINE STYLE CV OPERATION LOADING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Shuttle Dump To R.R. Car	0.61 Minutes	0.08
Load Shuttle (2 Shuttles)	1.49	0.98
Wait For Shuttle (2 Shuttles)	1.14	1.00
Position Equipment (2 Shuttles)	0.56	0.26
Machine Maintenance - Loader	4.80	0
Machine Maintenance - Shuttle	1.73	0.72
Remove Rock From Loader	0.75	0.25
Tram -- #1 Face - #1 Intersection	1.10	0
Tram -- #2 Face - #2 Intersection	1.10	0
Tram -- Non-Specified	1.45	0.83
Disconnect Hoses	0.65	0.02
Set Jack	0.80	0
Unnecessary Delay (2 Shuttles)	8.66	9.85
Hang Electrical Cables	1.14	1.23
Position Equip. For Clean-Up Loading	1.36	0.40
Clean-Up -- Load Shuttle Car (2 Shuttles)	2.64	0.65
Sweep Floor	1.05	0.44
Set Brattice	0.80	0.15
Methane Test	0.80	0.05
Unnecessary Delay (2 Shuttles)	16.40	0
Get Ready	2.00	0
Position Equipment (1 Shuttle)	0.95	0
Load Shuttle (1 Shuttle)	1.16	0.18

STANDARD TIME DATA

CATEGORY 11 MINE STYLE CV OPERATION ROOF BOLTING

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Hang Electrical Cables	1.75 Minutes	1.40
Survey Layout	1.50	0.60
Necessary Delay	0.91	0.70
Rework Bad Hole	1.10	0
Drill Core	1.35	0
Transport 12' Header	0.85	0.10
Set Header	0.90	0
Set Post	1.80	0.70
Get Supplies	7.03	5.47
Break Face	1.08	0.32
Test Roof	0.50	0.20
Tram -- Non-Specified	1.36	0.34
Tram -- Specified - Int. - Same Face	0.55	0.20
Tram -- Spec - #2 Face - #1 Face	1.20	0
Tram -- Spec - #1 Face - #3 Int.	1.50	0
Tram -- Spec - #3 Int. - #2 Int.	1.50	0
Empty Dust Box	1.17	0.17
Set Jack	0.91	0.21
Reset Jack	0.44	0.22
Remove Jack	0.55	0.14
Set Jack w/Header	2.10	0.55
Scale Roof	2.48	1.98
Machine Maintenance	1.76	1.30
Measure Roof Bolt Holes	0.88	0.17
Roof Bolt (48" Hole w/Header)	0.34	0.05
Roof Bolt (48" Hole)	0.28	0.09
Raise 12' Header & Roof Bolt (60" Hole)	0.95	0.27
Roof Bolt (60" Hole)	0.28	0.25
Roof Bolt (60" Hole w/1 Header) 2 Men	0.42	0.12
Roof Bolt (60" Hole w/2 Headers) 2 Men	0.44	0.13
Roof Bolt (60" Hole w/2 Headers) 1 Man	0.90	0
Drill 60" Hole (Bit Change Included)	1.89	0.51
Drill 48" Hole (Bit Change Included)	1.58	0.40
Drill 48" Hole (Bit Change Included)	1.08	0.37
Position Equipment	0.32	0.15
Change Bit	1.17	0.48
Methane Test	0.95	0.50

STANDARD TIME DATA

CATEGORY 11 MINE STYLE CV OPERATION ROOF BOLTING - STOPER

ELEMENT DESCRIPTION	MEAN ELAPSED TIME	STANDARD DEVIATION
Drill 60" Hole(Includes Change Drill)	2.65 Minutes	0.71
Roof Bolt 60" Hole	0.90	0.28
Position Stopers	0.38	0.16
Get Ready	2.10	2.48
Tram -- Unspecified	4.25	0