S K E G A

HISTORY

DESIGN

EXPERIENCE

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HISTORY

The A-S-H PUMP Division of Envirotech, has represented SKEGA of Sweden, since 1962. SKEGA has been manufacturing rubber wear components for many years, and rubber mill linings since 1959. The concept of rubber mill linings began in the early nineteen twenties, when the first tests were made in the United States. Various attachment systems and rubber compounds were tried with very little success. It was determined at that time that rubber could not compete with steel in the wear component market. Similar trials were subsequently conducted in other countries, with equally unsatisfactory results.

In 1959, SKEGA began full scale wear tests, using various rubber compounds, in cooperation with Boliden AB, a mining company, in Sweden. Some of these tests met expectations and indicated better wear characteristics than steel. Industrial use of rubber mill linings began in 1961, with the introduction of the SKEGA lining system. Today, Seventy percent of all rubber lined grinding mills in operation, world-wide, are equipped with SKEGA linings. A-S-H PUMP Division of Envirotech, is the exclusive U.S. licensee, for SKEGA. The industries which we serve include those mining silica, carbon, cement, pigments, mica, limestone, lead, zinc, copper, silver, nickel, gold, iron, and phosphate rock. Figure 1 represents a list of early installations. We have lining systems operating in mills of sizes ranging from three feet in diameter to seventeen feet in diameter. This does not include components provided for larger autogenous mills. We have provided mill linings for most of the grinding mill manufacturers in the United States. (Figure 2). There are presently over two hundred A-S-H SKEGA lined mills operating in the United States. We do not presume to design grinding mills. That is the purview of the mill manufacturers. After the user has chosen the mill, we do feel well qualified to recommend the type of linings to be applied.

DESIGN

It was discovered very early that little knowledge of the wear properties, or applications, of steel linings, could be used in the design of rubber linings. In order to utilize the characteristics of rubber, the current plate and lifter bar system was developed. The choice of plate thickness, width, and heigth of lifter bars, distance between the bars, shape of bars, all influence wearing capacity. These are in turn, directly determined by analysis of mill diameter, mill speed, choice of grinding material, and feed size. In addition, the design is influenced by consideration of corrosion, mill temperature, and chemical additives. The usual chemical composition of material ground, does not affect the rubber. The inclusion of petroleum based reagents from flotation processes, could be of importance, but they normally do not appear in high enough concentration to be considered.

The normal internal temperature limitation is eighty degrees, centrigrade. In batch mill applications, this temperature limitation can be allowed to reach a higher level. We design for impact by taking advantage of the elasticity of the rubber, when applied in the proper thickness, and with a flexible fastening system. The most important variables, from the point of view of wear, are: feed size, grinding media size, mill speed, and mill diameter. Ball sizes are generally limited to about eighty five millimeter in diameter, due to economical considerations versus wear. As a general rule, hard ores fed to the mill should not be coarser than eighty percent, passing six millimeters.

Comparatively soft ores, like phosphate, or cement clinkers, should not be coarser than eighty percent, passing twenty five millimeters. Larger feed size becomes undesirable because of the large ball diameters required, and results in high wear and less efficient grinding.

Consideration of mill speed indicates that the best economy is maintained at speeds below seventy eight percent of critical. When these various parameters have been considered, specifically corrossion, impact, abrasion, feed size, and hardness, the grinding media and size, mill speed and mill diameter, lifter spacing and height, a recommendation can be made as to the best type and configuration of lining for your mill. This data, applied to a nomograph, based on operating experiences from over sixteen hundred mills, provides a choice of the proper components, necessary for construction.

By studying the examples given, (Figure 3), you can see that the nomograph is designed to indicate three alternatives: maximum capacity, good life time and capacity, or maximum life span. The choice is then basically made at the customers direction.

EXPERIENCE

Our phosphate experience is based on three mills in operation at this time. The lining components for the fourth mill are on site, and will be installed sometime in June. There are also three mills in similar service in the cmenet industry in South Florida. We are aware of two other mills operating in phosphate service with competitors liners. We feel that we have demonstrated both the applicability and the practicality of rubber ball mill linings, in the wet phosphate grinding.

From January 1, 1977 to March 31, 1978, the three mills have processed a cumulative total, in excess of 2,450,000 tons of rock. Currently, one of these mills is schedule for replacement of one half of the lifter bars in June. At that time, the operating cost, based on parts replaced, will be .014 dollars per ton. Tons processed will be in excess of 730,000. Our records suggest that this mill could be operated to approximately 850,000 + tons, before scheduled replacement. At that point, the cost would be .012 dollars per ton. In this case, the mill superintendent has done an excellent job of maintaining a seasoned ball charge, at the manufacturers recommended level.

We are not implying that this is the first parts replacement to be performed. We have had problems. The problems resulted from poor field installation and depleted ball charge. Repairs were effected at no cost to the customer for components or supervision. The experience was traumatic for A-S-H and the customer, but the knowledge gained was important to the art of wet phosphate grinding.

There are several considerations to be made when planning for a major lifter bar and/or shell plate replacement. Since it can take two to three days, it should be coordinated with the Sulfuric Acid Plant turn-around. Consideration of lifter bar replacement, (Figure 4) is recommended when the height of the trailing edge of the lifter bar, above the shell plate, is worn to approximately one half the diameter of the grinding balls. Shell plate replacement is recommended when the plate thickness, adjacent to the leading edge of the lifter bar, has been reduced to a thickness of approximately one inch. These guide lines will vary with size of grinding media and milling conditions. The lining system is designed so that two to three sets of lifter bars will be replaced during the life span of the shell plates. Shell plates are reversible, in most mills, so the above ratio may be increased.

This procedure is often followed in other countries, but we have no data to indicate that it is economically feasible in the United States. The labor, in this case, would be approximately the same as required in a complete re-lining.

To obtain maximum wear and minimum scrap from a lining system, we recommend an inspection be made about every thirty days, on a regularly scheduled plant maintenance day. This takes about two hours. Profile measurements of the lifter bars, head plates, and shell plates, are recorded and plotted on a full scale mill drawing. This helps establish a wear rate and pattern for planned lining maintenance.

We have been making these inspections for the phosphate operators in order to gather and correlate as much specific phosphate data as possible, in a short time span. The data is reproduced on a full scale mill drawing and becomes a part of our inspection report. (Figure 5) Our current records in phosphate milling, cover about eighteen months of operation. With about twelve months data on a specific mill, the inspections can be reduced in frequency, due to the established pattern of wear.

Good wear life is a function of good operating practices. A practical approach should be taken to the elimination of tramp iron from the feed. Tie plates, wrenches, pry bars, and oversize balls, are commonly observed and can result in serious spot damage.

The ball charge should be maintained at the mill manufacturers recommended level. Most operators do this on a weekly basis. In addition, some operators add a seasoned charge. Normal usage is from 0.6 to 0.8 pounds per ton of rock ground. A nominal ball size of 1-1/2 inch appears to provide the best product results.

Feed rate should be maintained above 80% of rated mill capacity. Reduced feed rate causes accelerated wear, due to increased ball contact with the lining. We have specifically experienced this phenomenon. This is not a problem after the plant start up period, when rated operating loads have been obtained.

Quality of feed is important. Excess clay or slime apparently has a degrading effect on the grinding efficiency.

In preparing specifications or criteria for a rubber mill lining, consideration is often given to tons ground or processed. Perhaps a different approach should be taken.

An Acid Plant turn-around often governs the down time available to change out lifter bars, shell plates, and/or head plates. Therefore, a specification coordinating component replacement with plant turn-around, is more practical.

For example, the first lifter bar change out should occur after X months of operation; the second, after Y months of operation, and the shell and/or head plates, after Z months of operation. The time period referred to, of course, should be the periods between turn-around, in Sulfuric Acid Plants.

Specifications should also request that the fastening system be flexible in order to take full advantage of the elasticity of the rubber. Since rubber must be installed in compression to provide good wear life, and prevent errosion at the joints, and wash-outs, of the metal shells, factory supervision should be provided during the initial installation.

Summarizing our experiences:

(1) Wave type rubber linings do not perform well in wet phosphate grinding.

(2) Dimensional accuracy must be maintained through manufacturing and installation periods, to insure good wear life.

(3) A flexible fastening system is necessary to take full advantage of the elasticity of the rubber.

(4) Quality of feed with respect to metal tramp and clay content is important.

(5) Quality and size of balls must be considered.

(6) Ball charge level must be maintained to prevent excessive wear.

(7) Wear life will be equal to, or exceed that of steel, and will increase with the hardness of the rock.

(8) Wear life at or above rated load is generally better than below rated load.

(9) Maintenance and repair is faster, safer, and less expensive, than steel, due to the lighter weight of the rubber components.

(10) The ambient noise level in the mill area is drastically reduced, which is becoming more and more important, due to OSHA and MESA requirements.

CHART II

EARLY INSTALLATIONS

	Mill Size	Med. Size	N%	Initial Yr. Inst.	10 YR. 1968	1978
1. A.S. & R Mission, AZ	10½' x 15'	2"Ø		1965	1/3 Out	- 0 -
2. A.S. & R Silver Bell AZ	7' x 14'	3/4"	75%	1964	= Out	- 0 -
3. Anac. Butte Montana	12½' x 21'	(1" x 4")	75%	1964	=+	$11_p + 6_R$
4. Carborundum Co. New York	6' x 22" Con.	1"	80%	1964	=+	7 + 2 Batch
5. Cities Service, Texas	11'x3'x6'x10'	1"	65%	1966	=+	(4) + 3 E.P.D.
6. Marquette Iron (C.C.I.)Rep.	10½' x 14'	1½"	64.5%	1964	=+	Rep. (1) 10½'x14' (1) 11½' x25' (3) 10½' x19½'
7. C.C.I. Empire, Michigan	12½' x 24'	(1" x 3")	77-78	1967	(-)	Emp. 1 - 15½' x 25' 5 - 15½' x 31'8" 1- 10½' x 16' Research 1- 7' x 10'
8. Climax, Col.	9' x 8'	3"	75½	1965	(-)	Climax 5 - 8' x 20' 3 - 6'8 x 20' Henderson 4 - 10'8 x 20 3 - 8' x 10' 1 - 10'8 x 10'
9. Crystal Silica, CA	7' x 6'	2"	65%	1966	+	3
10. Duval Corp. AZ	12½' x 14'	2½"		1965	(-)	- 0 -
11. Erie Mining, MN	12'2" x 14'	2"	79.6%	1965	(-)	- 0 -
12. Hanna Gr. Michigan	10'8" x 10'	1¼"	69%	1964	+	4 - 10'8" x 10' 3 - 9' x 9' 1 -16½' x 18'
13. Inspiration Co.	10½' x 14'	2"	74%	1964	(-) Out	- 0 -
14. Kennecott Co. Hayden	7' x 10' 7' x 12'	2" 2"	74% 74%	1964 1964	= (-)	2 - 7' x 10' +
15. Kennecott Co. Hurley	10½' x 14' 7' x 12'	2½" 2½/3"	70% 67%	1964 1964	(-) Out (+) Out	- 0 -
16. Reserve Mining MN	10½ x 16	2"	79%	1966	-(60%m)	4

Figure 1

MILL MANUFACTURERS

Allis Chalmers

Denver

F. L. Schmidt

Kennedy Van Saun

Koppers

M. S. I.

Nordberg

Straub

Traylor

Dominion

El Paso Iron

FIGURE 2

Selection of rubber lining parameters

In accordance with the above criteria, and having collected data from more than sixteen hundred grinding mills, it has become possible to show diagrammatically how to design a rubber lining. Three alternatives are considered:

1. Maximum capacity
2. Good lifetime and capacity
3. Maximum life span

Different sizes of balls, pebbles and rods have been taken, and for each interval a series of different diagrammes has been constructed for various diameters of grinding mills.

The example (fig. 25) has been constructed for 30–50 mm balls; feed max. 4 mm (5 mesh); mill diameter 3.0–4.0 m.

Let us assume that we have the following conditions: mill = Ø 3.5 m, length 4.5 m, balls = 35 mm, max. feed = 3 mm, speed = 17 rpm (75 % of critical), number of rows of holes on the shell = 28 (corresponding to A = 400 mm). Diagrammes for alternatives 1, 2 and 3 are given in figs. 26, 27 and 28, respectively.

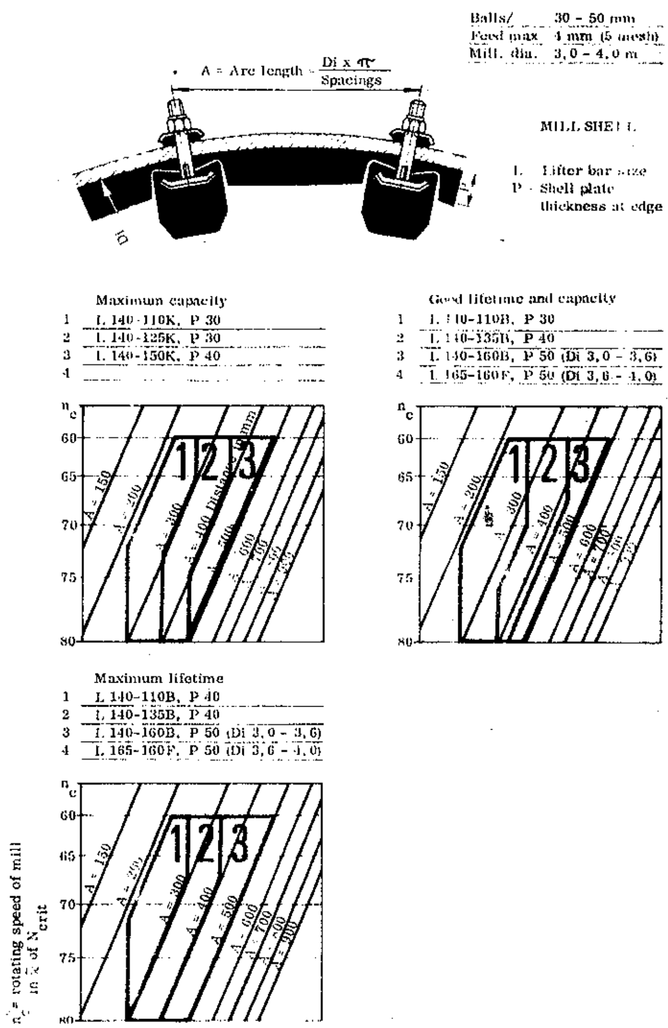


Figure 3

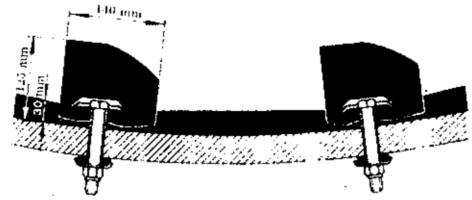


Fig. 26 Alternative 1 – maximum capacity: lining with 30 mm thick plate and 125 mm high K-type lifter bar.

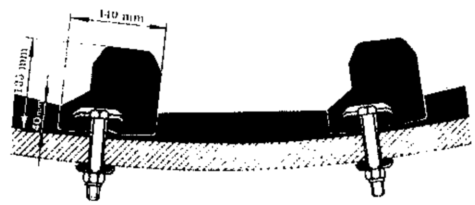


Fig. 27 Alternative 2 – good lifetime and capacity: lining with 40 mm thick plate and 135 mm high B-type lifter bar.

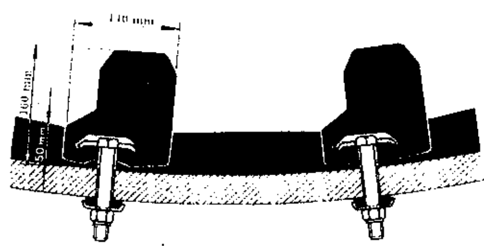


Fig. 28 Alternative 3 – maximum lifetime: lining with 50 mm thick plate and 160 mm high B-type lifter bar.

Figure 3a

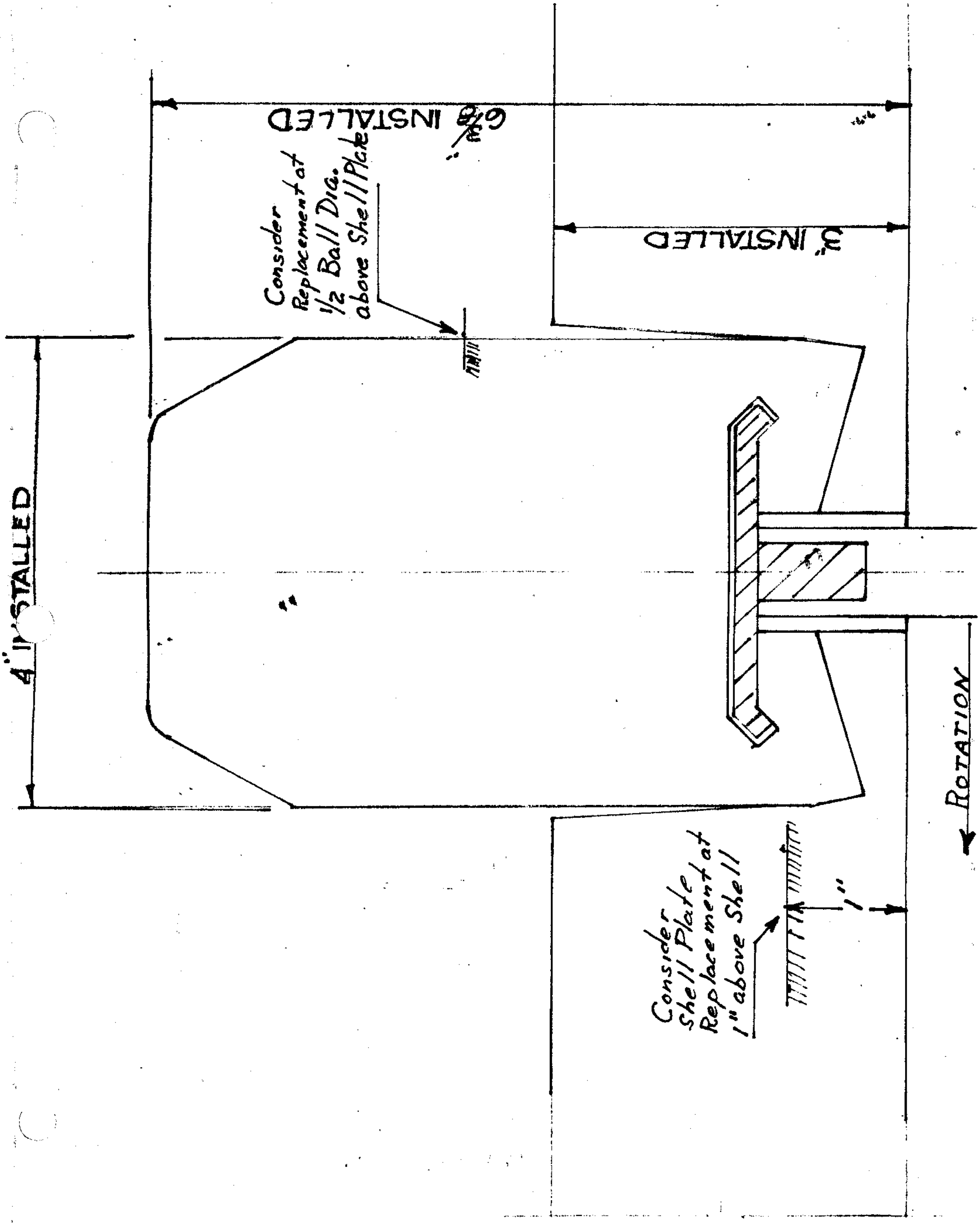
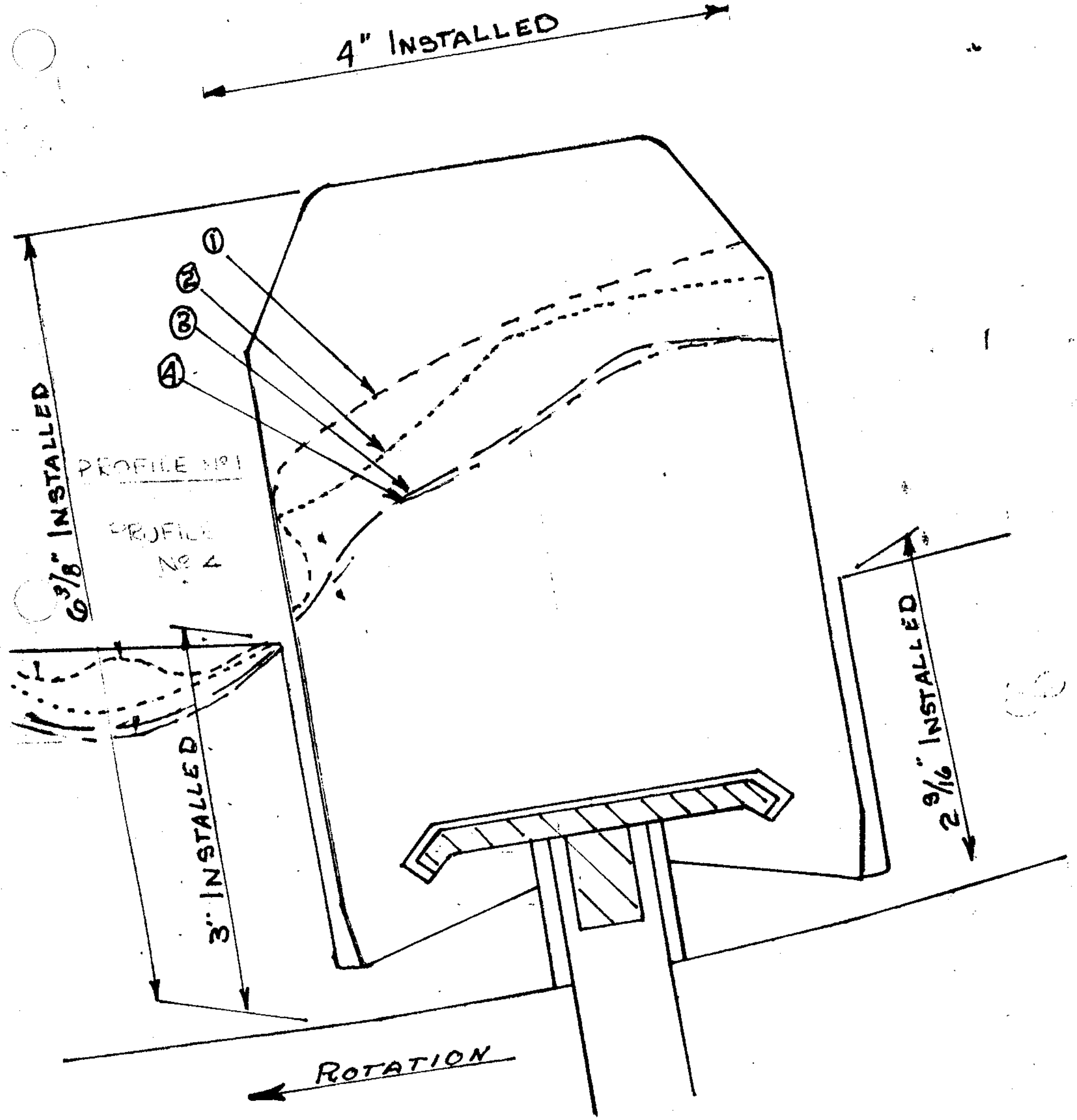

3" INSTALLED
Consider Replacement at 1/2 Ball Dia. above Shell Plate
Consider Shell Plate Replacement at 1" above Shell
1"
ROTATION

Figure 4



4" INSTALLED
6 3/8" INSTALLED
PROFILE Nº1
PROFILE Nº 4
3" INSTALLED
2 9/16" INSTALLED
ROTATION

Figure 5