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PRELIMINARY PROJECT.

ALUMINUM BRONZE FABRICATION

ANNUAL REPORT 1952

Responsible Technical-Scientific

Director:

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VVB of the Paint and Lacquer Industry

Leipzig 22 December 1952

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PRELIMINARY PROJECT FOR ALUMINUM BRONZE FABRICATION

TABLE OF CONTENTS

SKETCHES

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The entire plant has been laid out by the Collective Vahl/Jaehne/Herbold

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PRELIMINARY PROJECT: ALUMINUM BRONZE FABRICATION

Technical, National-Economic, and Plant-Economic Expertise

To date, the German Democratic Republic and the Peoples Democracies had not gone into the production of aluminum bronze, bronze paint, or pyrotechnic powder.

Therefore, it became necessary to import the materials from West Germany or from the countries of the West.

If such fabrication could take place in the German Democratic Republic, considerable savings in foreign exchange, time, and administrative work could be possible, disregarding the fact that this would make the German Democratic Republic independent of arbitrary measures by foreign countries or Western States.

Since the German Democratic Republic has sufficient stockpiles of aluminum and aluminum scrap (bars, sheets, foils, powder, etc.) and since the machinery and equipment required for the fabrication of aluminum bronze or pyrotechnic powder can readily be produced here, such a fabrication would be valuable in all respects from the national-economic as well as from the technical viewpoint.

To test the process and the production in a pilot plant, the following machinery would be required:

1 automatic shears for sheet cutting

1 cleaning tumbler

1 six-hammer mill for coarse crushing (flaking)

1 flake screen tumbler for grading

1 sixteen-hammer mill for pulverizing

1 copper screen tumbler for grading by particle size

2 polishing machines for buffing

(For pyrotechnic powder, no polisher is needed)

With such a pilot plant, about 200 kg aluminum powder for paint or pyrotechnics

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could be produced within one work week, using three shifts. The percentage of the powder in the finished aluminum bronze would be about 100-125 gm for each kilogram of paint. A more detailed description of the process and equipment is given below.

The pilot plant, with certain fire precautions, could be coordinated with an existing paint factory or else installed in newly erected buildings. The most suitable location, from the manufacturing viewpoint, for the buildings and equipment is shown in the attached schedules.

Fabrication Flow Sheet

(See Drawing 70-9-001)

In principle, the fabrication of aluminum bronze for paint, because of the dirty manufacture, is done separately from that for pyrotechnical purposes although type and design of the equipment are the same.

Three types of basic material for the fabrication of aluminum bronze are availavle, namely:

1. Aluminum bars
2. Aluminum scrap in the form of sheets, up to a maximum of 2 mm
3. Aluminum foils.

The fabrication processes are laid out accordingly.

1) Aluminum Bars

The approximate dimensions of the bars are 400 mm length, 50 mm width, and 50 mm height; however, these sizes are not binding. The bars are melted in a standard smelting furnace, the liquid material is cast in casting machines in the form of sheets of about 1/2 mm and then cut on automatic shears into small pieces of about 80 x 100 mm area max. Then, the material is fed to a six-hammer mill where it is crushed to flakes under addition of a small amount of stearins. The flakes are sorted according to size in a wire-screen tumbler. The large particles are returned to the six-hammer mill for recrushing, while the small particles are

STAT

fed to the sixteen-hammer mill where they are pulverized under admixture of a small amount of stearin. From here, the material is passed to the copper screen tumbler, where the product is graded as to fineness.

Up to this point, the process for producing pyrotechnic powders is the same except for an admixture of powdered charcoal to both hammer mills.

For the production of aluminum paint, the graded powder is passed to the polishing mill where the required gloss is produced under addition of small amounts of olive oil and stearin.

Then, the material is forwarded to the packing and shipping unit.

2) Aluminum Scrap

The aluminum scrap is used in the form of sheets of a maximum thickness of 2 mm. The pieces can have any form or size and are cut on the above-mentioned automatic shears. The further fabrication process is exactly as described under 1), except that a burnishing mill is installed in front of the polishing mill.

3) Aluminum Foils

As starting material, aluminum foil is used in this case. This foil is crushed in a foil shredder and otherwise is processed exactly as described above.

Explanations of the Entire Unit, with Characteristics for the Process

(See Ground Plan 70-9-002 to 006)

The total area of a factory site for the fabrication of aluminum bronze and pyrotechnic powder encloses about 163 m^2. The fabrication rooms are subdivided into three groups, depending on the type of fabrication. The largest percentage of products required is aluminum lacquer and pyrotechnic powder.

The buildings are arranged in accordance with the production flow, as shown in the sketch 70-9-002.

The special building contains dressing rooms and washrooms with shower facili-

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ties for men and women, and also houses the cafeteria and toilets.

The connecting buildings contain the smelting furnace and the casting equipment as well as the automatic shears and the cleaning tumbler. This building complex also includes storage sheds for aluminum bars and other scrap as well as for the coal required for heating and hot-water makeup.

The actual production rooms, because of the danger of explosion, are arranged individually. For the same reason, the electric motors for the transmission drives are housed in closed rooms. The walls of the buildings are solid, while the roofs (as specified for rooms housing explosives), are of a light-weight construction. In all other points, the specifications of the UVV 56 for the fabrication of aluminum bronze must be observed.

Groups of three buildings each are provided for the hammer mills, copper screen tumblers, and polishing mills.

Each hammer-mill building is equipped with two 16-hammer mills and two 6-hammer mills in addition to a screen tumbler for flaking. The rooms for the copper screen tumblers contain four such machines with various mesh size, while the rooms for the polishing machines contain six machines.

The burnishing machine is adjacent to the shipping rooms; only one machine is erected. This building contains an attachment used as drying room where the aluminum powder or the bronze is dried by electric heaters at prescribed temperatures. The shipping shed has a built-on ramp so that the filled metal drums can be loaded directly on the trucks.

With the above-described equipment, about 4.5 tons can be fabricated per month in three shifts. If the starting material in this department is aluminum scrap or foil, two female and two male operators are occupied for 24 hrs. If the starting material is aluminum bars, two male operators more are needed per shift.

The total requirement of electric power for illuminating and driving purposes as well as for heating is about 30 kw.

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Description of Machinery

1) Smelting Furnace and Testing Machine

These can be purchased in standard designs and therefore have not been sketched separately.

2) Automatic Shears

The automatic shears are not sketched separately since they can be purchased on the open market in commercial designs and can be obtained at any time. The water-level cycle is about 80 per minute, and the power requirement is about 3-4 hp.

3) Cleaning Tumbler (Sketch 70-9-008)

In general, this machine is used for freeing the aluminum scrap from adhering oils and dirt, before further processings.

The machine comprises mainly a sheet-metal tumbler of 1.10 m diameter and 1.80 m length, equipped with a continuous fixed shaft used for driving and guided in two bearings at the outside. The jacket of the tumbler is provided with a closeable flap for filling and emptying the goods and is perforated over its entire circumference with holes of about 2 mm diameter. Dry wood shavings are charged together with the aluminum scrap, to ensure proper cleaning of the material. The soiled sawdust drops through the perforations on rotating the tumbler. The rotation period per charge is about 3/4 hr and the rotational speed is about 40 rpm, at a power requirement of approx. 1.5 hp.

4) Foil Shredder (Sketch 70-9-007)

The foil shredder is used for shredding aluminum foil to prepare them for further processing in the six-hammer mill. This will considerably shorten the processing period in this machine.

In principle, the foil shredder consists of four U-iron NP 16 stands, supporting the two tumblers. The tumblers have a diameter of about 280 mm and a length of approx. 800 mm. The tumblers are provided with staggered teeth over their cir-

STAT

cumference, engaging with a serrated flat iron strip at the center of the machine.

The aluminum foil charged into the machine is entrained in this manner and shredded in the toothed flat iron strip; the goods drop on a chute below the tumblers and then travel into a container installed next to the machine, which can be emptied when required. The foils are fed to the machine by hand through a hopper. The tumblers are driven by two cogwheels attached to the shaft extension. The rotational speed of the tumblers is about 200 rpm, at a power requirement of approximately 2 hp.

5) Six-Hammer Mills (Sketch 52.4-3; 70-9-009 and 010)

The six-hammer mill is used for producing so-called flakes from aluminum scrap or foils.

The stand of the machine consists of four U-irons NP 16 of about 2.20 m length, interconnected by three bracers and screwed, at the base, to a rectangular oak beam of about 375 mm height and 450 mm thickness.

Wood is used to prevent the vibration and bouncing of the pots which the rammers contact with considerable force. The rammers, which are combined in pairs, are guided in the lower and upper bracers so that they are free to move up and downward. The bearing caps are so arranged that they can be adjusted. The stroke takes place over cam disks that are keyed to a shaft. The shaft itself is supported on the four U-iron stands. The cam disk produces a torsion of the rammer; in this manner, a bolt inserted right in front of the rammer base stirs the scrap in the pot and throws it downward, so that the rammer itself hits compact material. The cam disk rolls along a hammer-hoist ring, attached to the rammer shaft, thus lifting as well as turning the rammer.

To fill and empty the pots, the rammers must be stopped individually for short periods of time. This is done by a locking lever with a toothed reed, which is moved by hand and thus permits the cam disk to idle. These locking levers are rotatably attached to the center bracer.

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The pots, containing the goods to be processed, are made of cast steel and are attached to the wooden machine base by means of two pointed steel bolts. Screws cannot be used because of possible loosening due to vibrations. The pots are provided with covers to prevent dust from forming. The number of strokes of the rammers is about 80 per minute, at a power requirement of approx. 2 hp.

6) Screen Tumbler for Flaking (Sketch 70-9-011)

This machine has the function to sort the material coming from the six-hammer mill. The tumbler consists of a wooden box of about 3.20 m length, 1.25 m height, and 0.8 m width which, at the same time, forms the stand. At the inside, this box is subdivided into three compartments and is provided at its upper part with a two-part hinged flap, while the lower front side carries three additional hinged flaps. The upper flap is used for inserting the screen tumbler, while the sorted material is discharged through the front flaps. The inside of the box carries a cylindrical drum, permanently screwed to a continuous shaft and consisting of three wheel disks which are covered on all sides with stretched wire netting. The wire netting, in accordance with the compartments, has various mesh sizes that permit the grading. The finest mesh is at the inlet end of the drum, followed by the next coarser mesh. The screen tumbler does not protrude into the last compartment of the box where the coarse flakes, passed through the perforated bottom of the last wheel disk, accumulate and are then returned to the six-hammer mill for further crushing. The shaft of the tumbler is supported at both front ends of the box.

The flakes are charged into the screen tumbler through a hopper attached to the outside of the box front. The discharged and sorted flakes are further crushed and divided on the sixteen-hammer mill.

The rotational speed of the screen tumbler is about 40 rpm, at a power requirement of approx. 0.5 hp.

7) Sixteen-Hammer Mill (Sketch 52.4-1; 70-9-012 and 013)

The purpose of this machine is to pulverize the flakes discharged from the screen tumbler.

The stand of the machine consists of three columns of gray cast iron which are screwed to the cast machine base. The tops of the three columns are interconnected by a cast bracer, containing the bearing shells for the hammer guide. The pots for the material to be pulverized are screwed to the machine base, with one pot intended for four hammers each. This means that the hammers are arranged in four groups of four hammers each.

The mode of operation is similar to that used for the six-hammer mill, meaning that the hammers are lifted and turned by cam disks which run along the hammer-hoist rings. The cam disks are rigidly keyed to two shafts, supported by the columns. The shafts are driven by a pulley over cogwheels.

Stopping the hammers, as in the six-hammer mill, is done by locking levers with reed disks. These levers are hinged to the cover of the upper bearing guide. The shaft of the hammer is provided at its upper end with a locking ring which engages the reed disk of the locking lever. The lower end is provided with an exchangeable impact head, which is conically attached.

The cast-steel pot, screwed to the machine base, is equipped at its upper end with stuffing boxes for the hammer guides as well as with covers to prevent dust formation. The back of the pot is provided with one take-off nipple for each pot, through which the powdered material is sucked to the silo over an exhaust fan. In addition, the pot can be discharged at the front side through a hinged door. This door is provided with a slanted charging flap which serves for charging the bulk material as well as for checking the fineness of the powdered material. The center inside of the pot has an integral cast cone which, after each hammer impact, causes the material to drop back to its original spot. At the point of the pot, struck by the impact head of the hammer, a surface-hardened insert plate is shrink-fitted;

STAT

which can be exchanged when worn. The insert plate is pushed out by a long mandrel from the lower side of the pot, when replacement is required. For this purpose, the bottom of the pot is provided with four round bores for the mandrel.

The rate of strike-hammer is 80 per minute, at a power requirement of approx. 3 hp.

8) Copper Screen Tumbler with Screening Box (Sketch 52.4-5; 70-9-014 and 15)

The copper screen tumbler is used for grading the pulverized material by particle size. The mode of operation is similar to that of the flaking tumbler No. 6.

In this unit, the stand consists of a large wooden box, closed at its upper end by three hinged flaps of different size. The lower front side of the box stand is provided with three wooden drawers lined with zinc sheets. Within this wooden box stand, a conical copper screen tumbler rotates on a continuous, long shaft, rotatably supported on both front ends of the stand. The tumbler consists of three hexagonal wooden spoked disks which are provided at their extreme ends with wooden twin strips. The copper-wire netting is stretched between the strips over the entire circumference of the tumbler and is screwed on. The netting has various mesh sizes, with the finest mesh (about 70 mesh per cm^2) at the front of the tumbler, followed by the next larger mesh. The box stand contains three compartments of which the first two correspond in length to the pertaining sector of the screen tumbler. The coarsest powder drops into the last (smaller) compartment into which the tumbler does not protrude.

The aluminum and bronze powders are charged through a hopper, lined with zinc and attached to the upper drive side. This hopper feeds the powder to an adjustable regulator which controls the amount of the screened powder. This regulator comprises two thin disks of sheet zinc, provided with radial longitudinal slits. The lower of these disks can be staggered with respect to the upper disk, thus varying the size of the slit and, consequently, the screened amount of powder.

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The slotted disks are driven by the large tumbler shaft over a built-in pair of bevel gears; each rotation of the tumbler causes one rotation of the regulator disk. The rotation of these disks agitates the powder in the hopper so that the powder drops by gravity through the slits and cannot stick to the sides. The powder reaches the inside of the tumbler through a duct, in entrained by the conical screen tumbler, and is thus graded. The powder dropping through the screen tumbler accumulates in the drawers in accordance with the particle size and is withdrawn from there from time to time. The coarser powder, collected in the last smaller drawer, is returned to the sixteen-hammer mill for further processing.

The rotational speed of the tumbler is about 50 rpm, at a power requirement of approx. 1.5 hp.

9) Cyclone Unit with Charging Device (Sketch No.70-9-016

The fine aluminum dust, created during operation of the sixteen-hammer mill and suspended within the pots, must be removed in a closed duct in order to safeguard the operators. This is done by a cyclone unit, driven by exhaust fans, which removes the dust through the studs at the back of the pots in the sixteen-hammer mill and conducts the dust through a collector line into the next building where the copper screen tumbler is installed. The end of the exhaust line terminates in a false attic of this building in a filter bag woven of tight canvas which is permeable to air but not to dust. From the filter bag, the dust drops through a riser of zinc or aluminum piping, over an adjustable hood, into the upper part of the stand for the copper screen tumbler, into a sheet-zinc trough installed there. From this trough, the material is fed over vanes to the hopper of the copper screen tumbler itself. The hood is slideable to prevent dust formation, as far as possible, during discharge of the riser into the metal trough. In the exhaust tube as well as in the riser, a manually operated closure flap is installed shortly below the filter bag, suspended from the ceiling. This flap closes either of the two tubes for charging or discharging. Before discharging, the exhaust fan must be stopped

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and the filter bag as well as the waste pipe must be properly emptied by tapping.

Because of the danger of explosion, the filter bags are mounted in the above-mentioned false floor of the attic. For this reason, the walls of this false floor are made of light-weight material (laminated cardboard, sandwich sheets, etc). In addition, the driving motor for the exhaust fan must be mounted outside the building for the same reason.

10) Burnishing Machine (Sketch 70-9-017)

The burnisher is used for preparing the powder, discharged from the copper screen tumbler, as dry pigment for special purposes.

The machine consists of a stand with six pedestals which are braced over six struts made of angle iron. A round wooden plate of about 1.65 m diameter within this stand carries a smooth bed stone on the same diameter, made of hard dust-free stone. Along the circumference of the wooden disk and of the bed stone a beveled rim is attached whose upper edge protrudes about 80-100 mm beyond the bed stone. The wooden plate and bed stone both are provided with a bore at their center of about 75 mm diameter and are pushed over a shaft journal. The lower end of this journal is rotatably supported in the stand on a thrust ball bearing. The small interspaces between the bed stone and the rim on the one hand and the shaft journal on the other hand are filled out with a thin cement slurry. A large cogwheel is screwed horizontally to the lower side of the wooden plate, driven by an electric motor (installed next to the stand of the machine) over a bevel gear. The outer circumference of the stand is provided with three clamping bolts along which a three-bar cross can be displaced up and downward, using the bolts as guides. The three-bar cross carries three conical, uniformly distributed, stone rollers which are rotatably arranged. The axle bolts of the rollers are guided in screw bolts which, in turn, are screwed into the arms of the three-bar cross.

The vertical displacement of the three-bar cross and thus of the roller system takes place over a screw-type spindle attached to the center of the cross and held-

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by three yokes. A hand wheel is used for shifting the spindles or the rollers, by causing the screw-type spindle to contact the head of the shaft journal in the bed stone. When the rollers are in their upper position, the machine can be discharged; in the opposite case, the three conical rollers are entrained by the friction produced during the rotation of the bed stone.

As a result of this arrangement, the aluminum powder or bronze powder, mixed with water and gum arabic and spread over the bed plate, is crumbled and slurried by the motion of the stone and rollers. After running for a few hours, the machine is stopped and emptied by flushing with water. The removed material is carefully washed with water which causes a powdered mass to settle to the bottom by gravity after a short time. Then, the supernatant contaminated water is carefully decanted. The settled powder slurry is dried by heat of a certain temperature in cardboard boxes, in a separate small room and is then fed to the polishing machine.

The rotational speed is about 20 rpm at a power consumption of approx. 2 hp.

11) Polishing Machine (Sketch 70-9-018)

As indicated by the name, the machine serves for polishing and burnishing the powder.

The stand comprises a rectangular wooden box of about 1 m length, 0.5 m width, and 0.35 m height. The box contains one drawer lined with zinc. A sheet metal drum of about 0.5 m diameter and 1.0 m length is screwed to the upper side of the box on two front walls raised on small feet. This drum is equipped at its upper and lower end with a charging or hinged flap; the lower flap is operated by means of a lever so that it will open through its own weight as soon as the spring bolt of the locking device is pulled away.

The tumbler jacket is provided along its circumference, at distances of about 15 mm, with grooves which are 6 mm wide, 3.5 mm high, and 15 mm long. The material of the jacket is commercial black sheet iron of about 2 mm thickness.

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Within the tumbler, two 3-bar crosses (spoked wheels) of cast iron rotate on a continuous shaft which is supported at both front ends outside the drum and, for making the arrangement dust-tight, is equipped with stuffing boxes. These spoked wheels are provided with head pieces along their circumference, to which two superposed wooden strips are screwed with a countersunk screw bolt. The upper strip, facing the inside drum wall, is provided with a horsehair brush along its entire length and width and is attached to the lower strip with small brass screws. The brush strips are as long as the drum, and the brushes sweep the entire inside area of the drum during the rotation. To lengthen the horsehair brushes, when they become worn, exchangeable U-washers are placed below the inner strip.

The powder is charged by hand through the upper charging flap, admixed with stearin and a very small amount of olive oil. After this, the flap is closed and sealed against dust.

Then, the polishing machine is started externally over a pulley drive and is stopped after about 10 hrs to be emptied.

From here, the finished, polished powder is forwarded to the packing and shipping room.

The rotational speed of the machine is about 200 rpm, at a starting power of approx. 1.5 hp.

Cost Accounting; Estimate Cost of Machinery and Equipment

1) 1 Automatic metal shears, cutting to 2 mm	DM 5,000
2) 1 Foil shredder	DM 5,000
3) 1 Cleaning tumbler	DM 3,000
4) 1 Six-hammer mill	DM 15,000
5) 1 Screen tumbler for flaking	DM 2,500
6) 1 Sixteen-hammer mill	DM 22,000
7) 1 Copper-screen drum	DM 3,000
8) 1 Burnisher	DM 8,000

9)	1 Polishing machine	DM 4,000
10)	1 Cyclone unit	DM 4,000
11)	Freight and shipping cost	DM 2,500
12)	Building cost for foundations, partitions, etc.	DM 2,000
13)	Assembly and electric installation	DM 4,000
		Total DM 80,000

The cost for a pilot plant could be estimated as follows:

1)	1 Automatic metal shears, cutting to 2 mm	DM 5,000
2)	1 Cleaning tumbler	DM 3,000
3)	1 Six-hammer mill	DM 15,000
4)	1 Screen tumbler for flaking	DM 2,500
5)	1 Sixteen-hammer mill	DM 22,000
6)	1 Copper screen tumbler	DM 3,000
7)	2 Polishing machines	DM 8,000
8)	Freight and shipping cost	DM 1,500
9)	Building cost for foundations, etc.	DM 1,200
10)	Assembly and electric installation	DM 2,000
11)	Contingencies	DM 1,800
		Total DM 65,000

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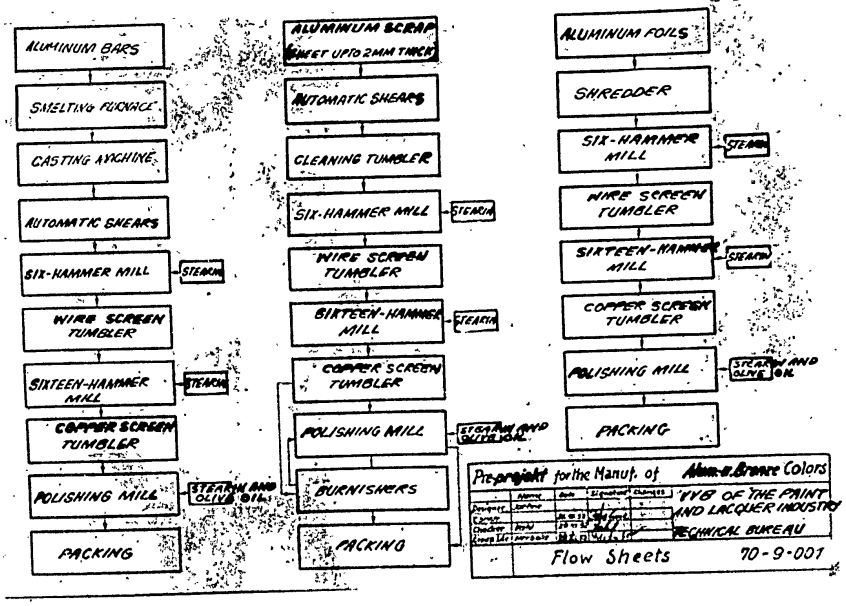

Fig.1 – Flow Sheets for the Production of Aluminum and Bronze Paints

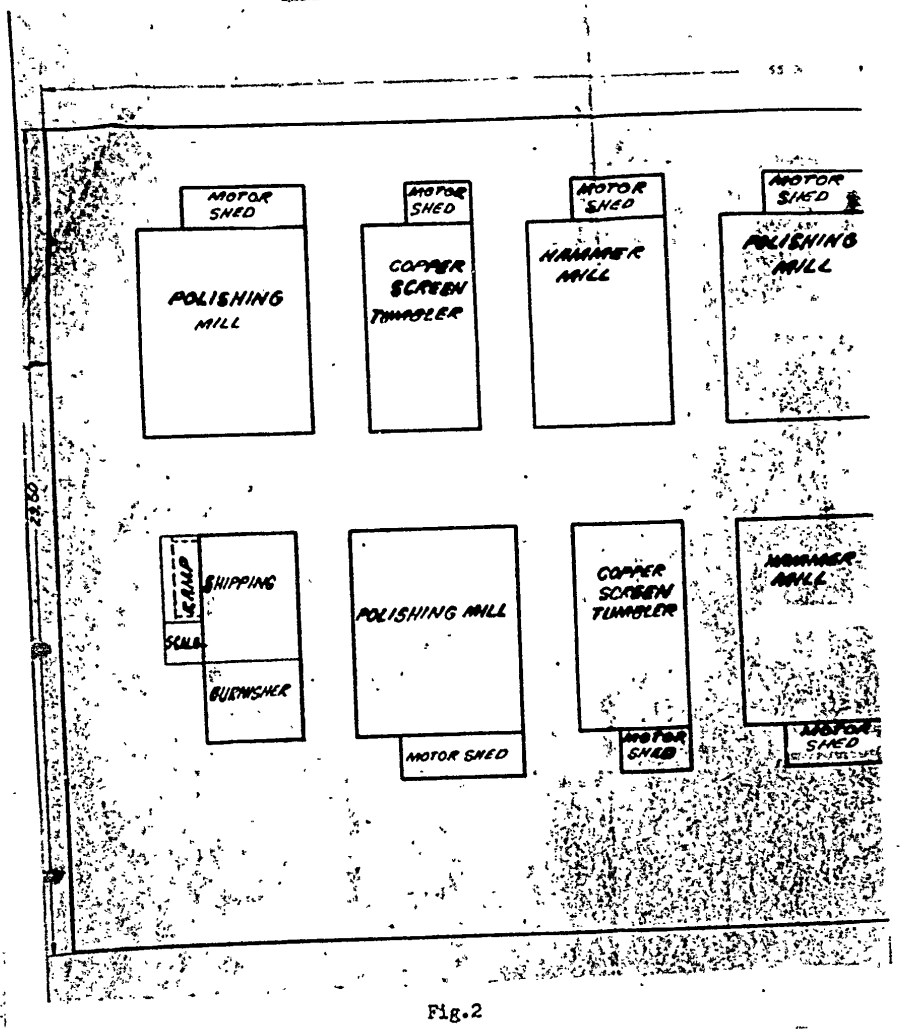

Fig.2

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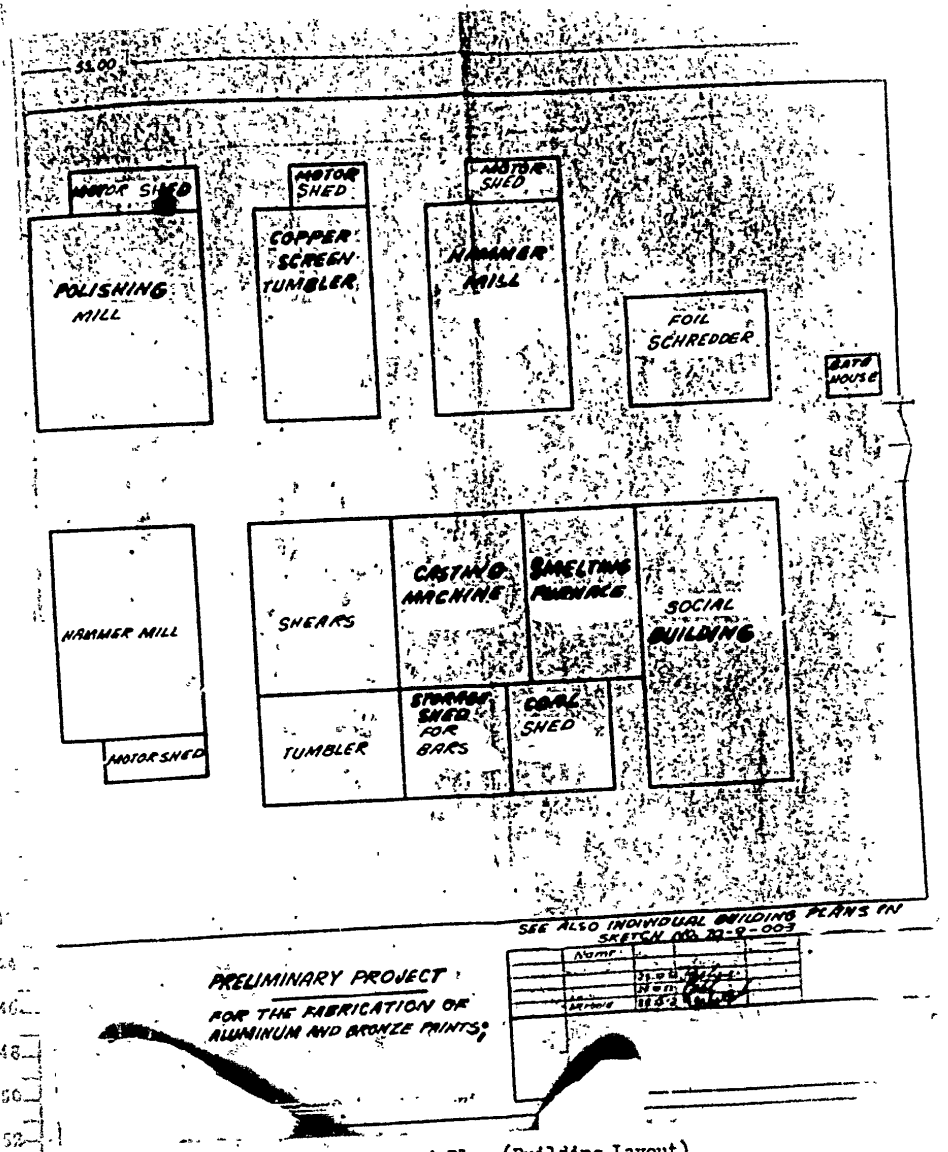

Fig.3 - Ground Plan (Building Layout)

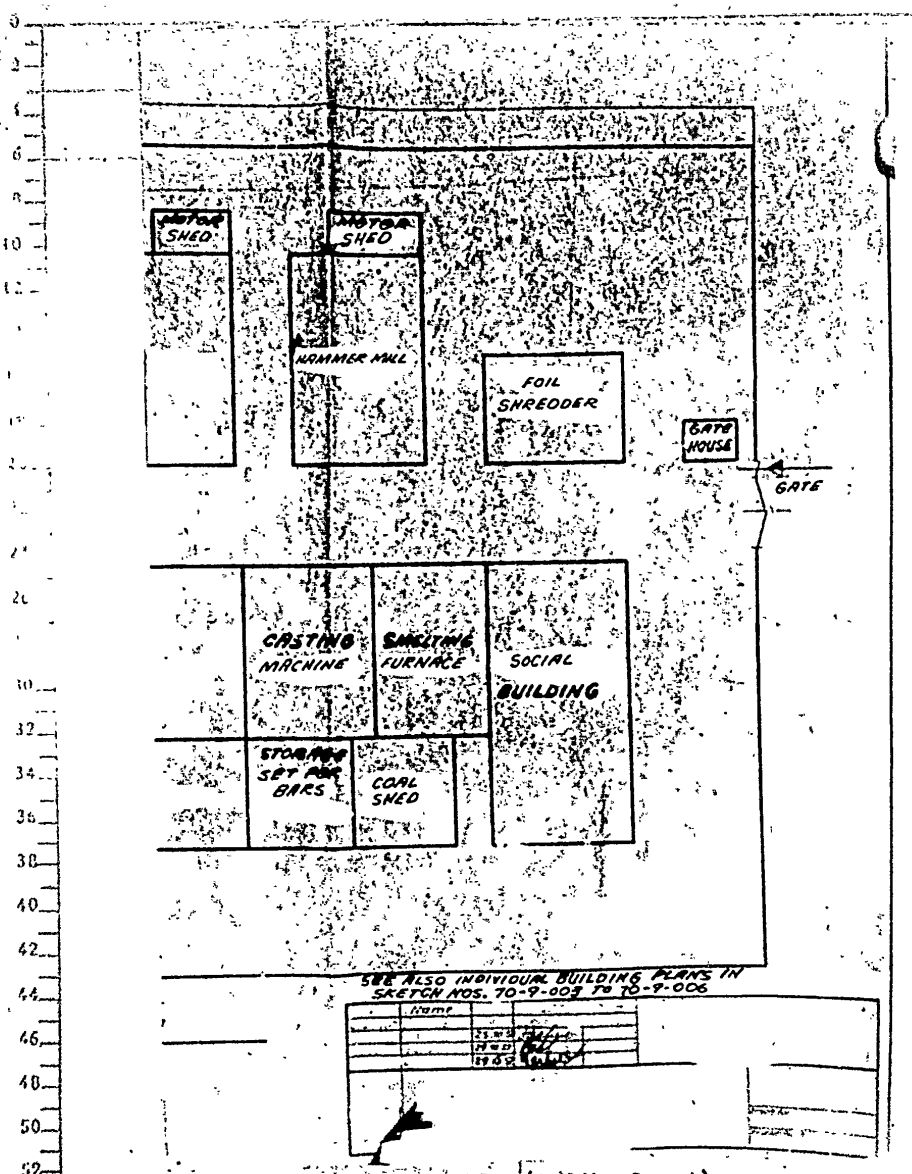

Fig.4 - Ground Plan (Building Layout)

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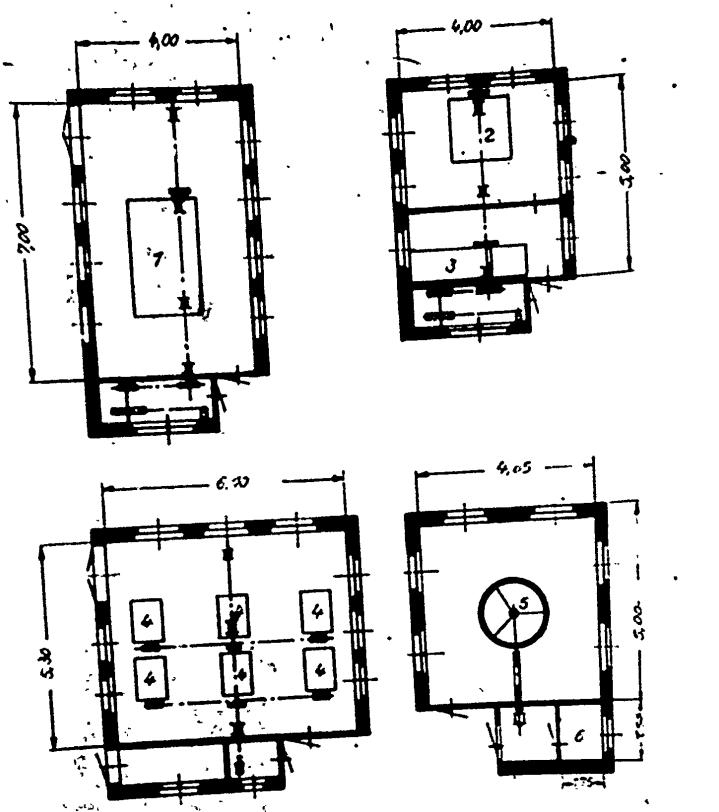

Fig.5 – Preliminary Project for the Manufacture of Aluminum and Bronze Paints (See also Ground Plan 70-9-002)

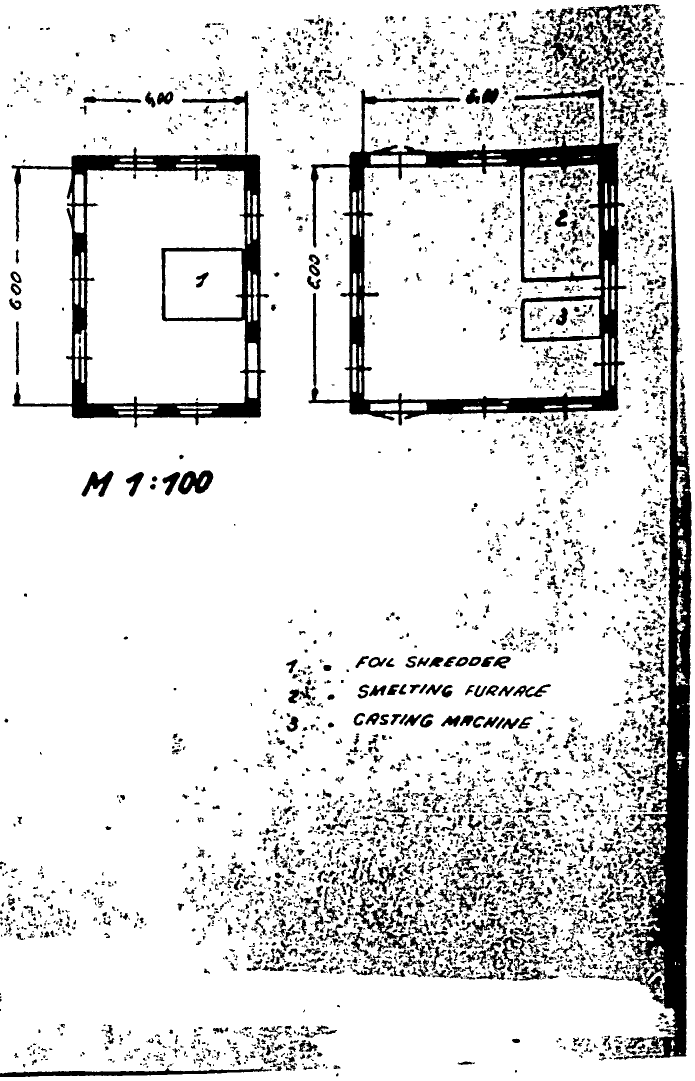

Fig.6 - Preliminary Project for the Manufacture of Aluminum and Bronze Paints (See also Ground Plan 70-9-002)

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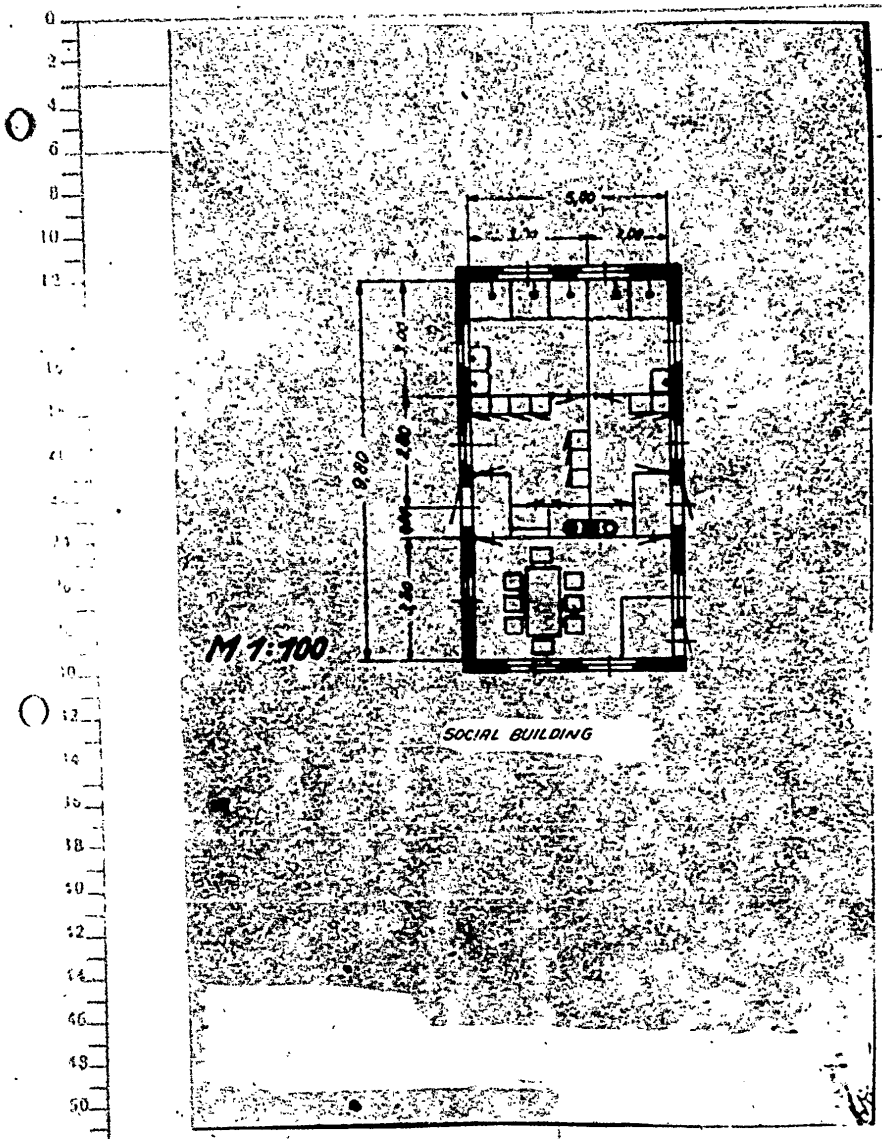

Fig.7 - Preliminary Project for the Manufacture of Aluminum and Bronze Paints (See also Ground Plan 70-9-002)

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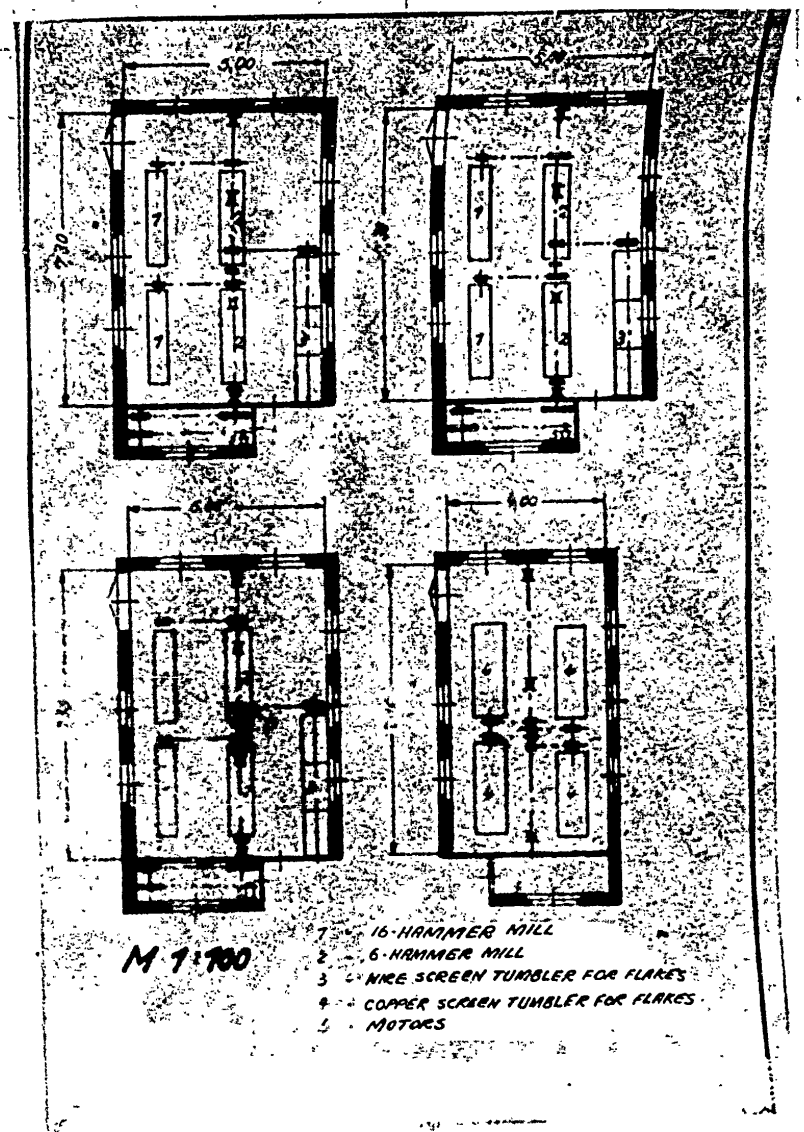

Fig.8 - Preliminary Project for the Manufacture of Aluminum and Bronze Paints (See also Ground Plan 70-9-002)

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36

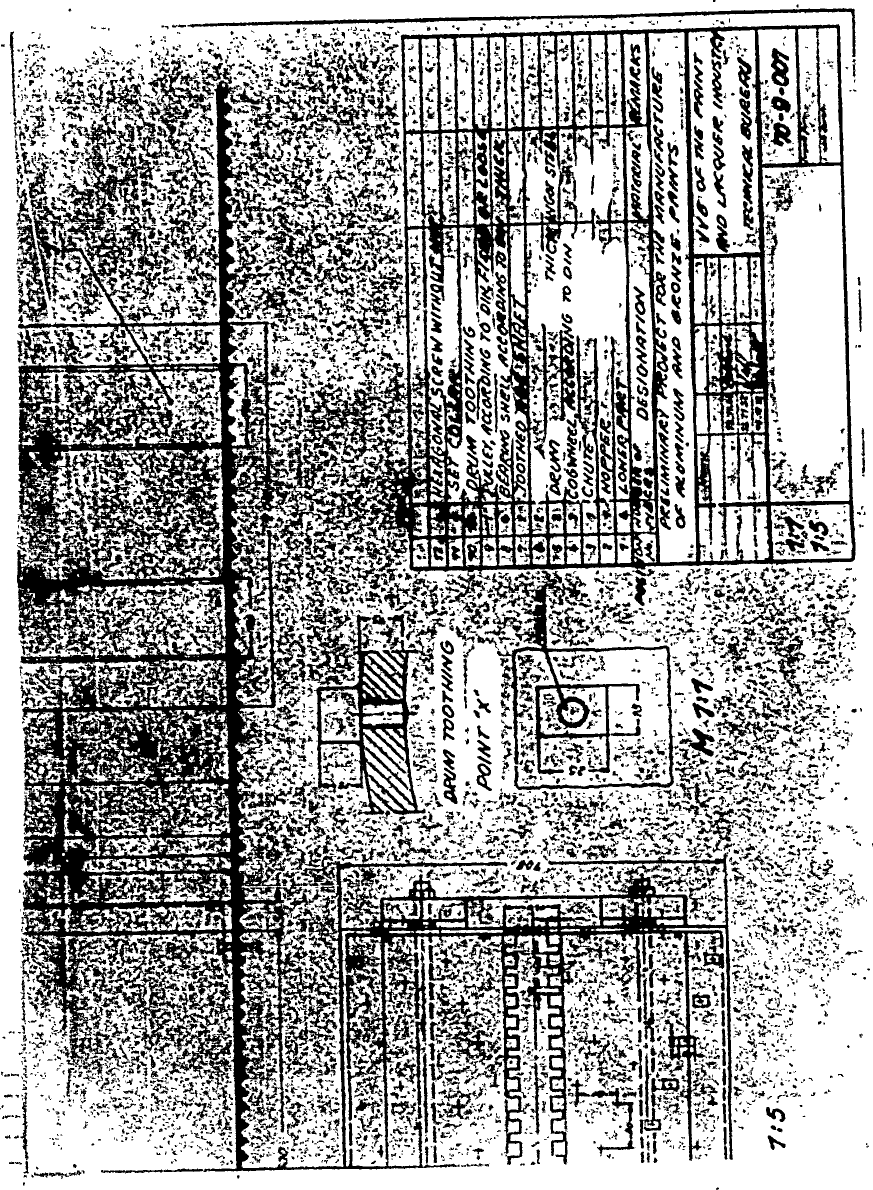

Fig.9 - Foil Shredder

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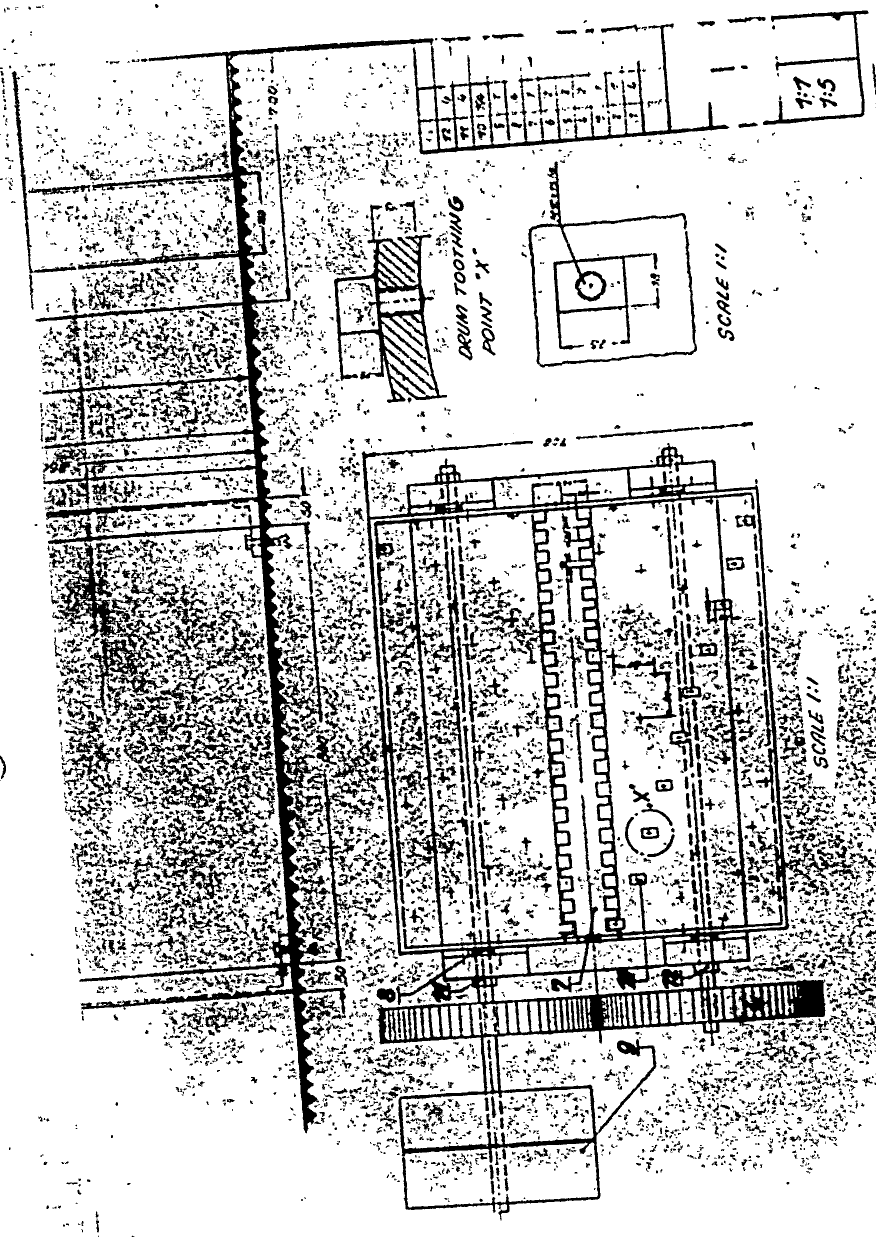

Fig.10

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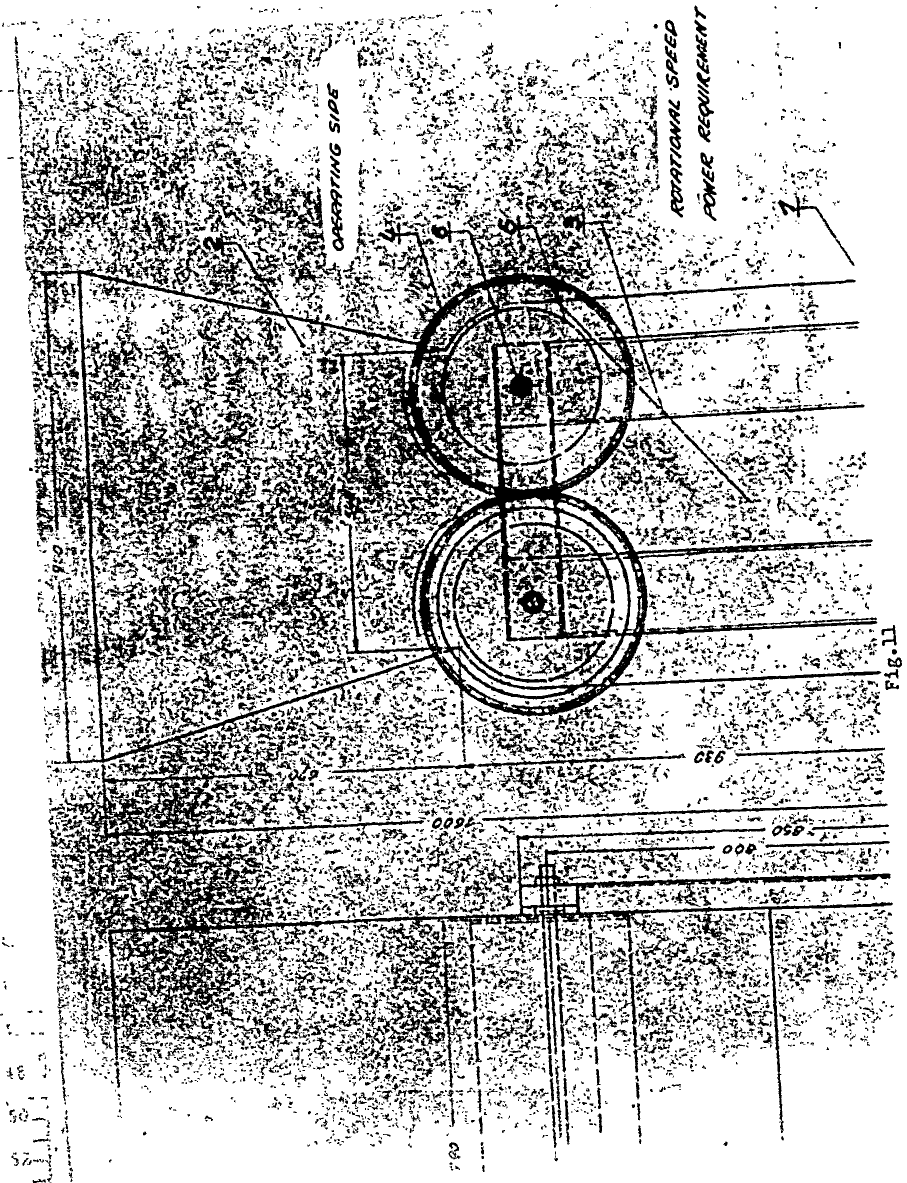

Fig.11

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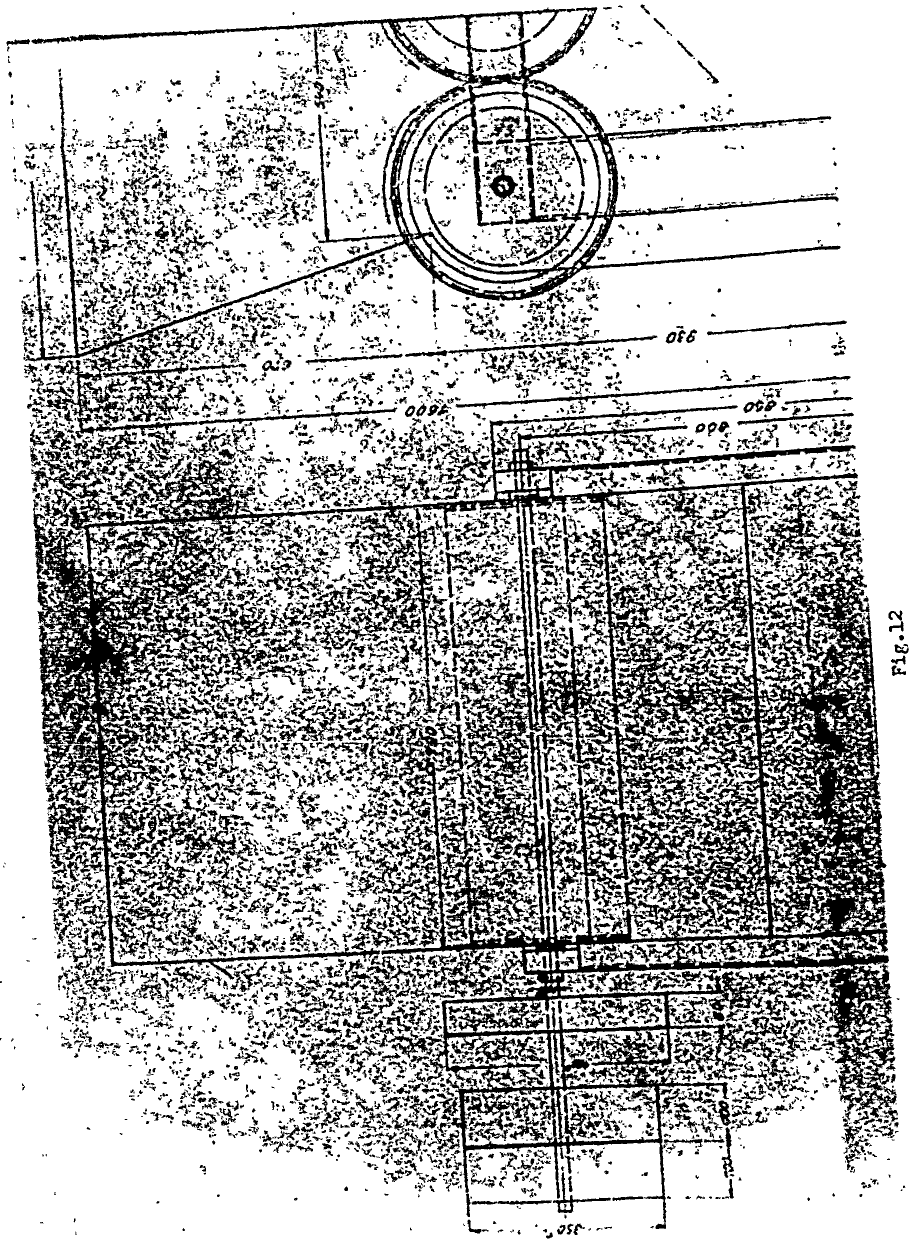

Fig.12

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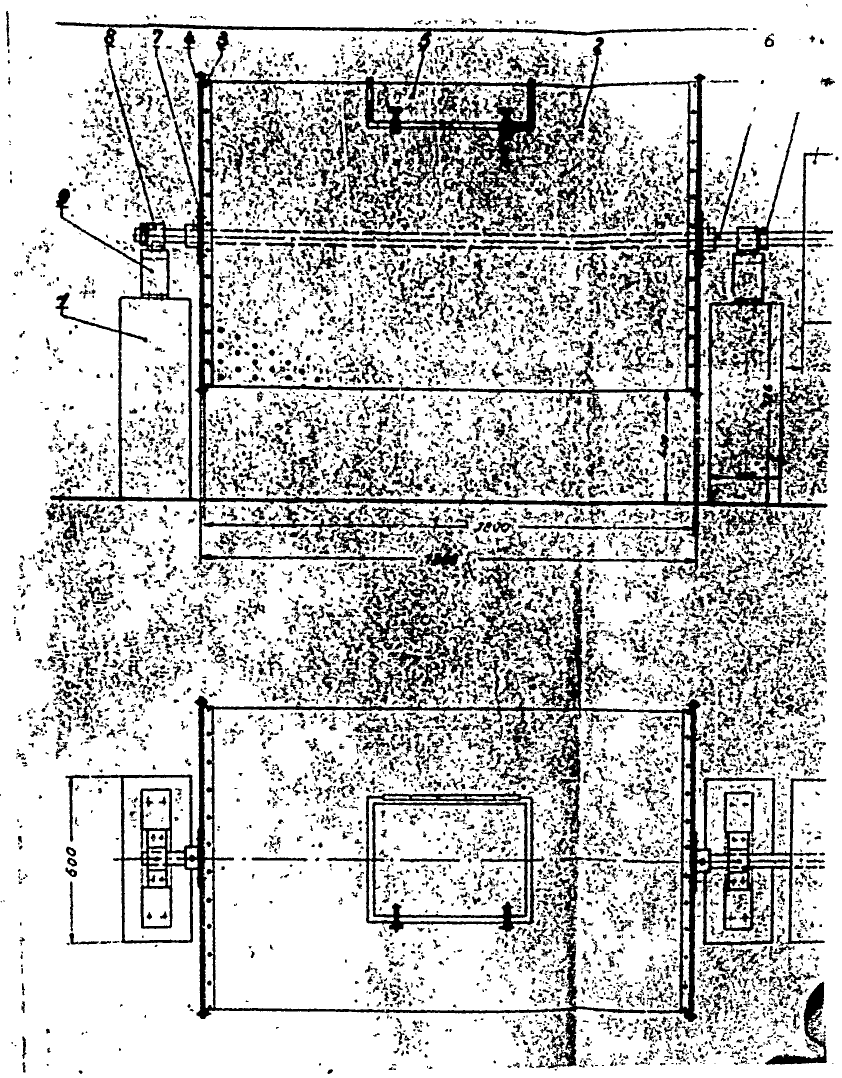

Fig.13

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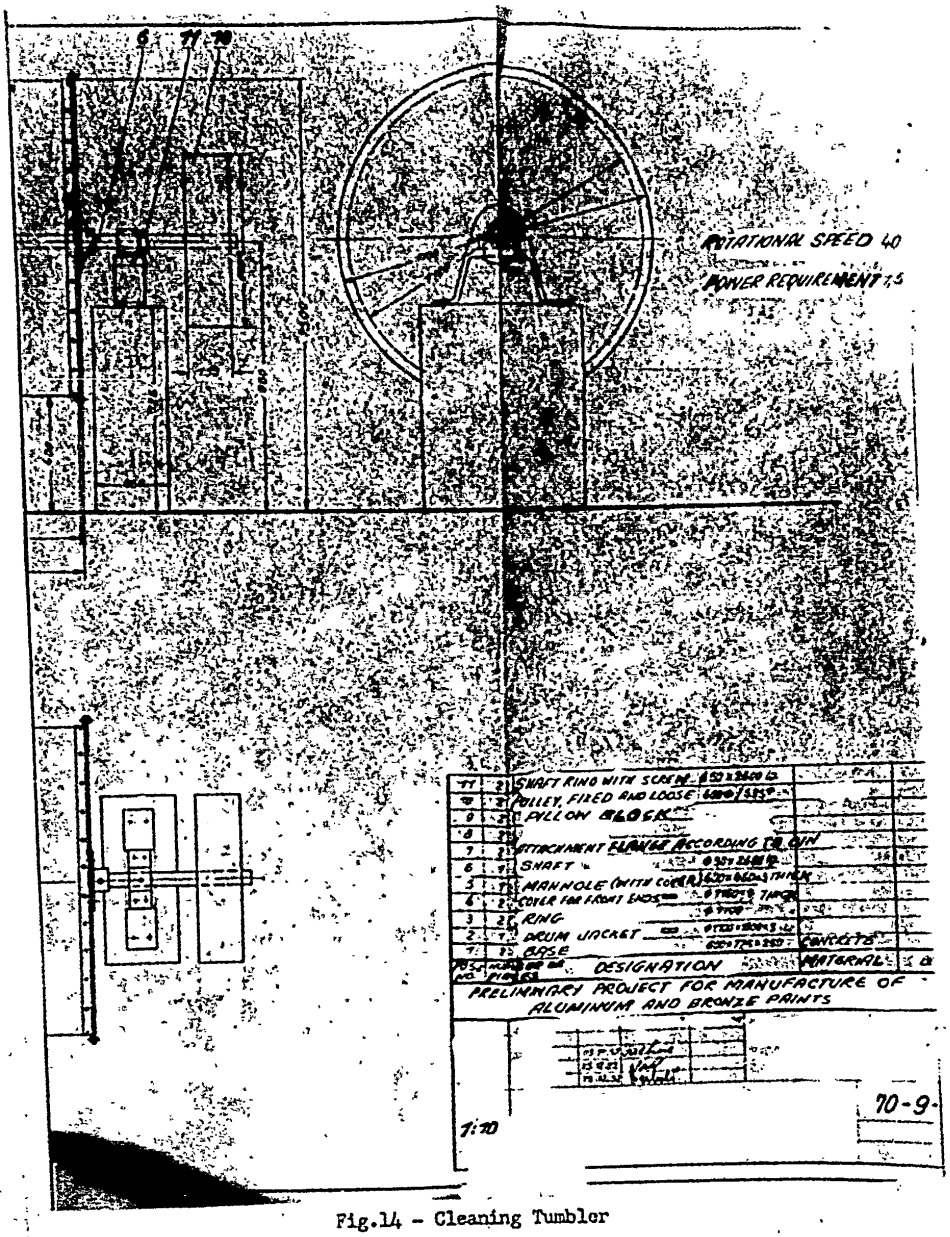

Fig.14 - Cleaning Tumbler

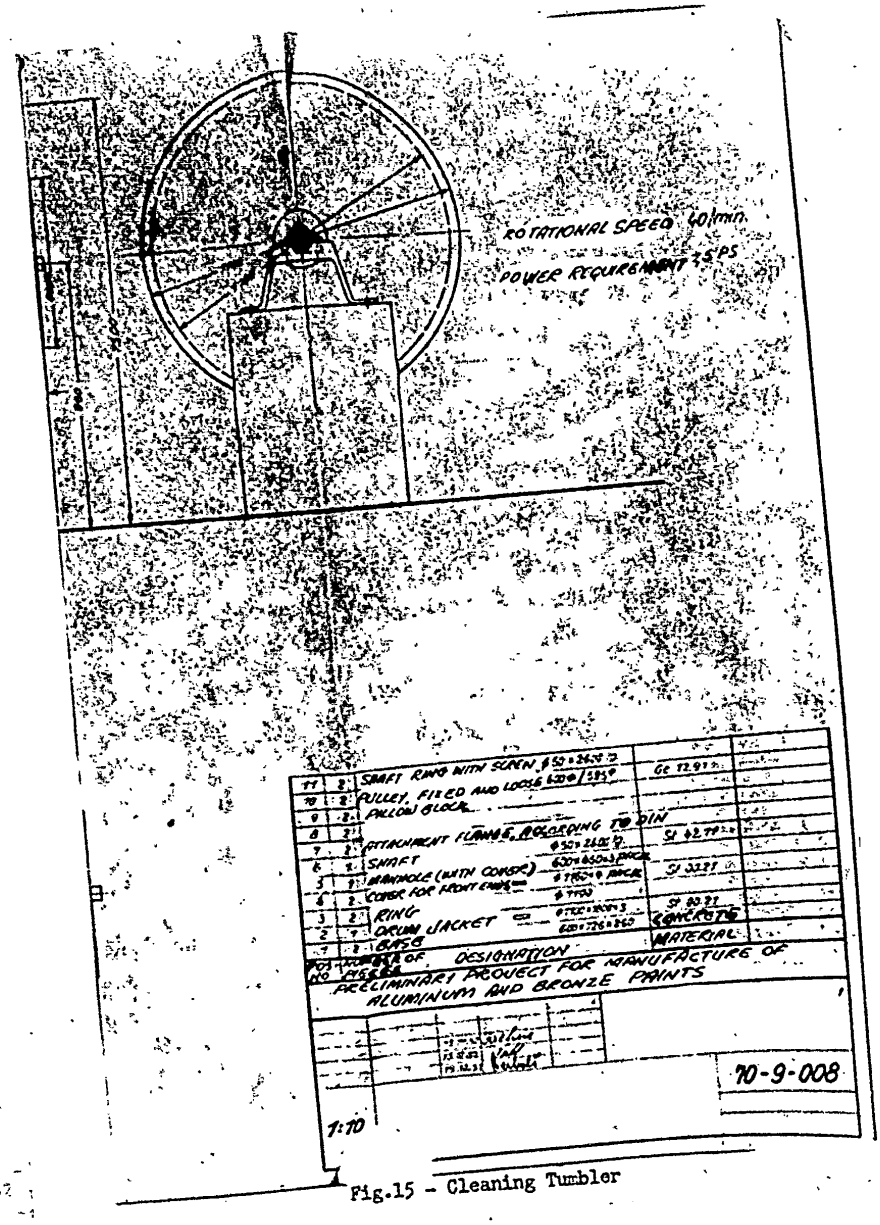

Fig.15 - Cleaning Tumbler

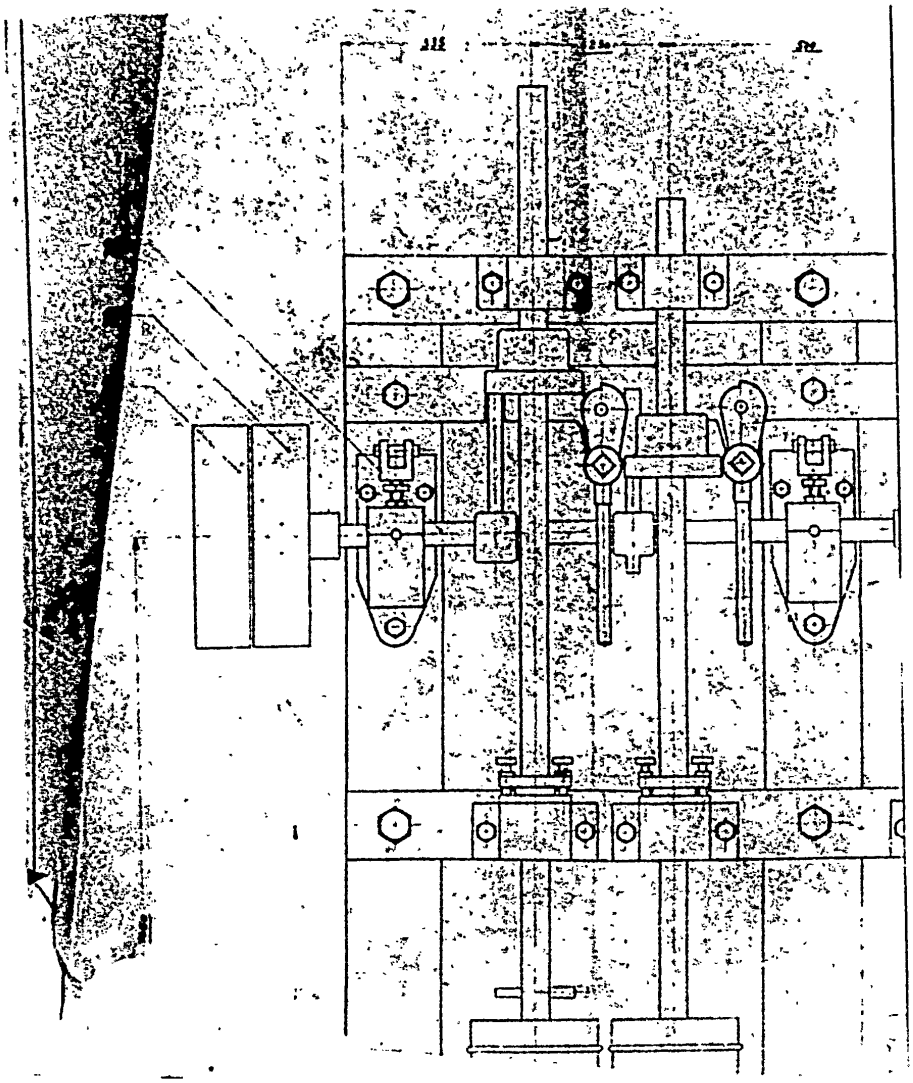

Fig.16

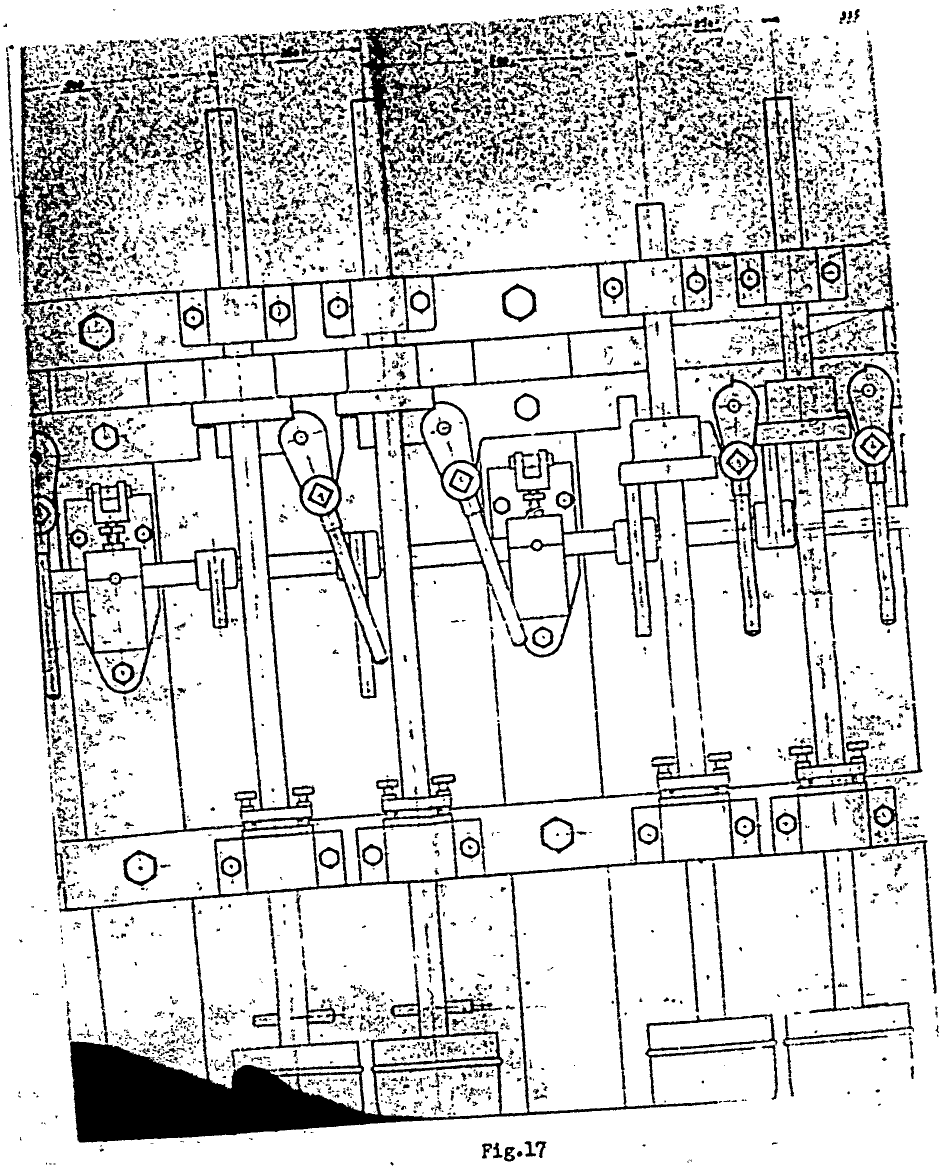

Fig.17

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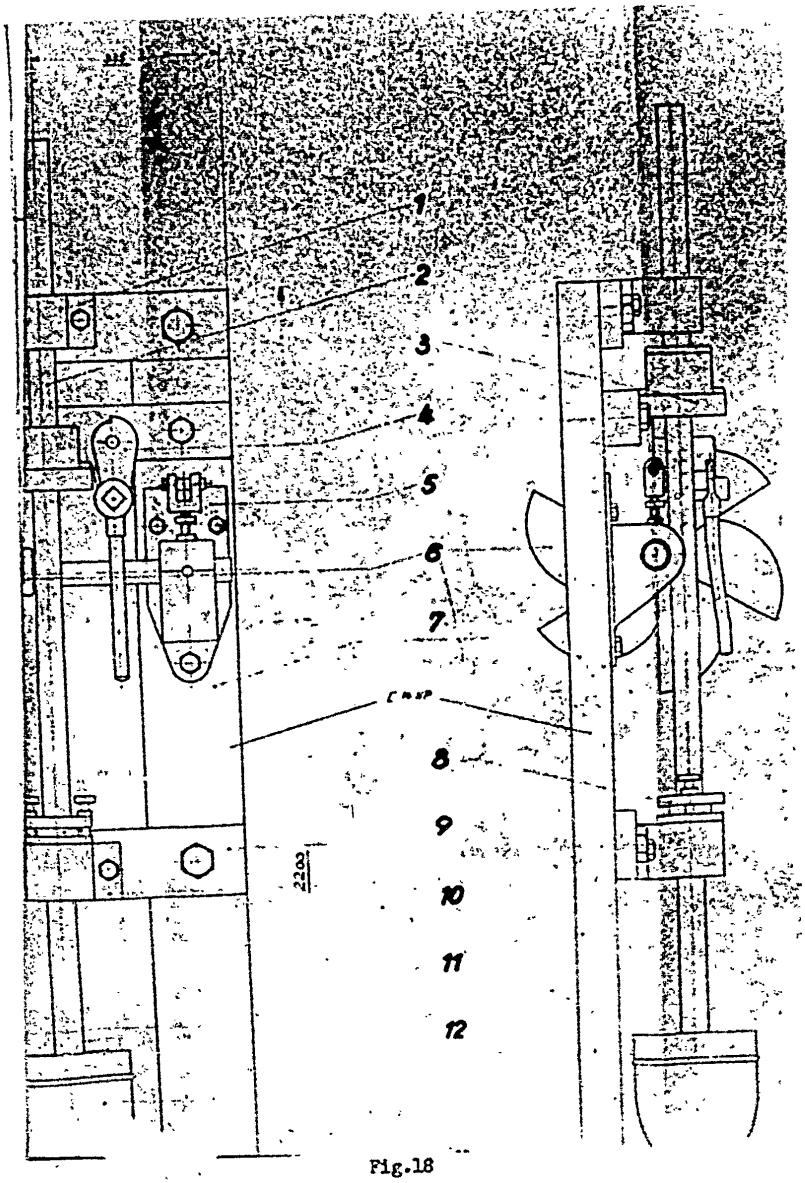

Fig.18

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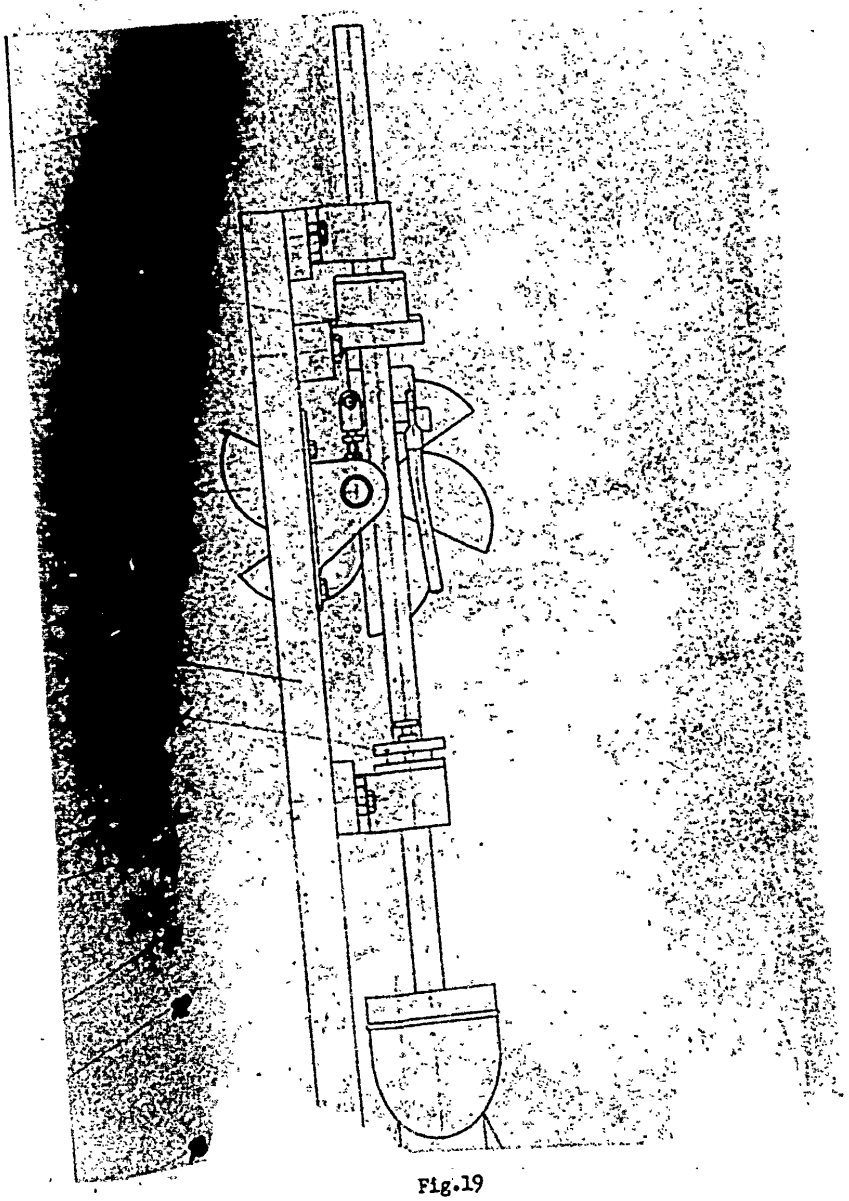

Fig.19

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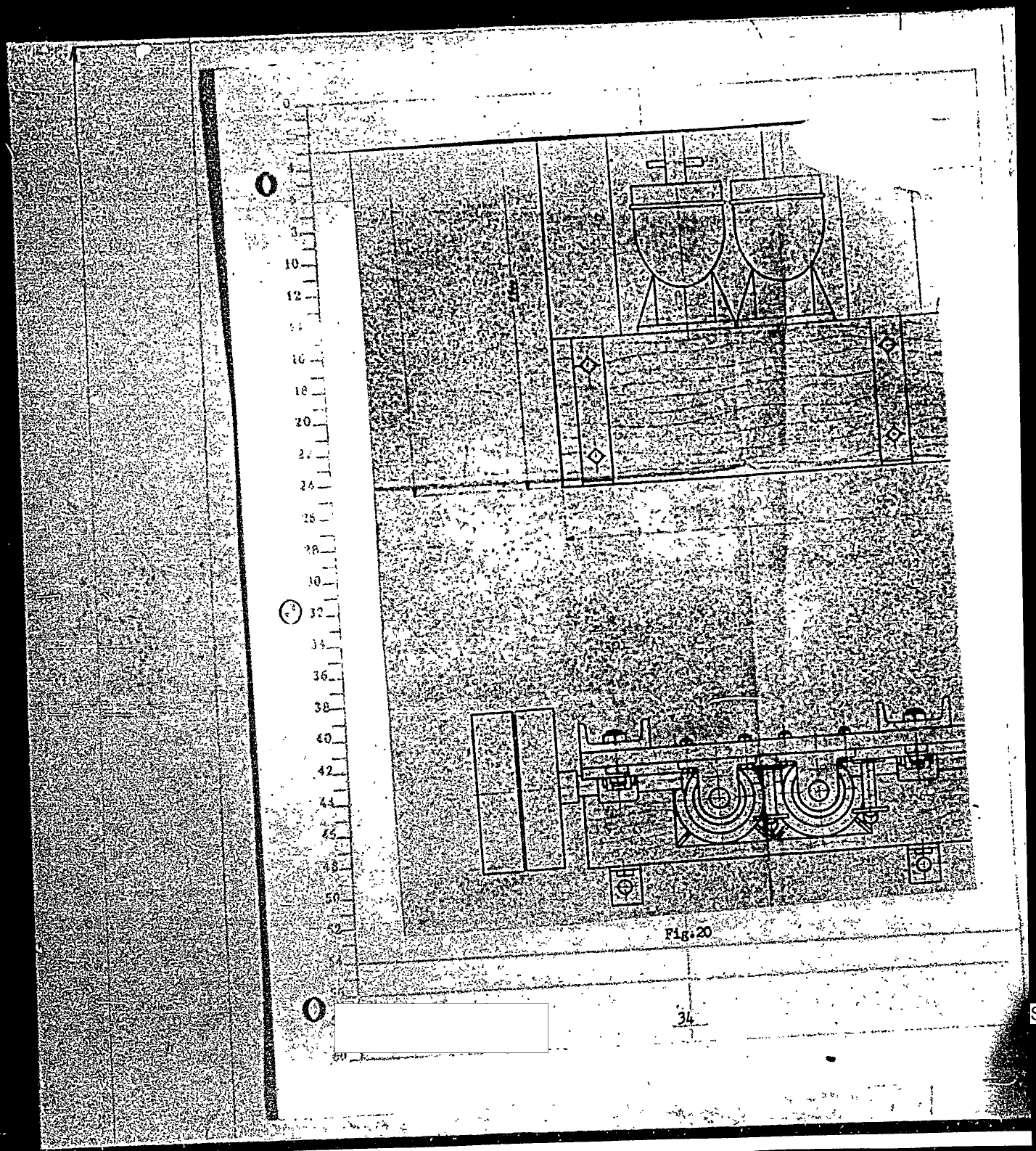

Fig. 20

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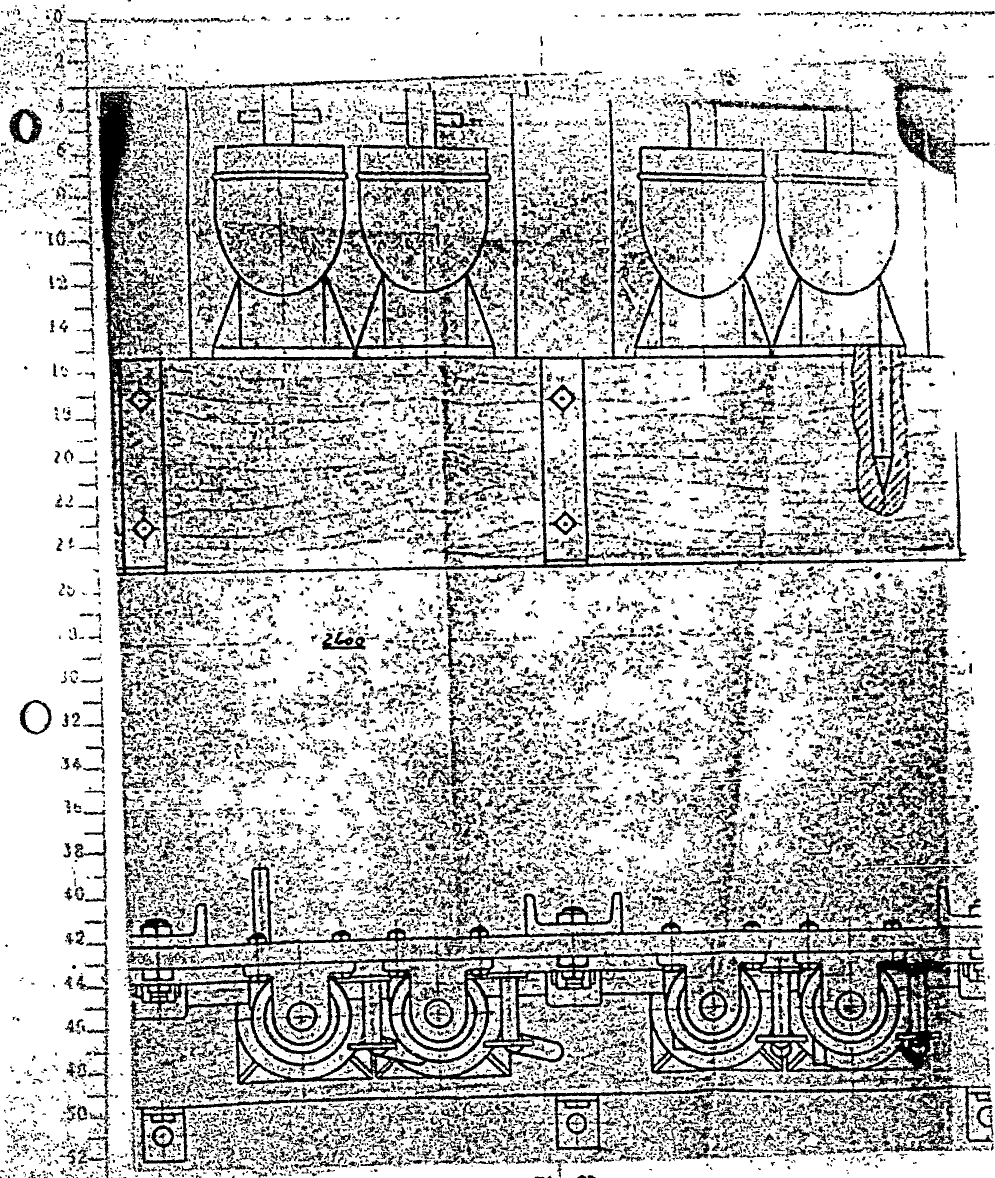

Fig.21

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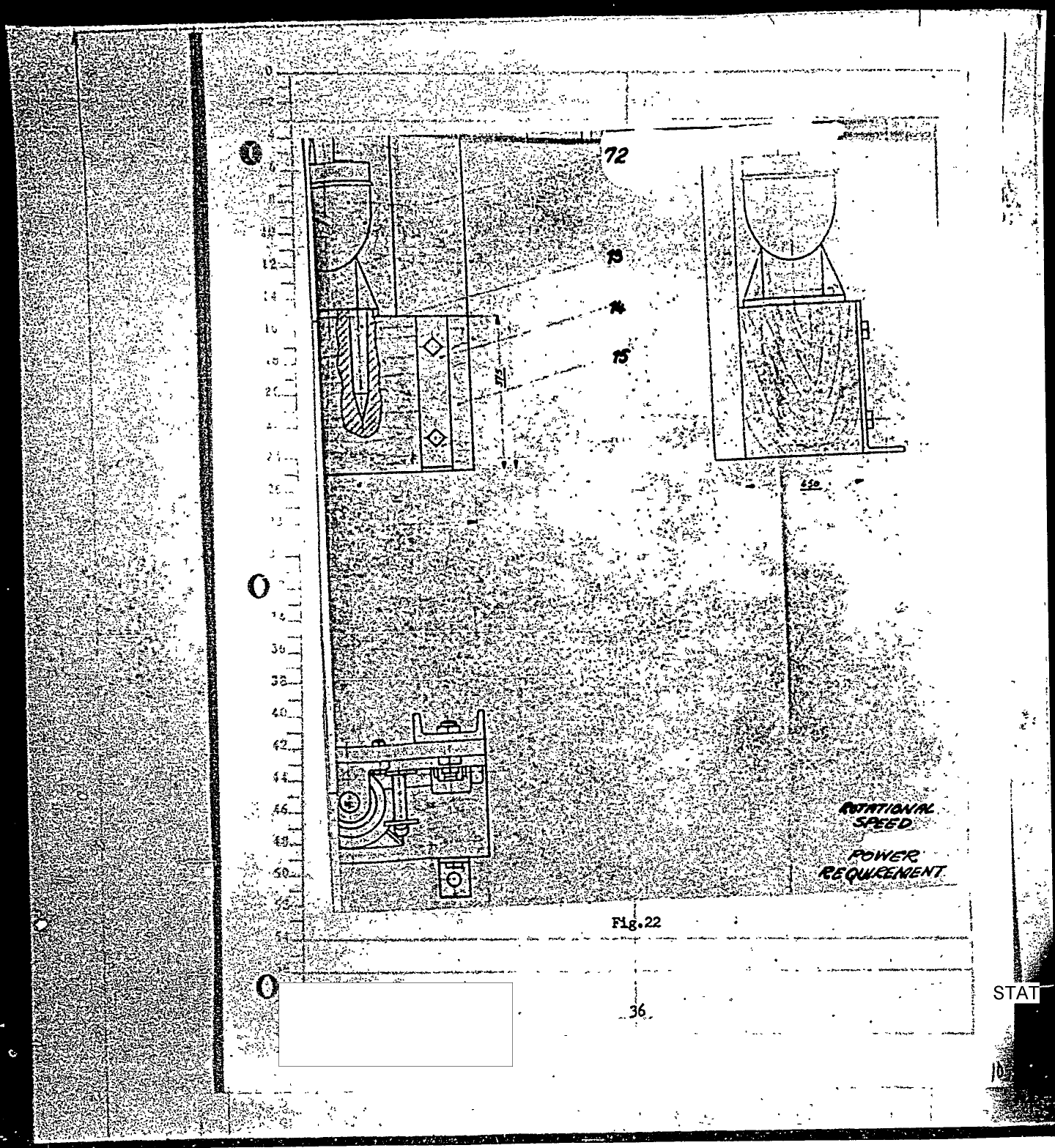

Fig.22

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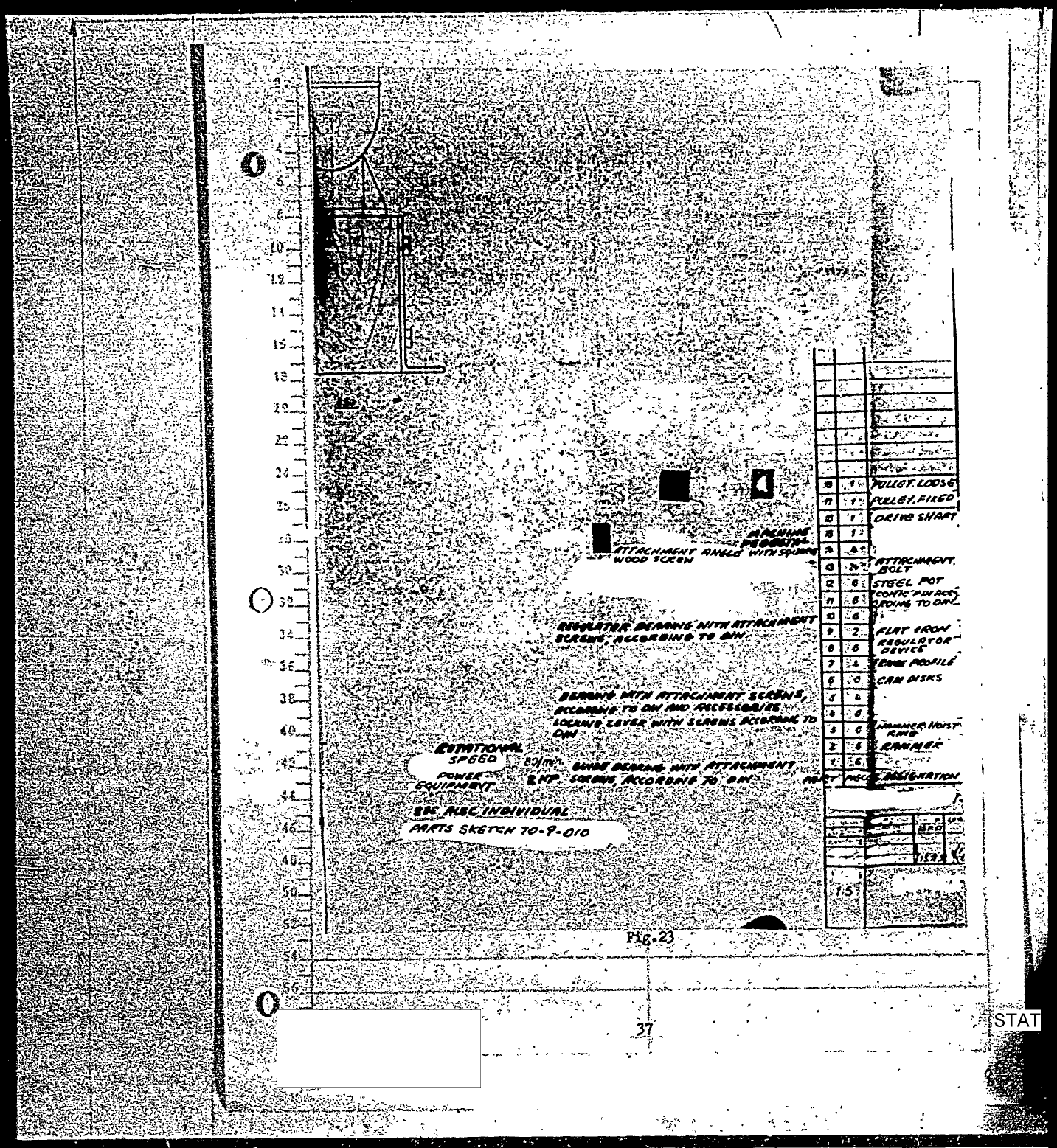
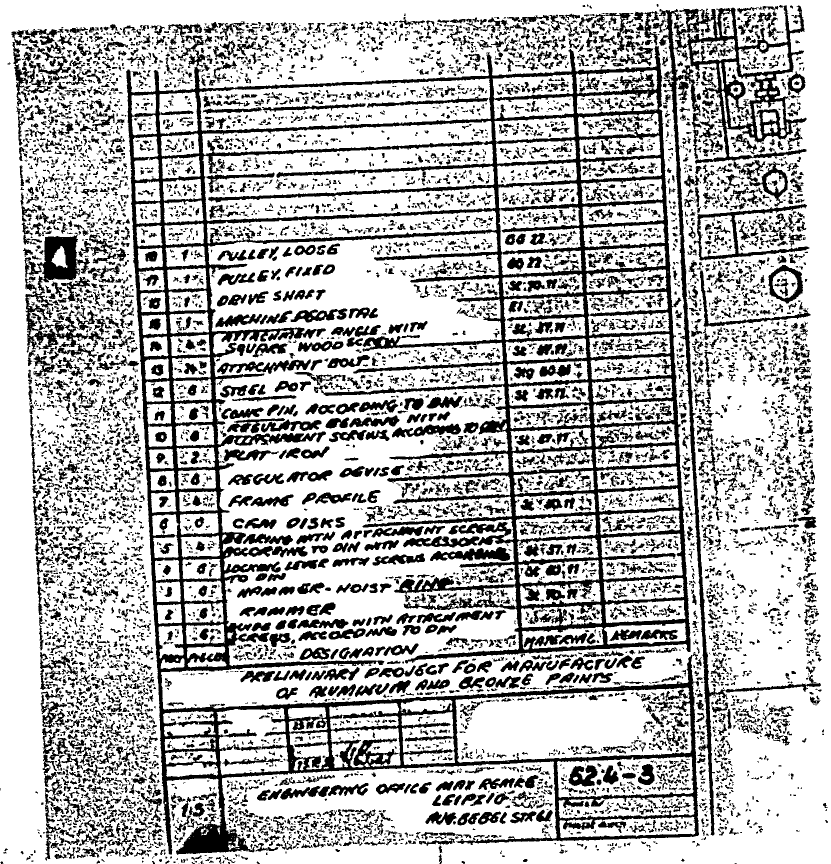


Fig. 23



10	1	PULLEY, LOOSE			
11	1	PULLEY, FIXED			
12	1	DRIVE SHAFT			
13	1	MACHINE PEDESTAL			
14	4	ATTACHMENT ANGLE WITH SQUARE WOOD SCREW			
15	24	ATTACHMENT BOLT			
16	6	STEEL POT			
17	6	CONE PIN, ACCORDING TO DIN			
18	6	REGULATOR BEARING WITH ADJUSTMENT SCREWS, ACCORDING TO DIN			
19	2	FLAT IRON			
20	6	REGULATOR DEVISE			
21	6	FRAME PROFILE			
22	6	CAM DISKS			
23	6	BEARING WITH ATTACHMENT SCREWS, ACCORDING TO DIN WITH ACCESSORIES			
24	6	LOCKING LEVER WITH SCREWS ACCORDING TO DIN			
25	6	HAMMER - HOIST RING			
26	6	HAMMER			
27	6	GUIDE BEARING WITH ATTACHMENT SCREWS, ACCORDING TO DIN			
PIECE	PIECES	DESIGNATION	MATERIAL		REMARKS

PRELIMINARY PROJECT FOR MANUFACTURE OF ALUMINUM AND BRONZE PARTS

ENGINEERING OFFICE MAY REMKE LEIPZIG

62.4-3

Fig. 24 - Six-Hammer Mill

STAT

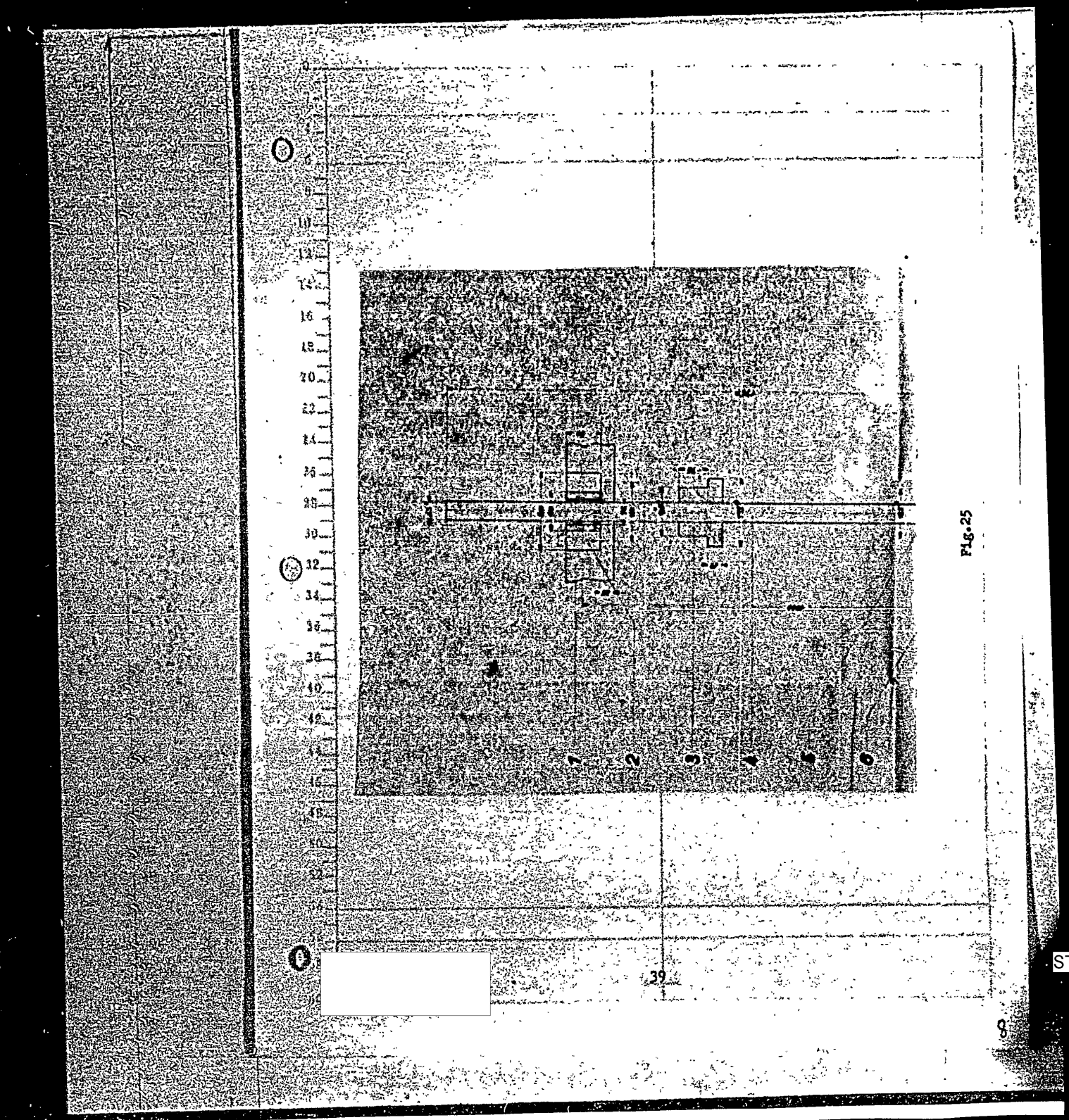


Fig.25

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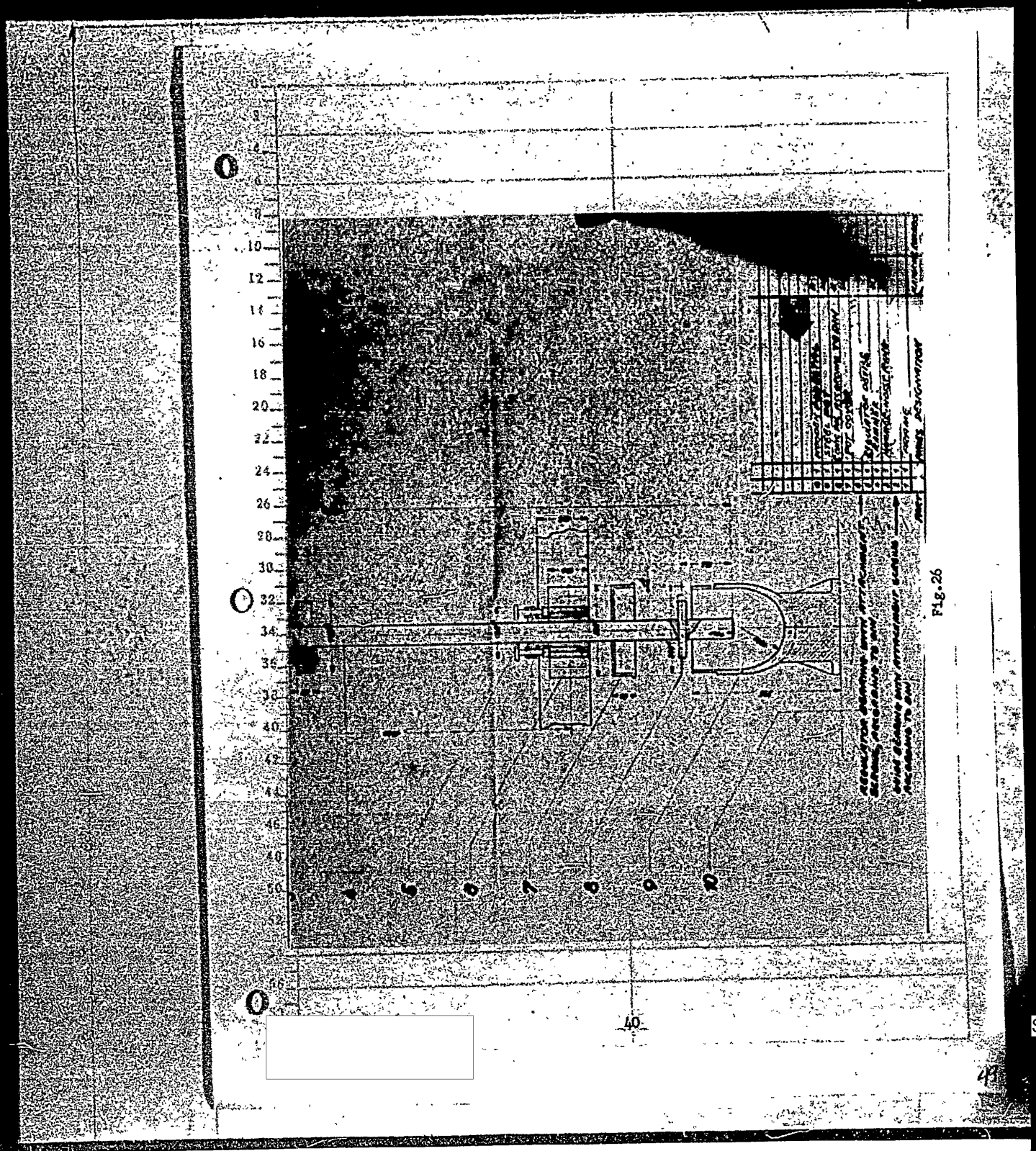

Fig. 26

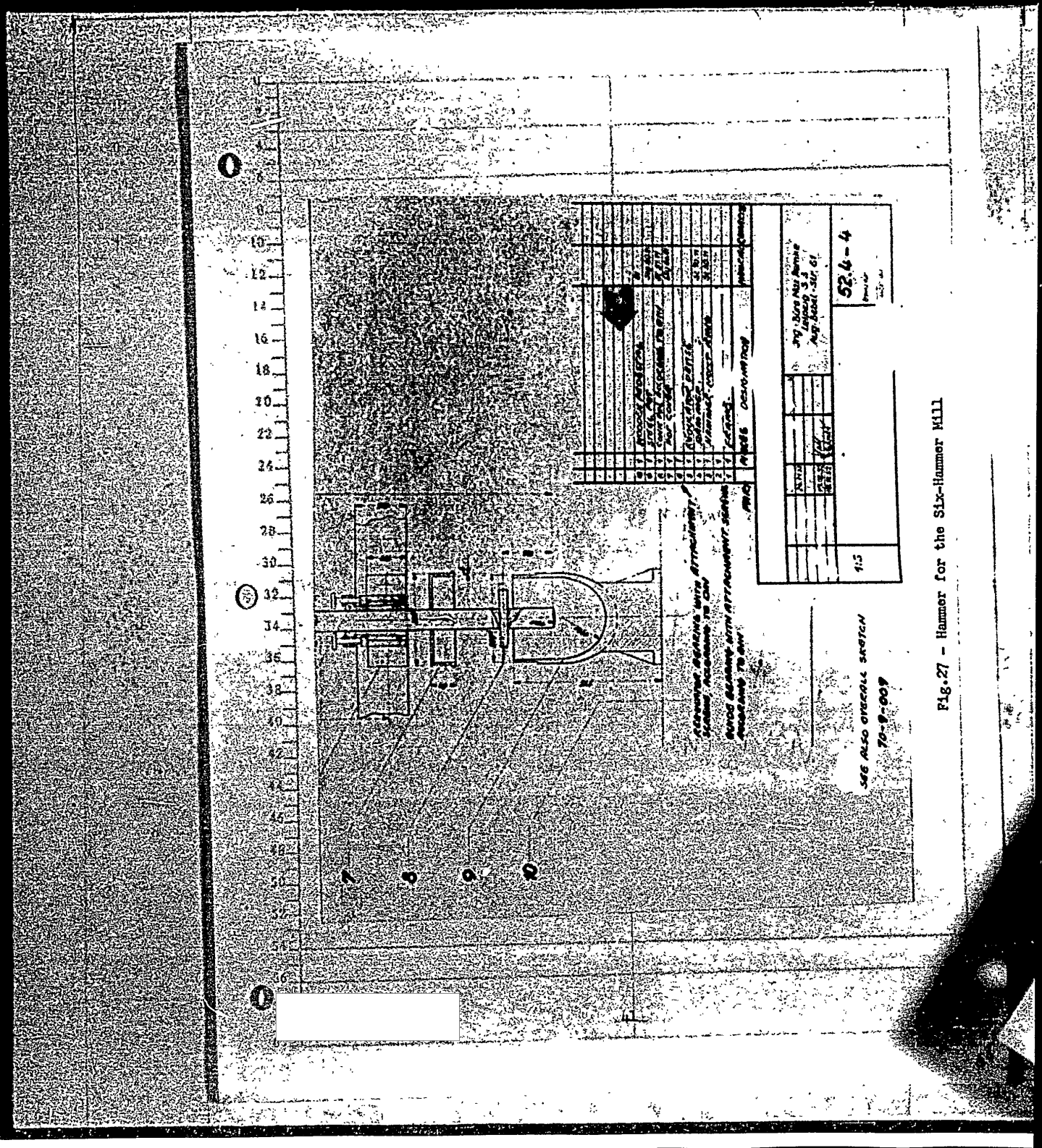

Fig.27 - Hammer for the Six-Hammer Mill

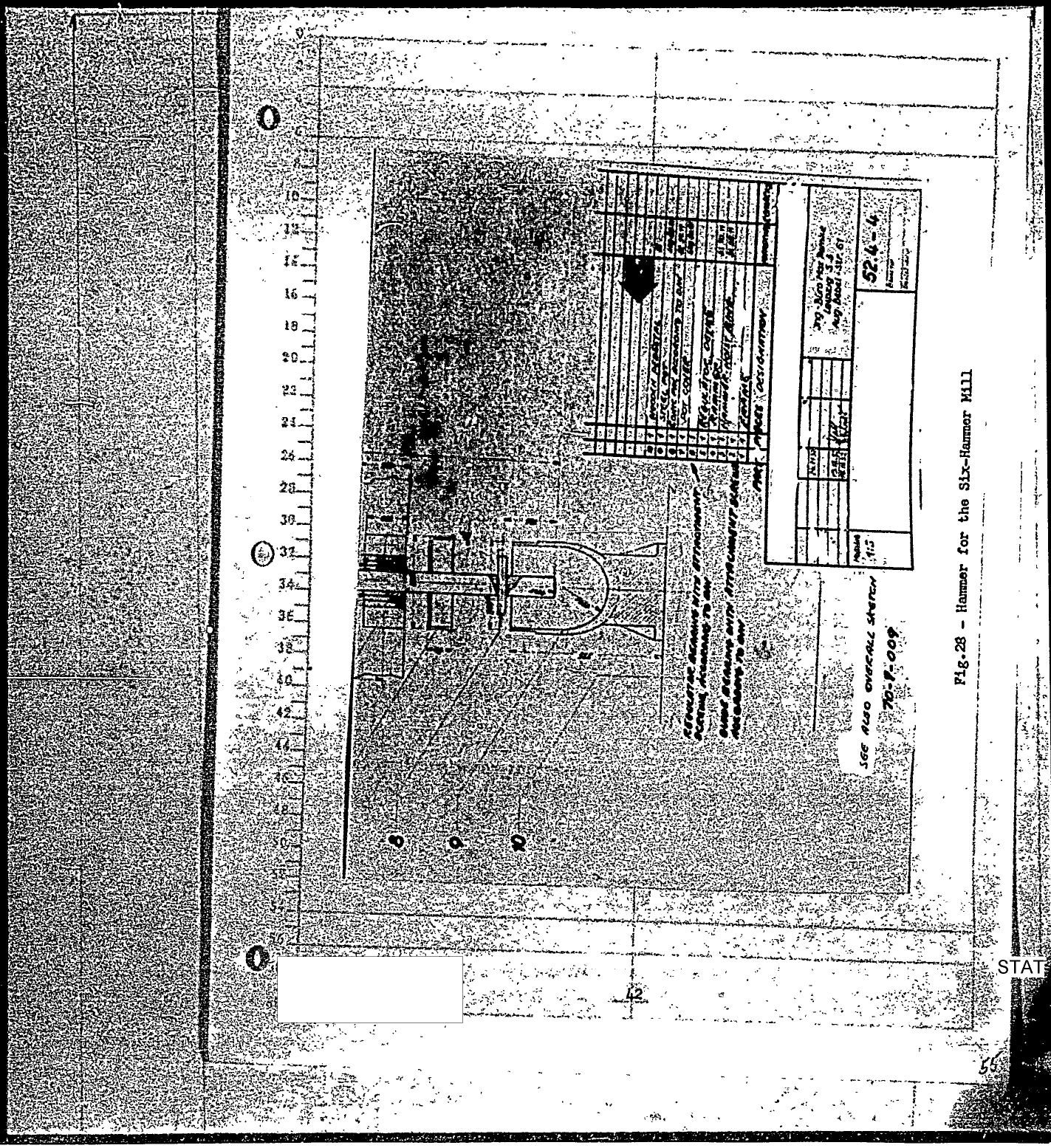

Fig.28 - Hammer for the Six-Hammer Mill

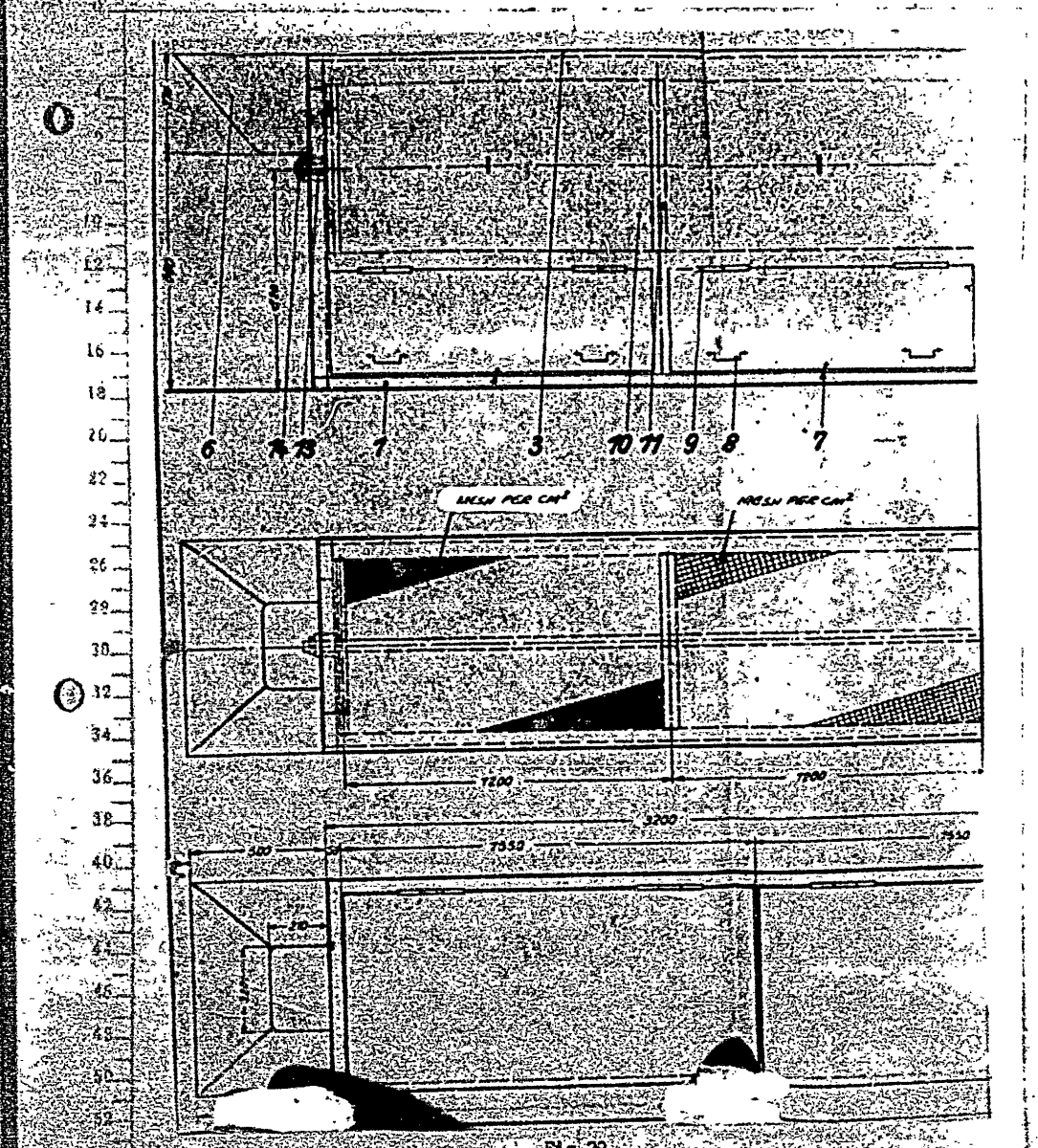

Fig. 29

STAT

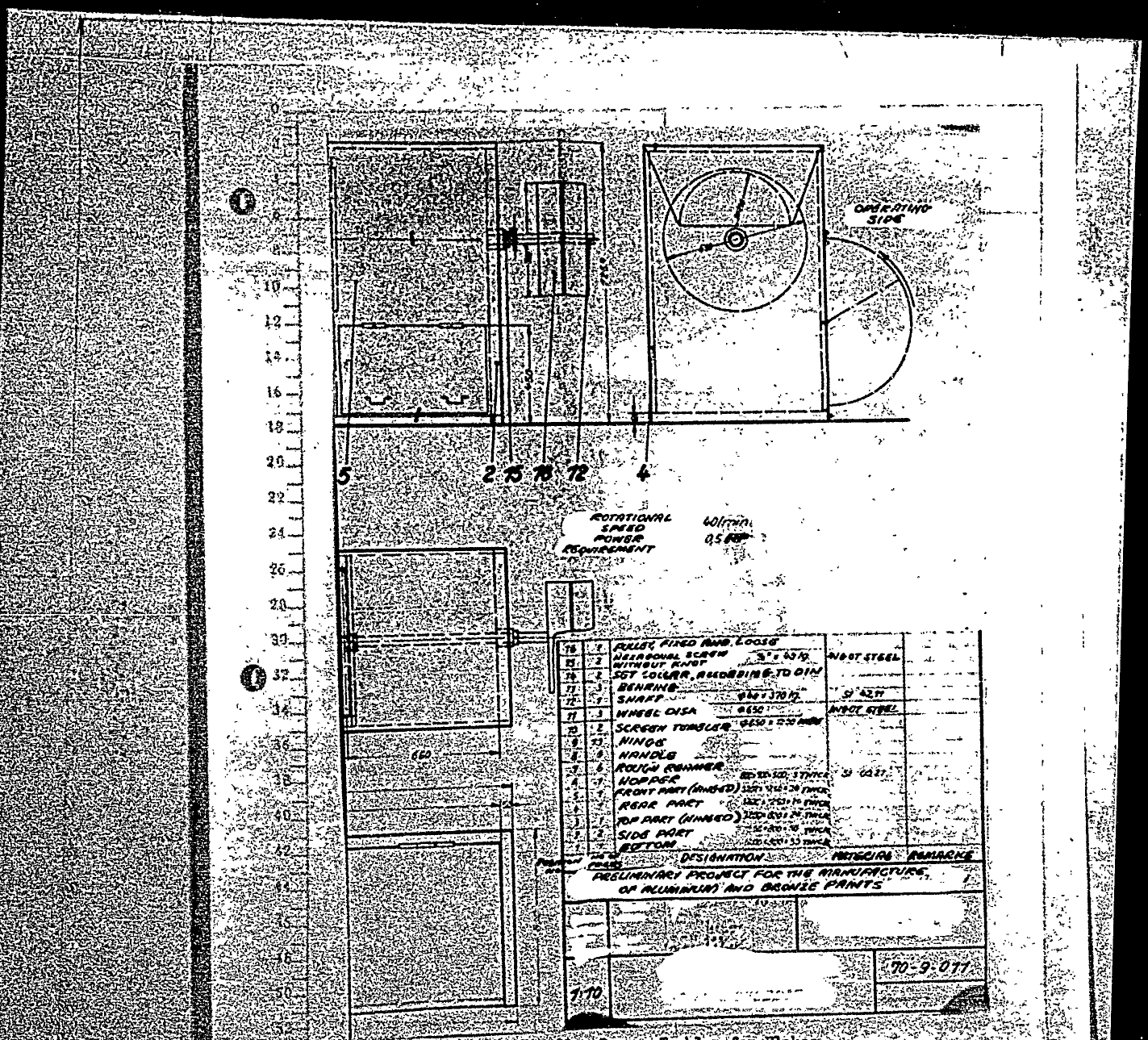

Fig.30 - Screen Tumbler for Flakes

STAT

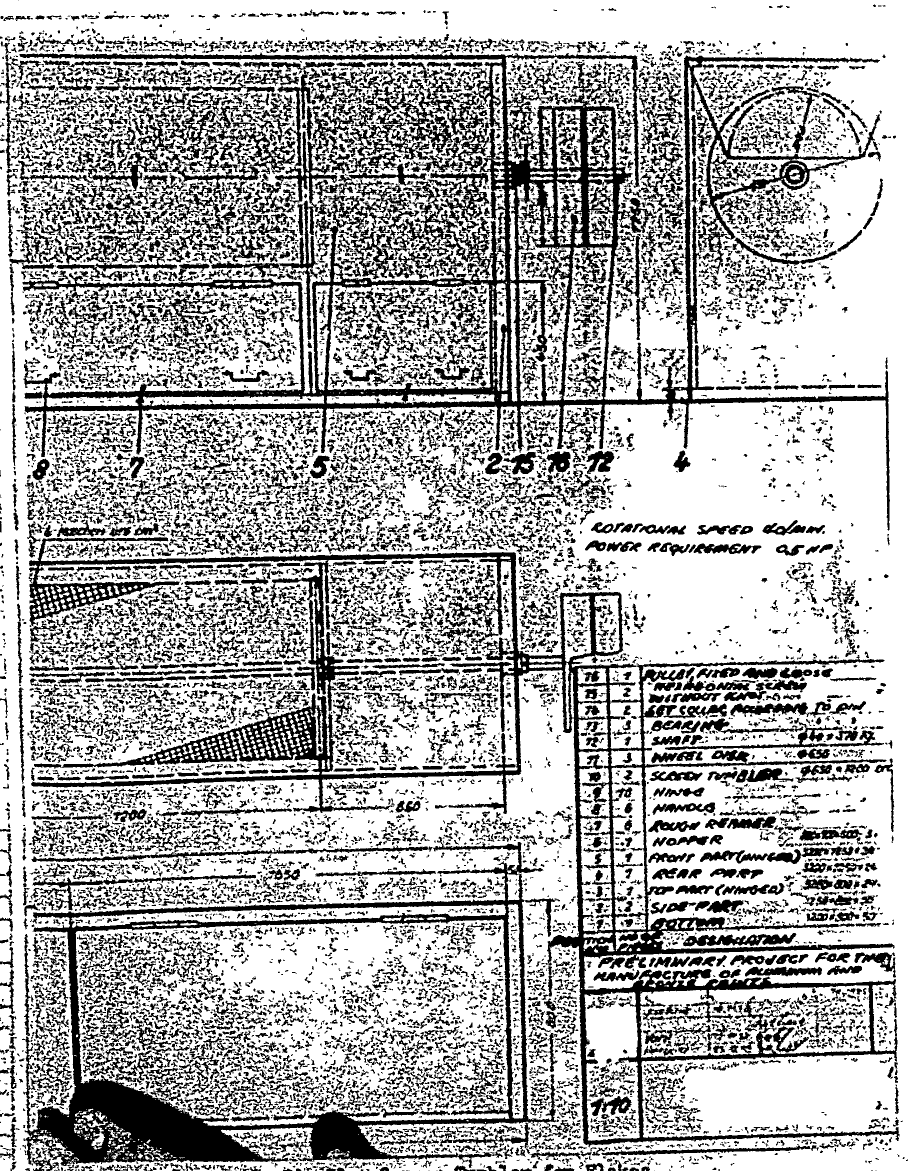

Fig.31 - Screen Tumbler for Flakes

STAT

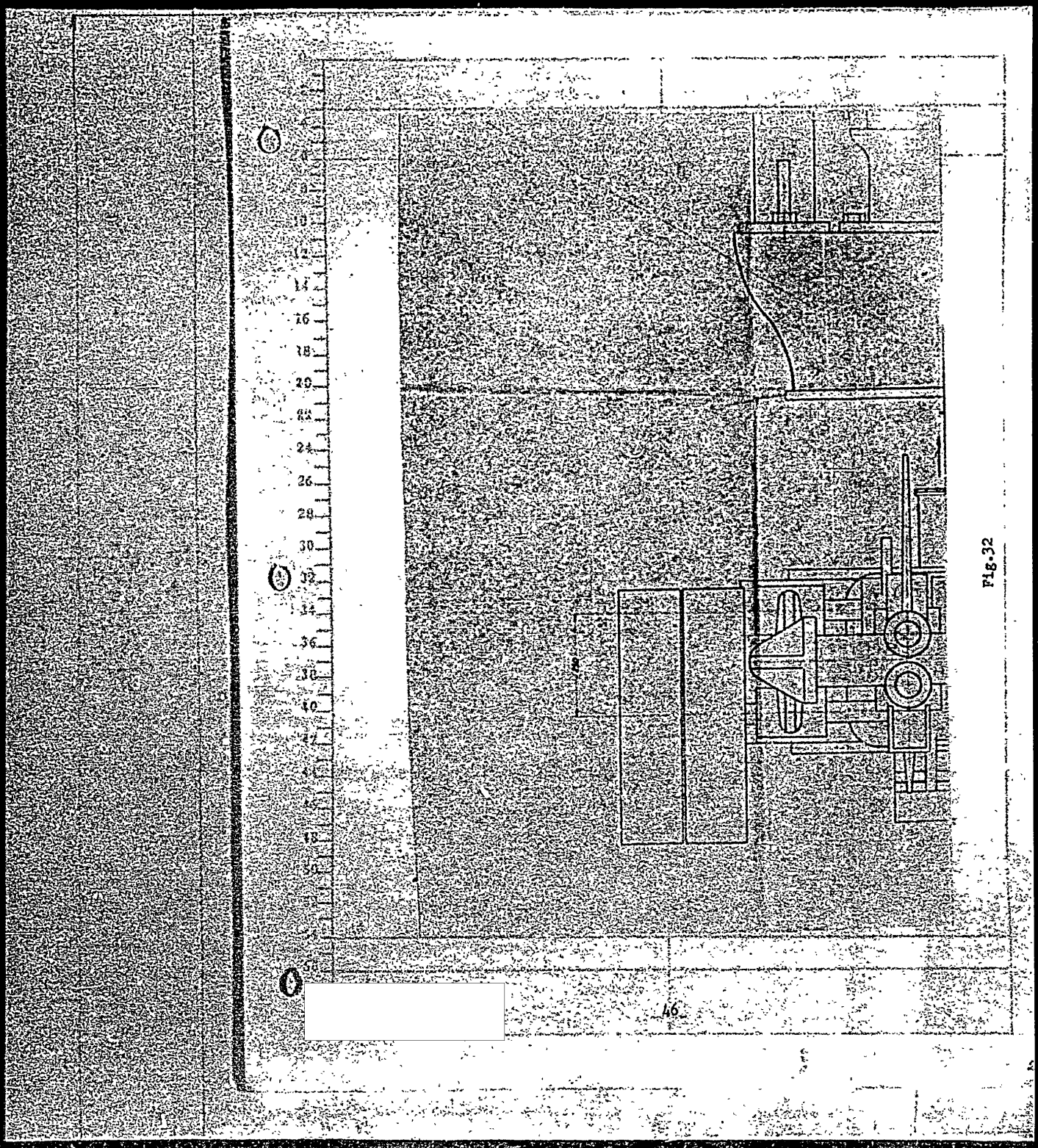

Fig.32

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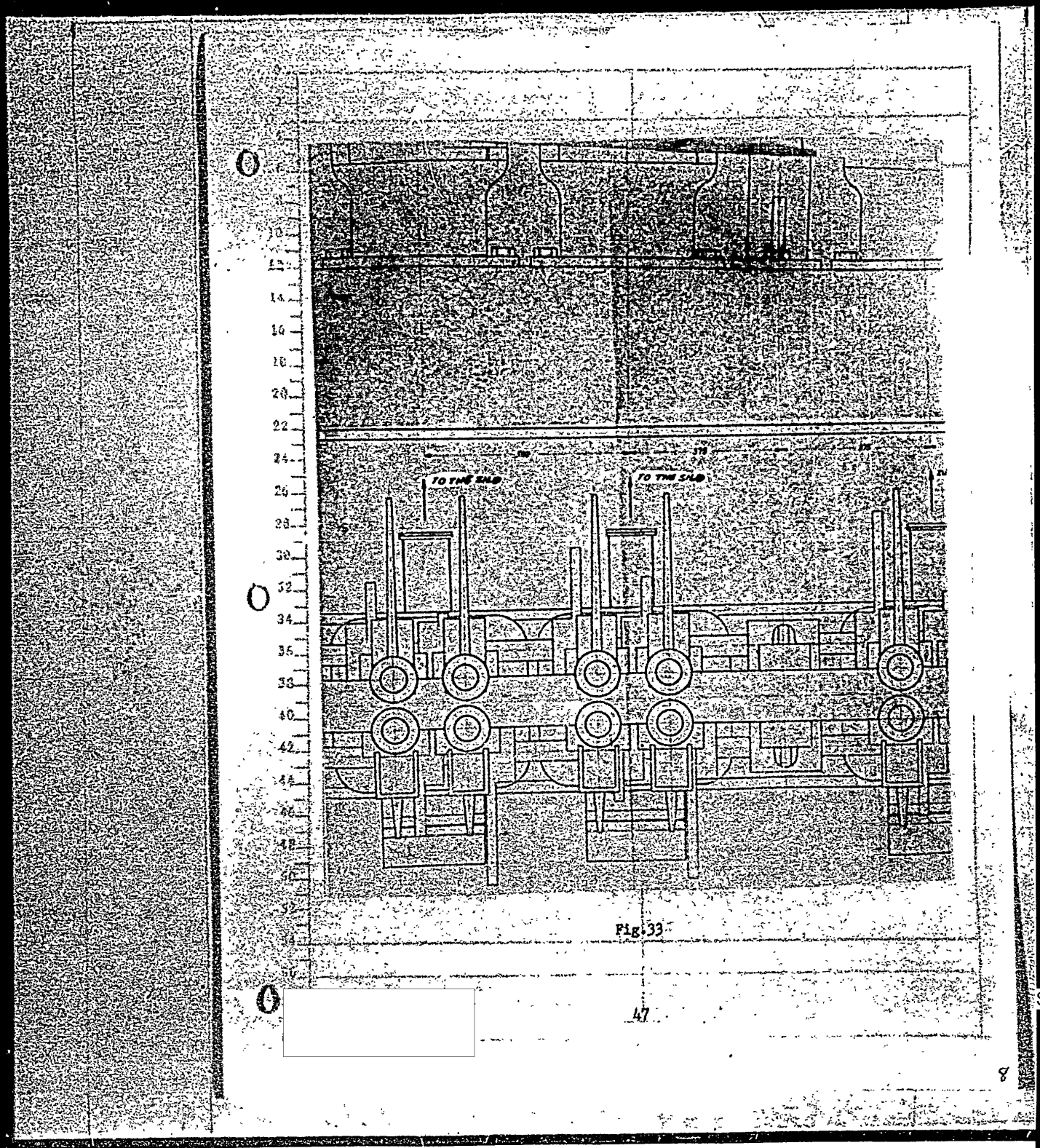

Fig. 33

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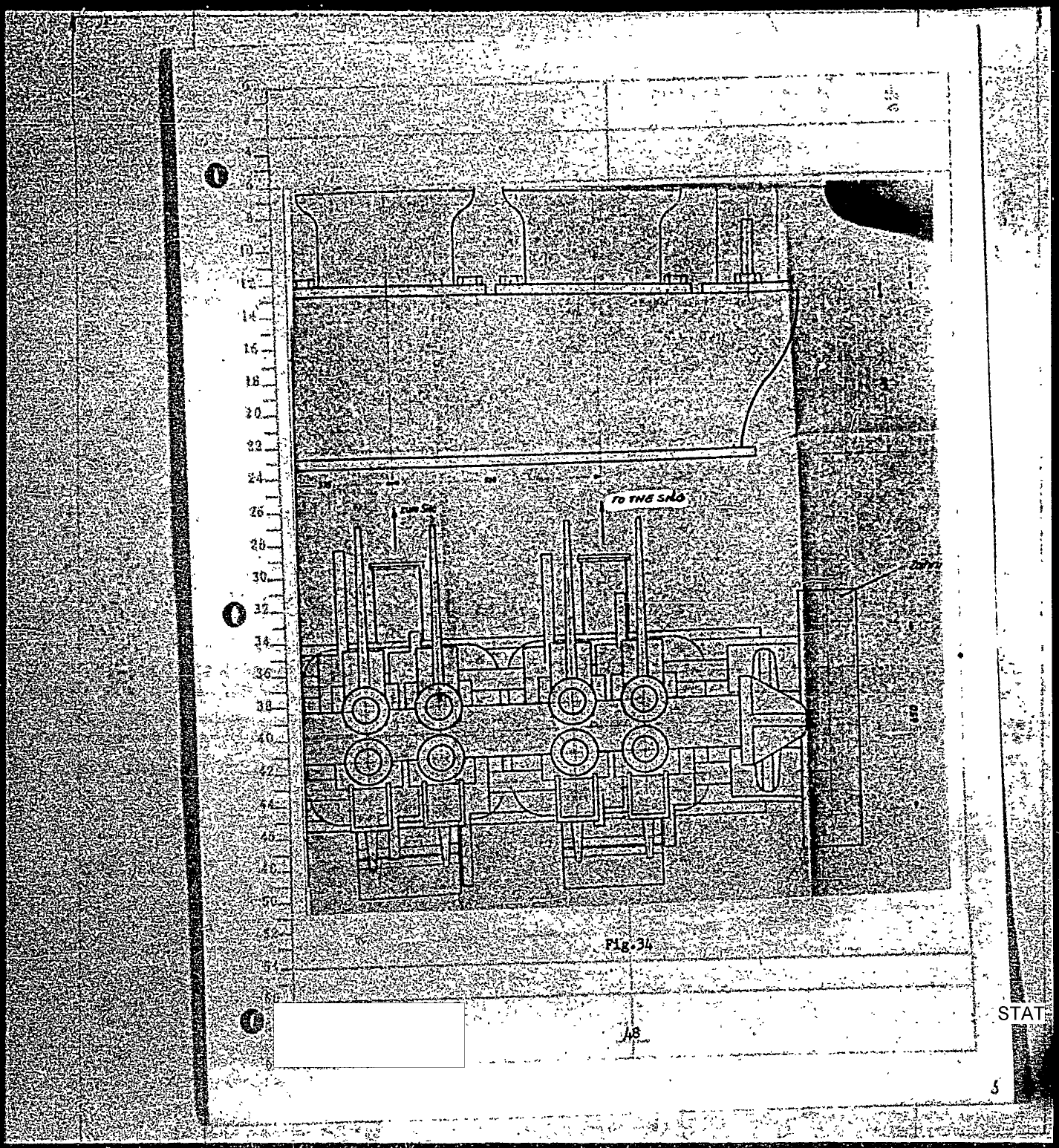

Fig. 34

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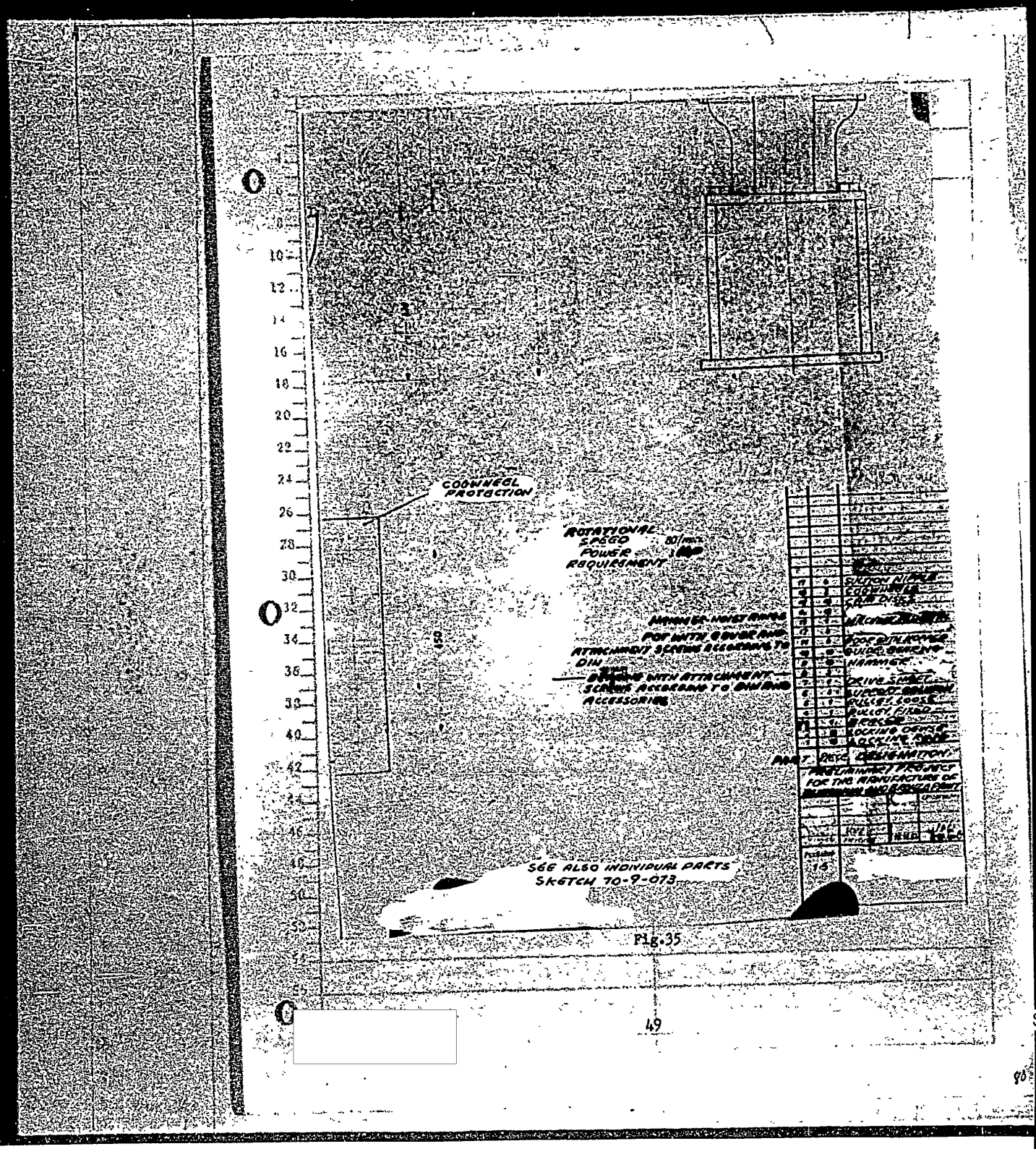

Fig. 35

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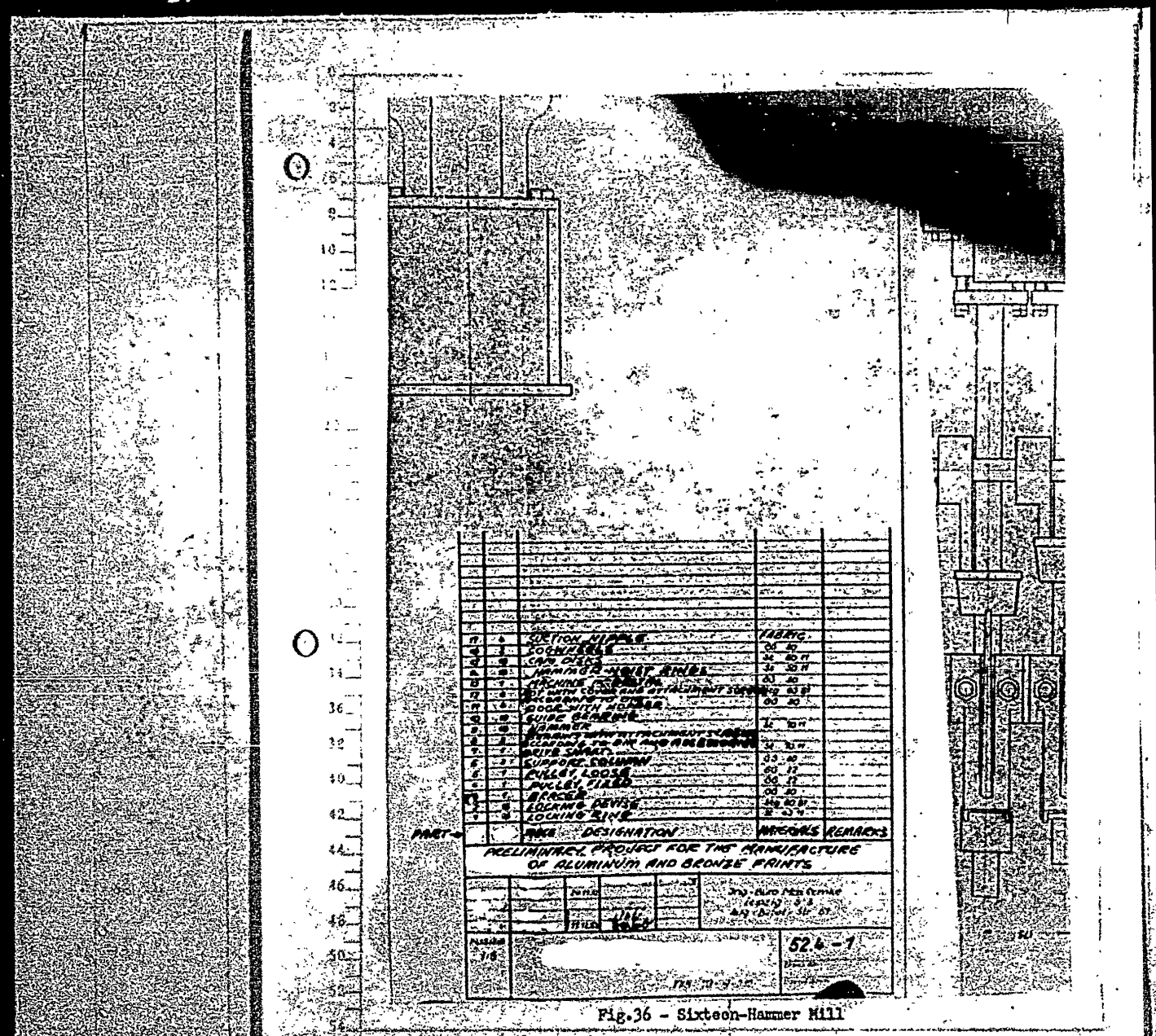

Fig.36 - Sixteen-Hammer Mill

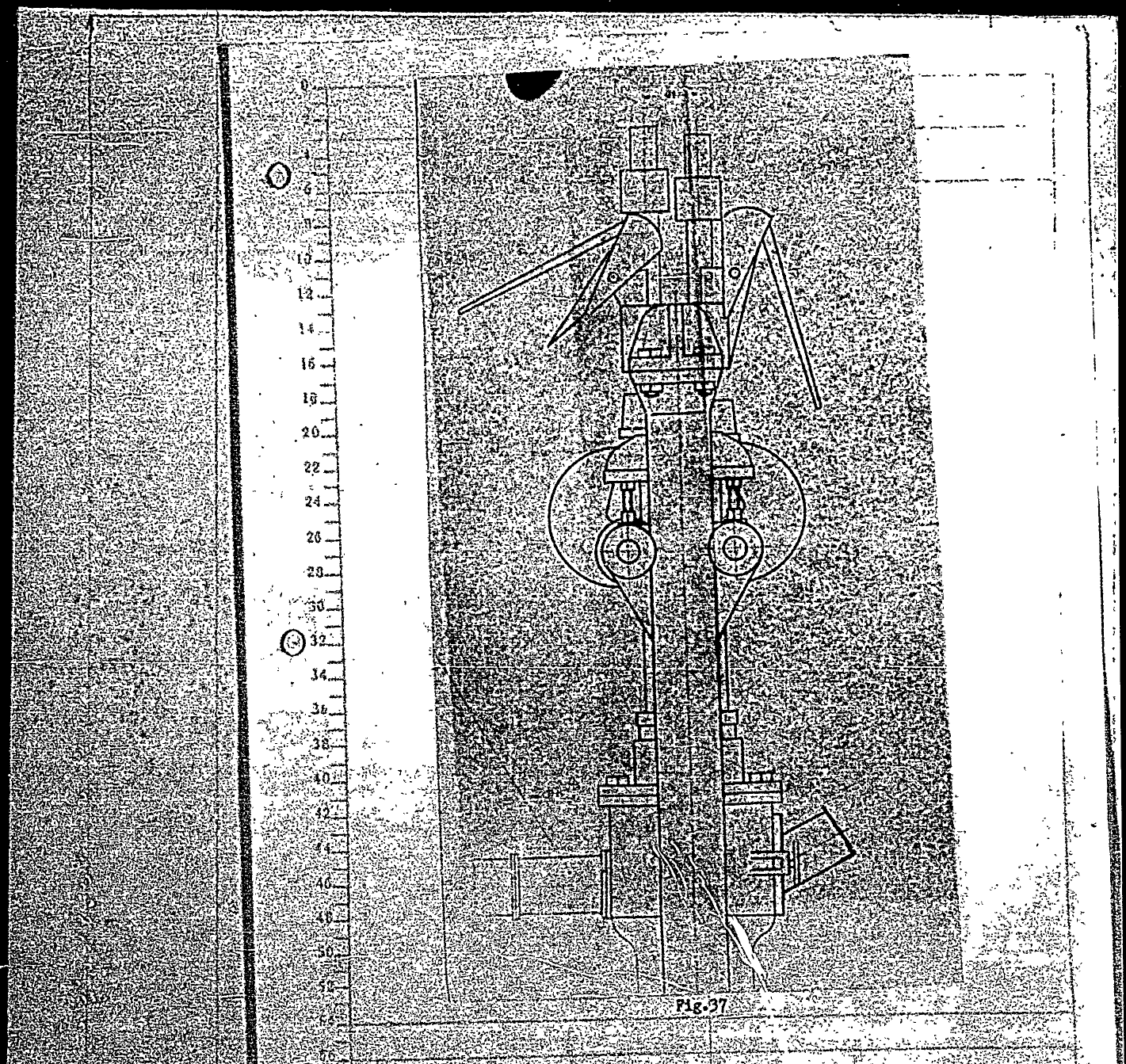

Fig. 37

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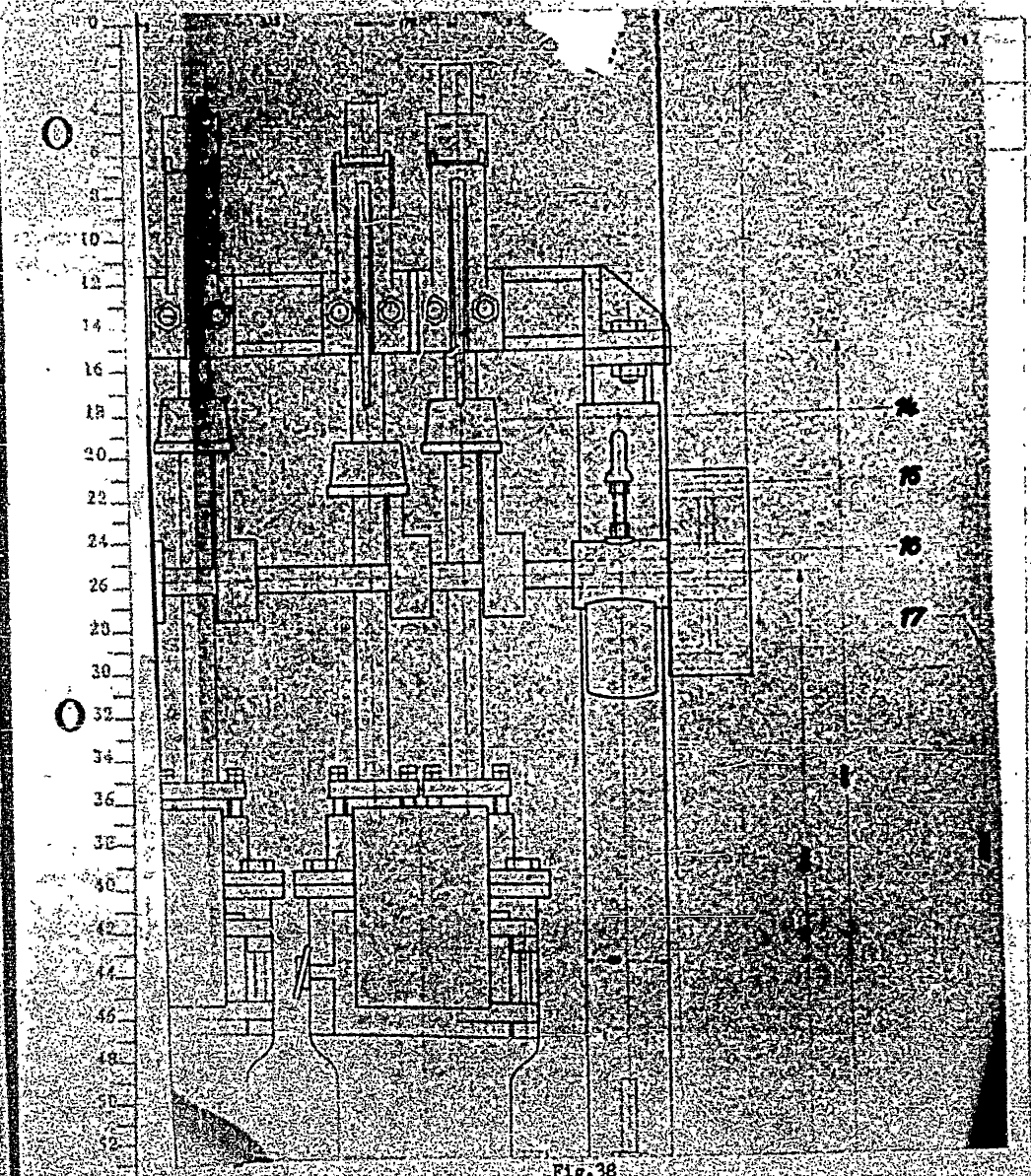

Fig.38

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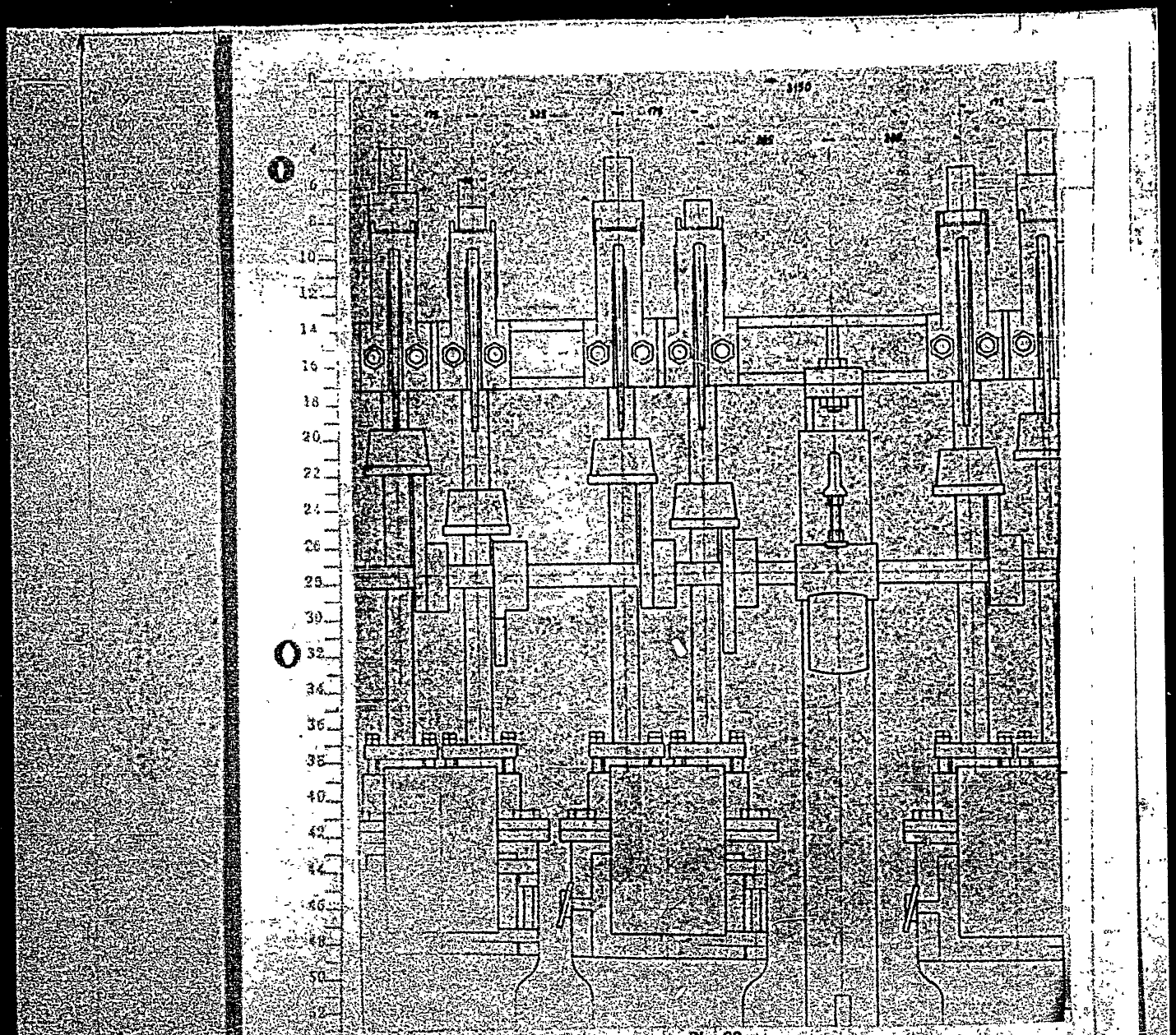

Fig. 39

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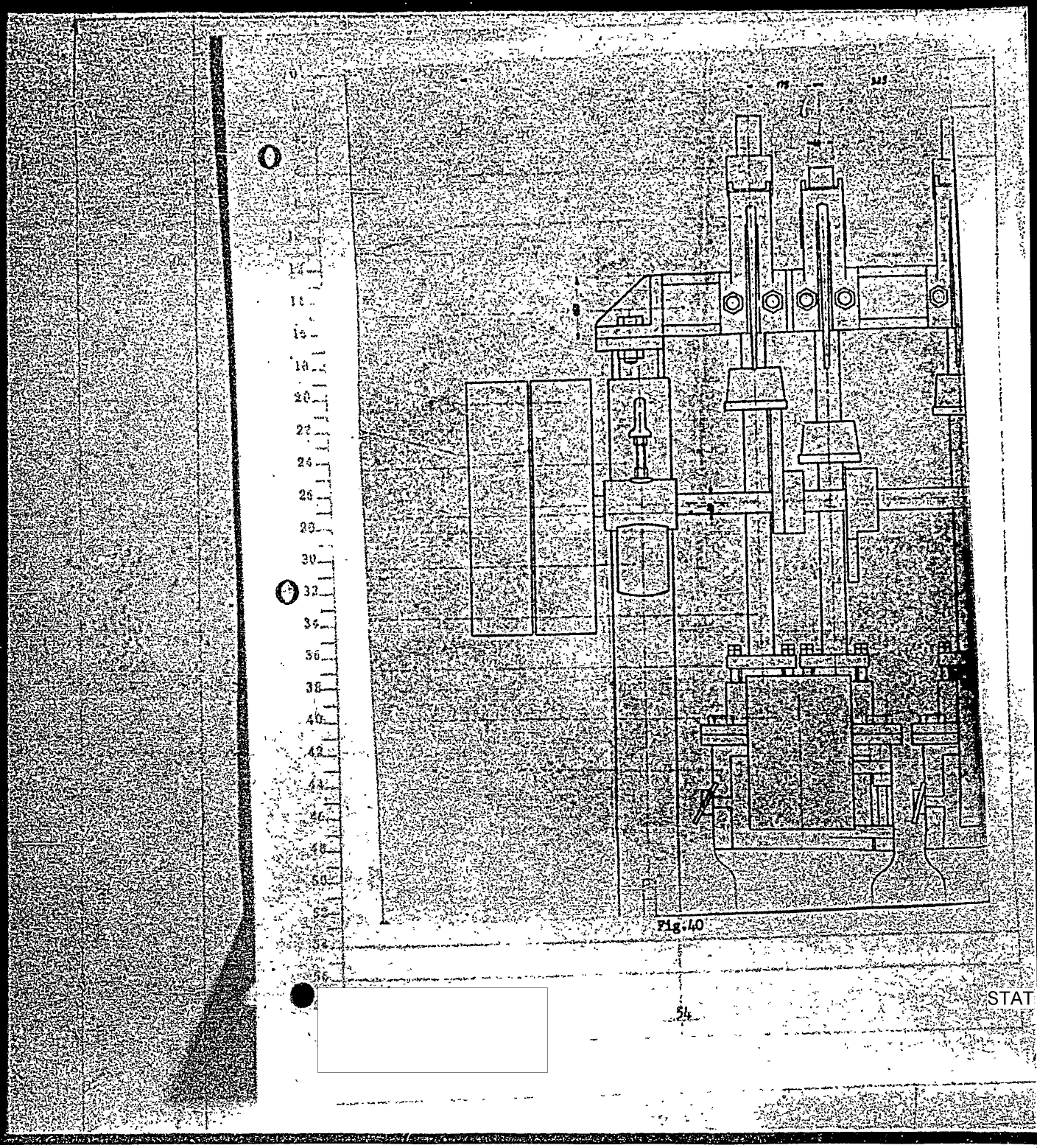

Fig. 40

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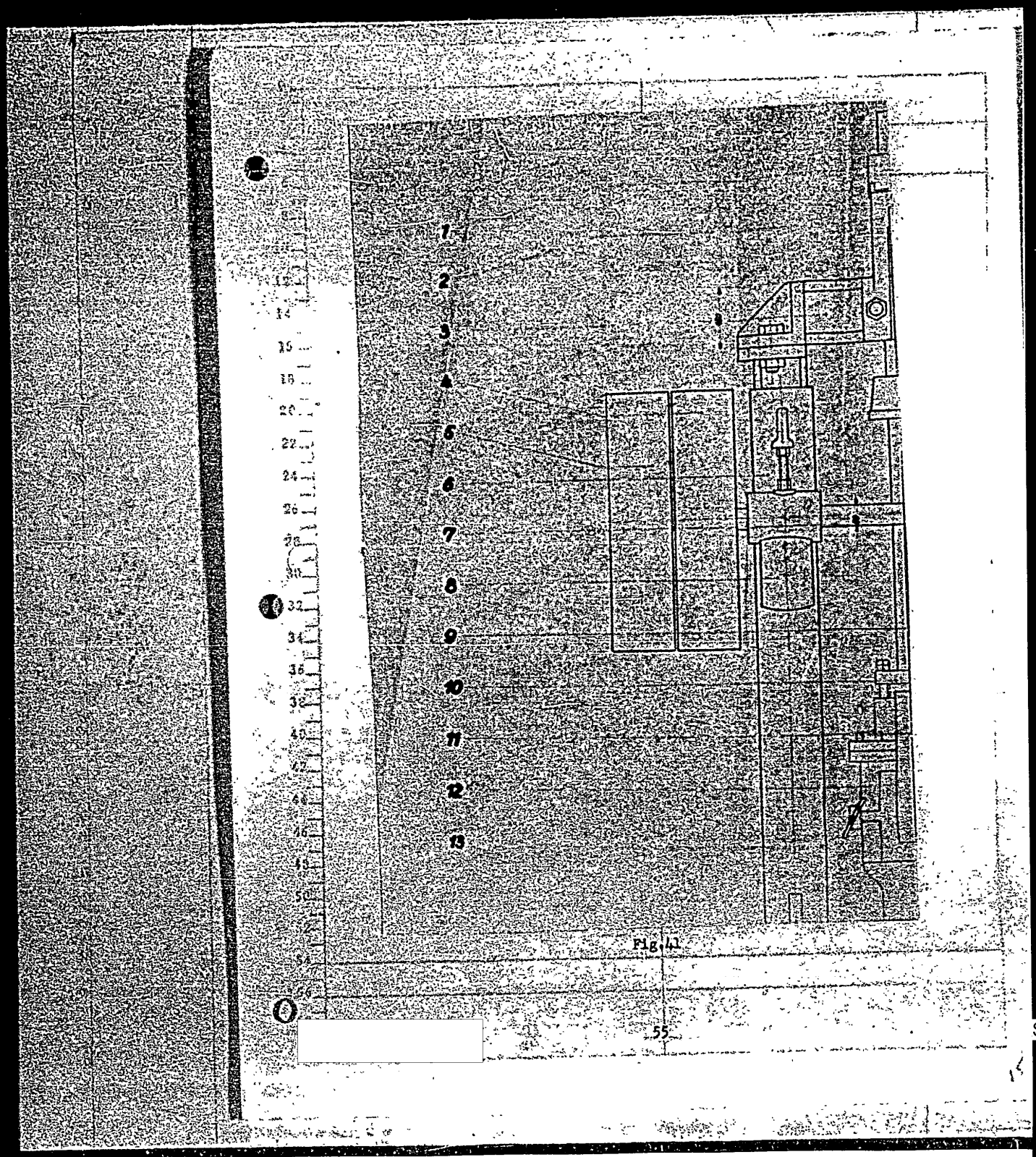

Fig. 41

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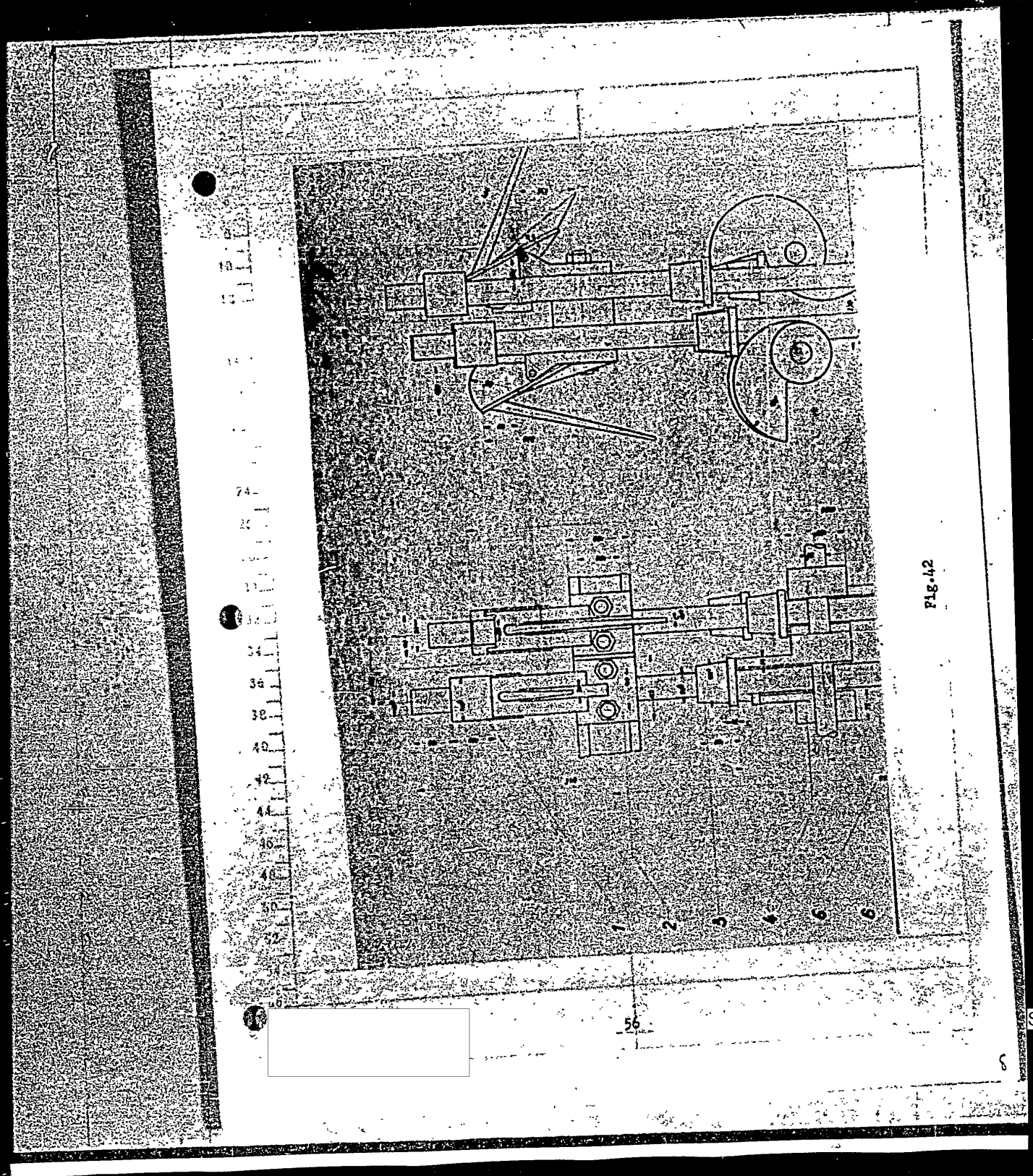

Fig. 42

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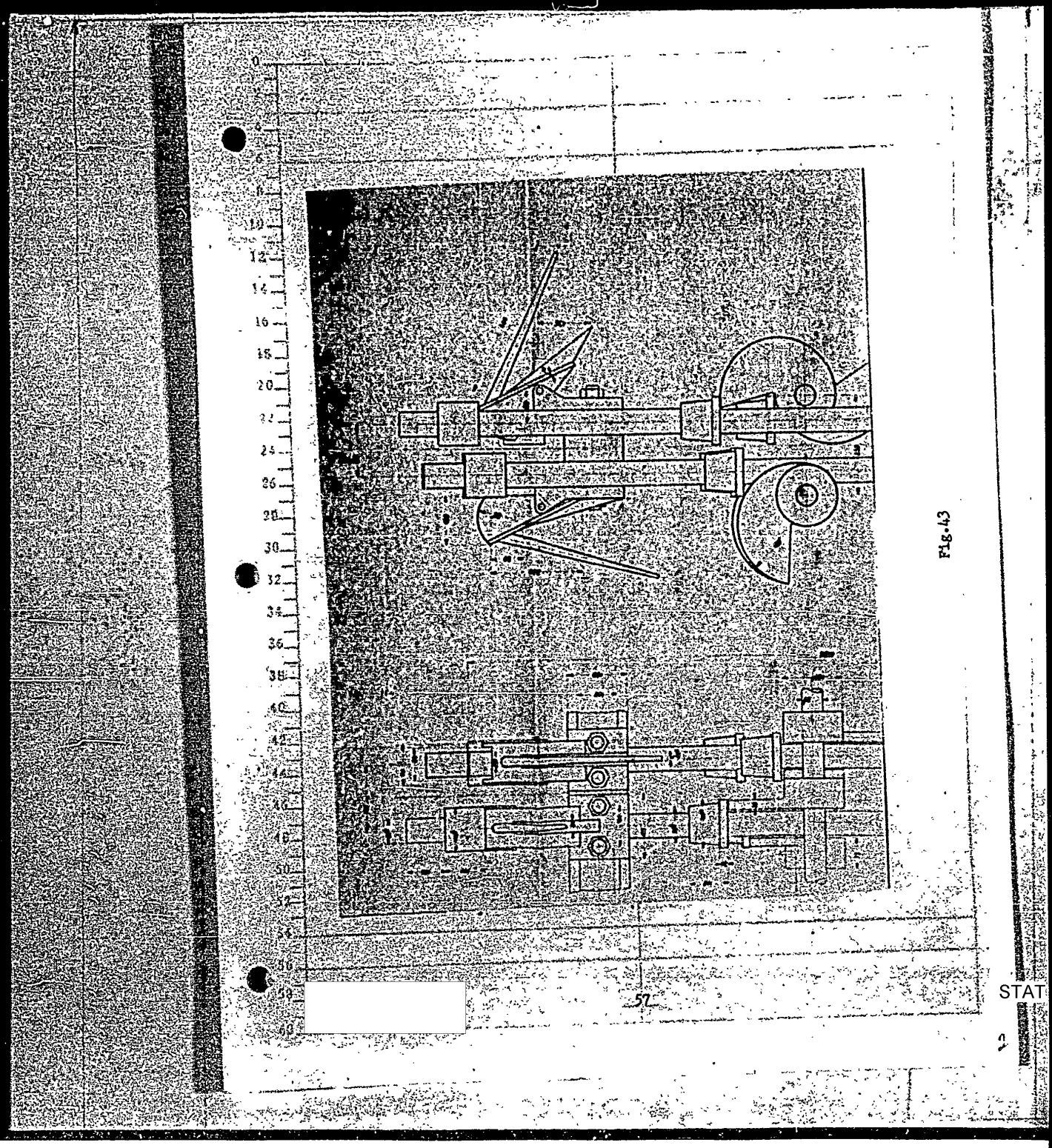

Fig.43

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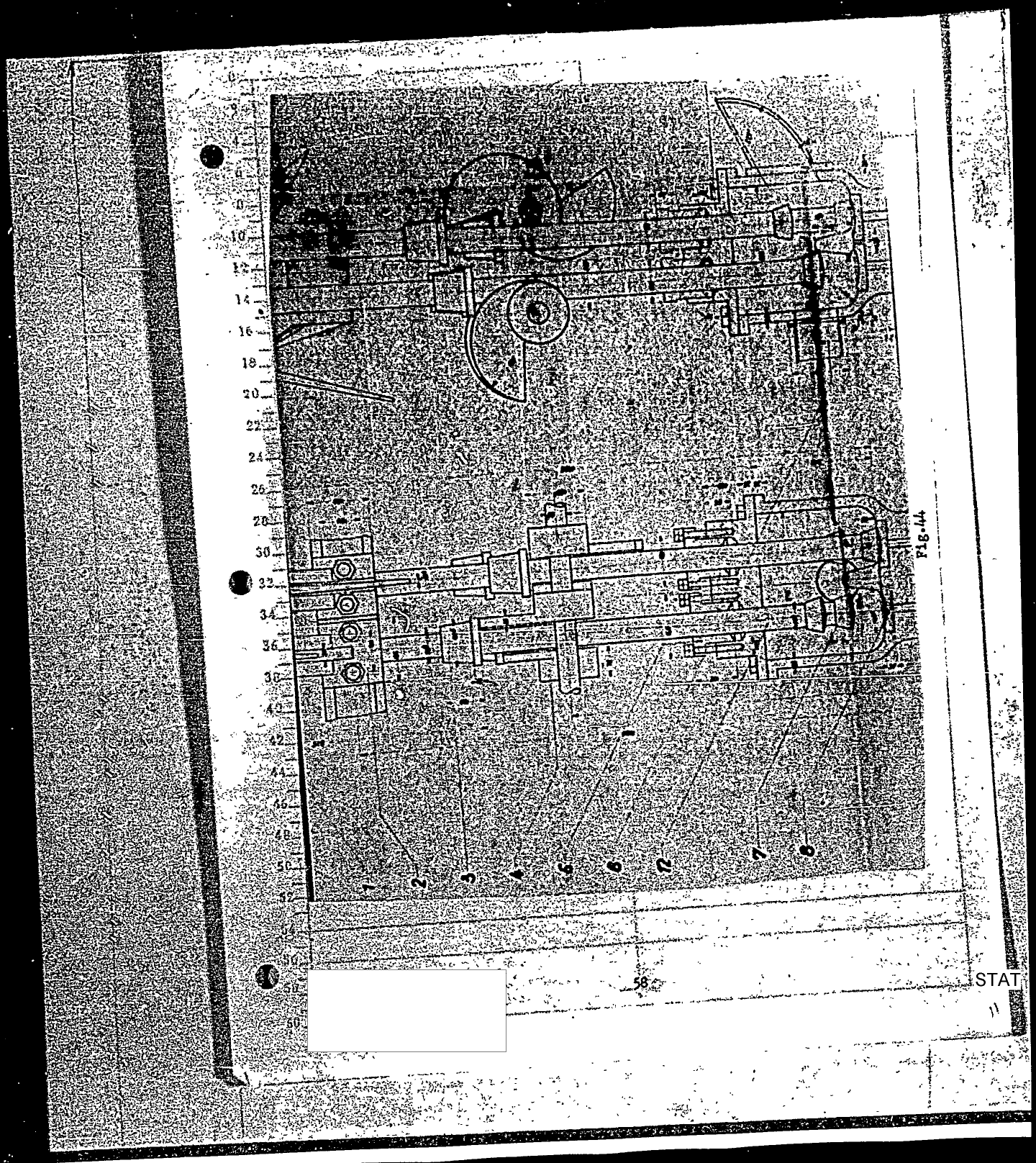

Fig. 44

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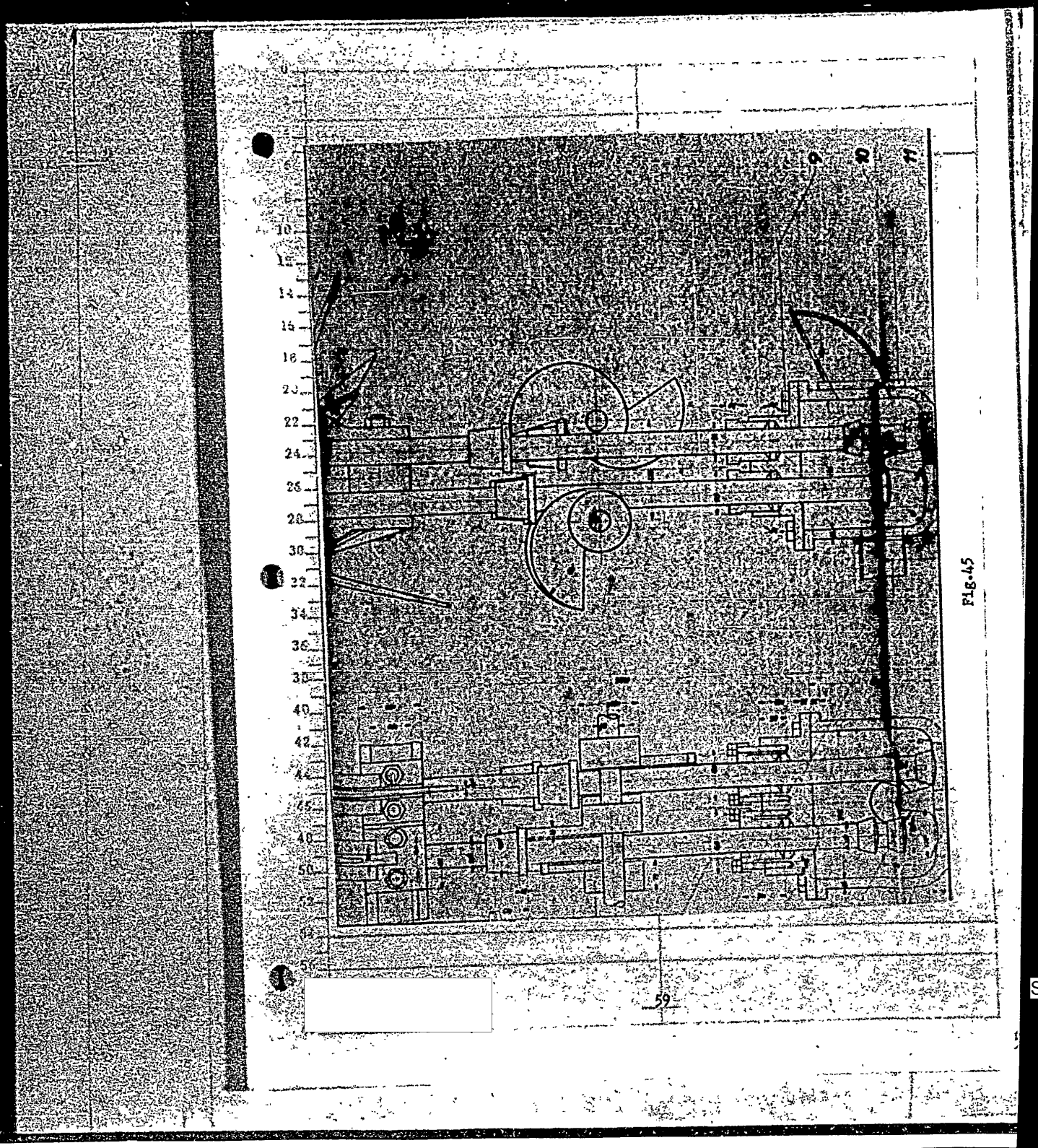

Fig. 45

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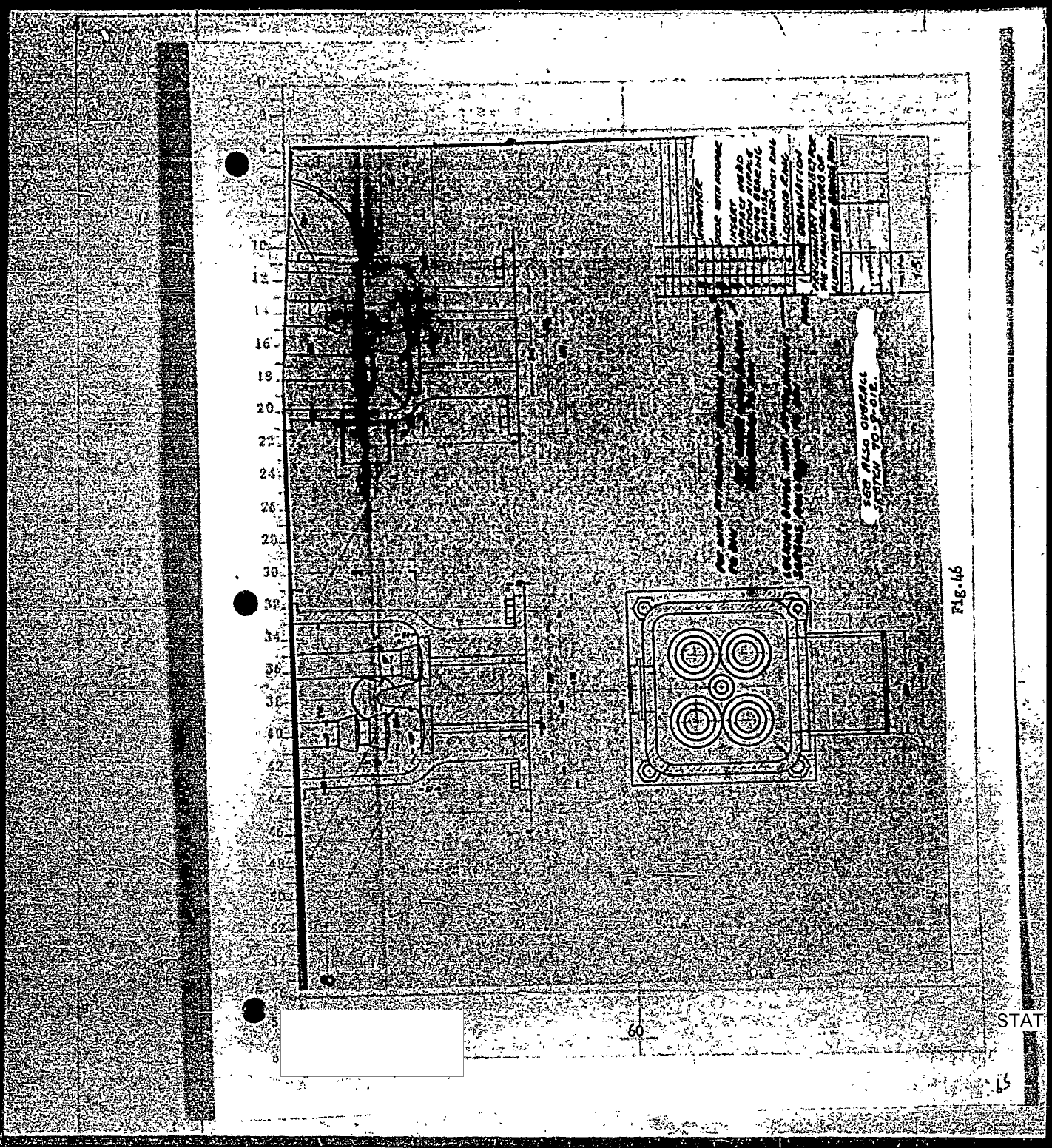

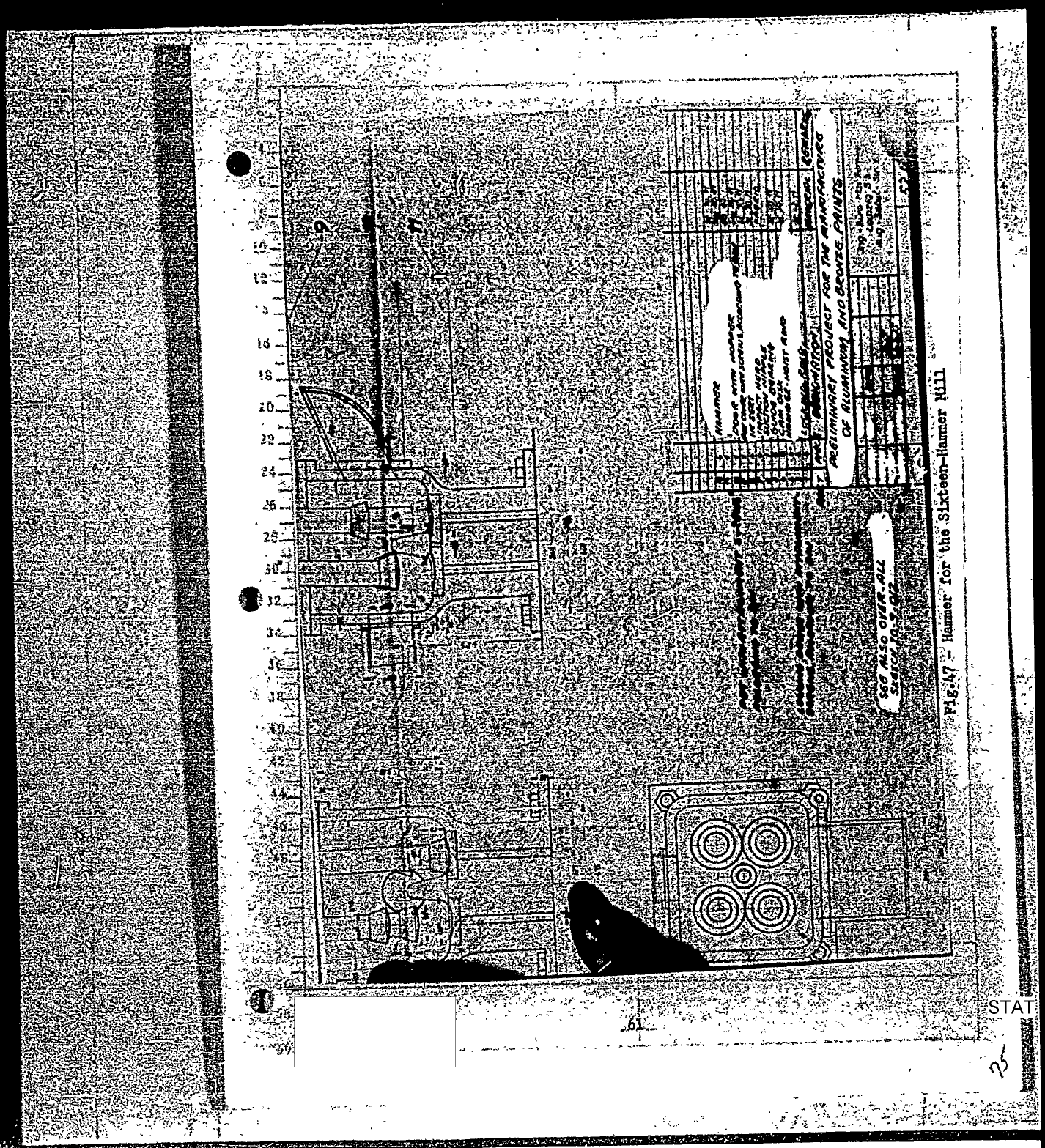

Fig 47 - Hammer for the Sixteen-Hammer Mill

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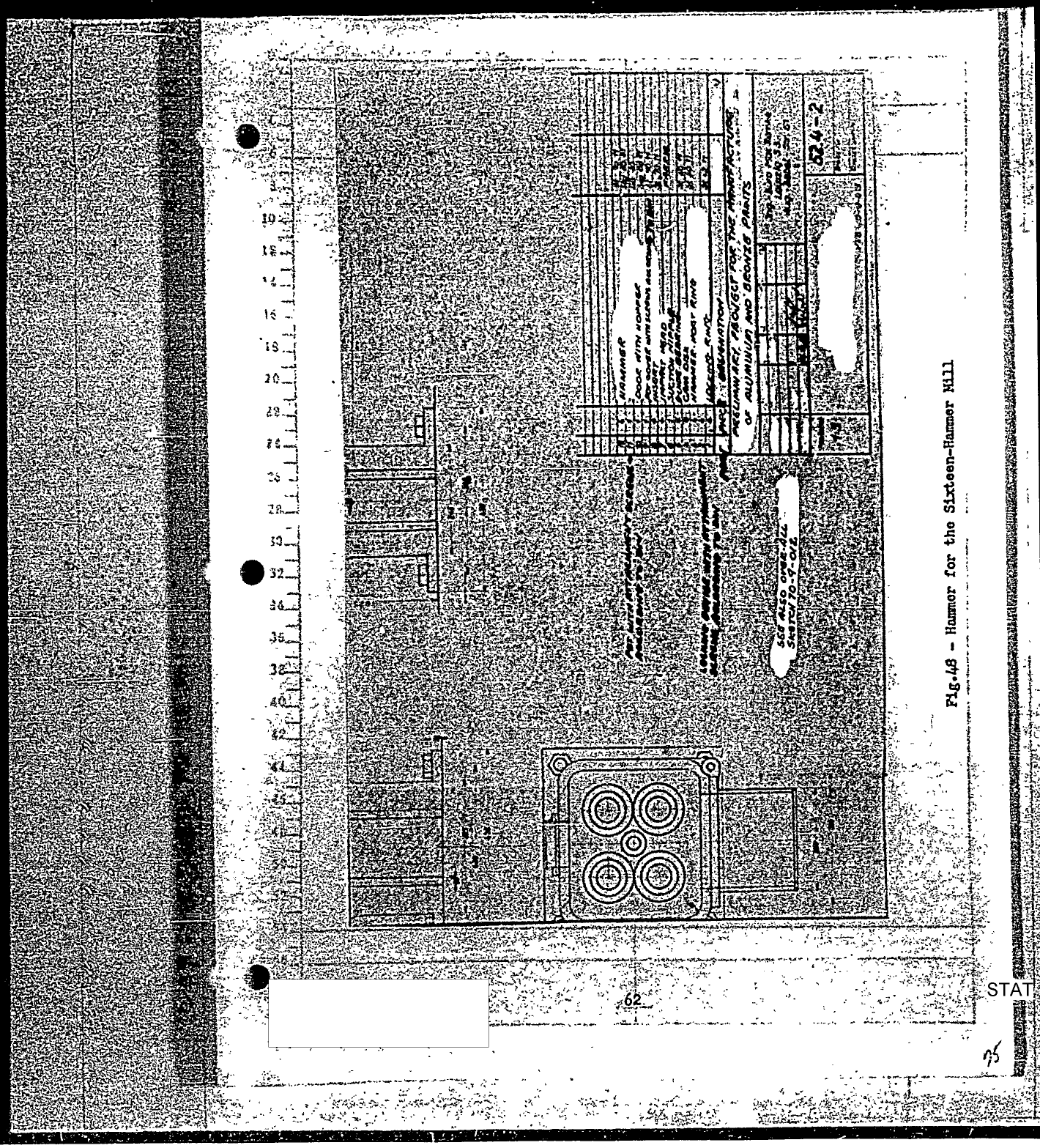

Fig.48 - Hammer for the Sixteen-Hammer Mill

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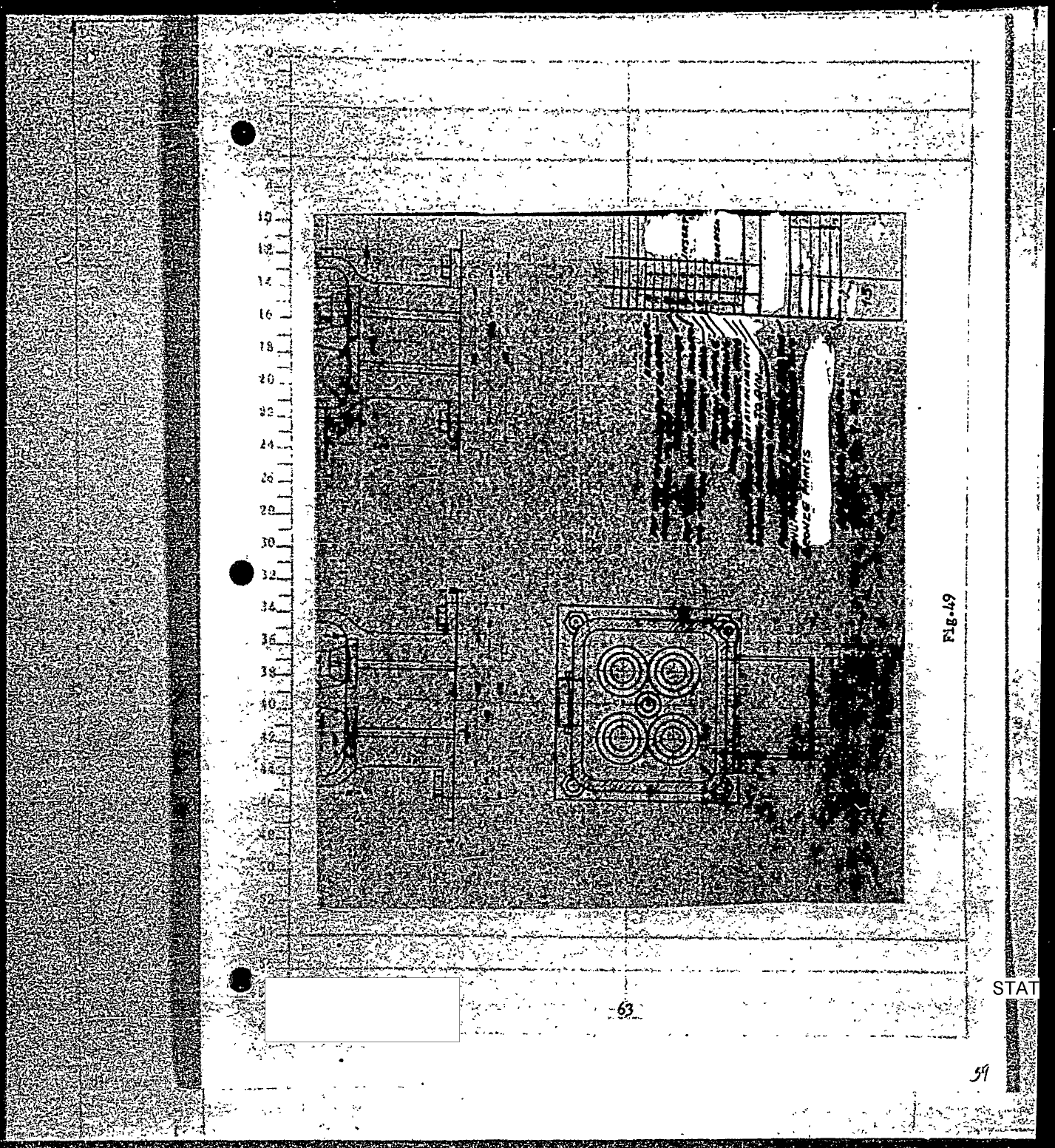

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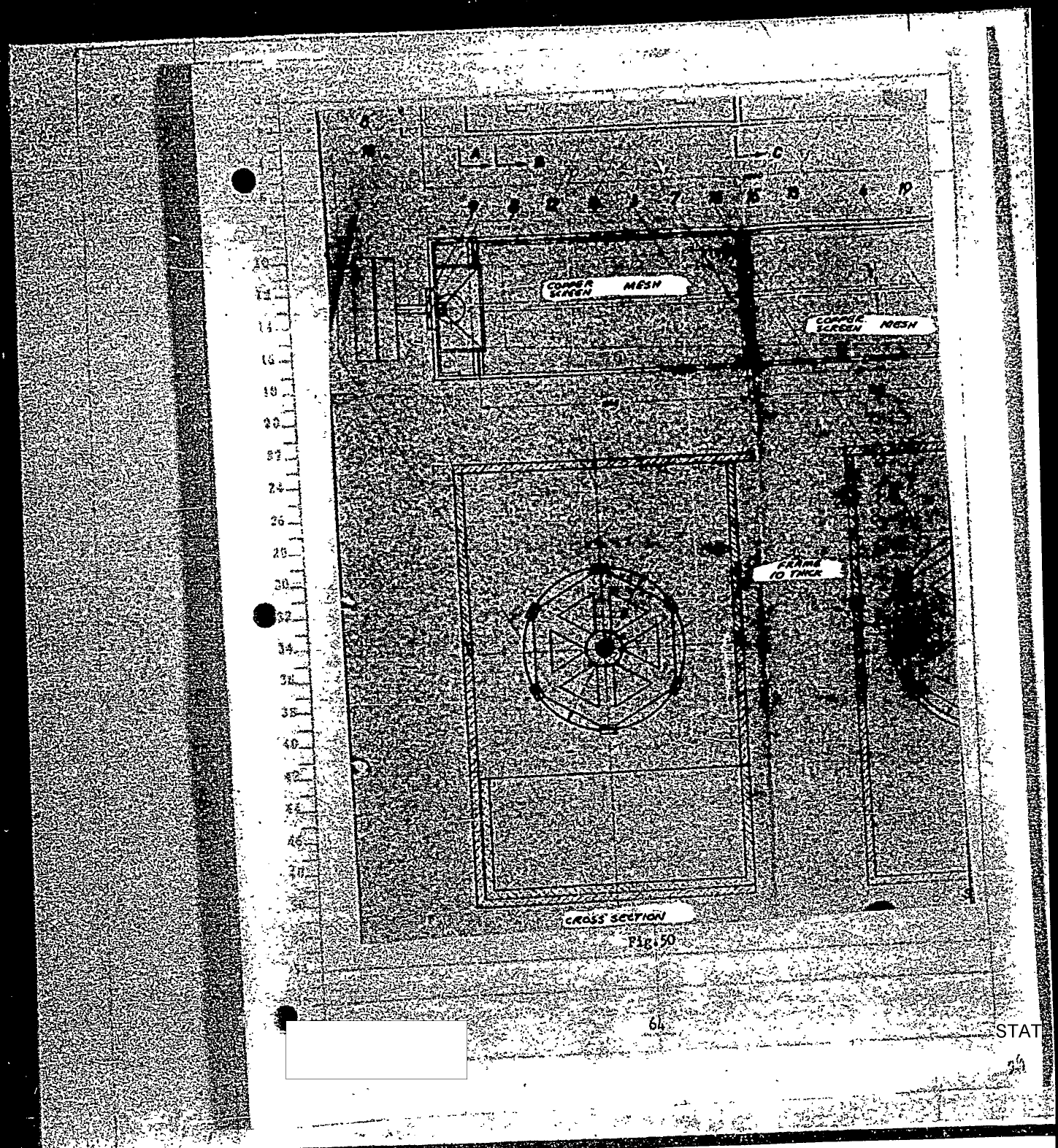

Fig. 50

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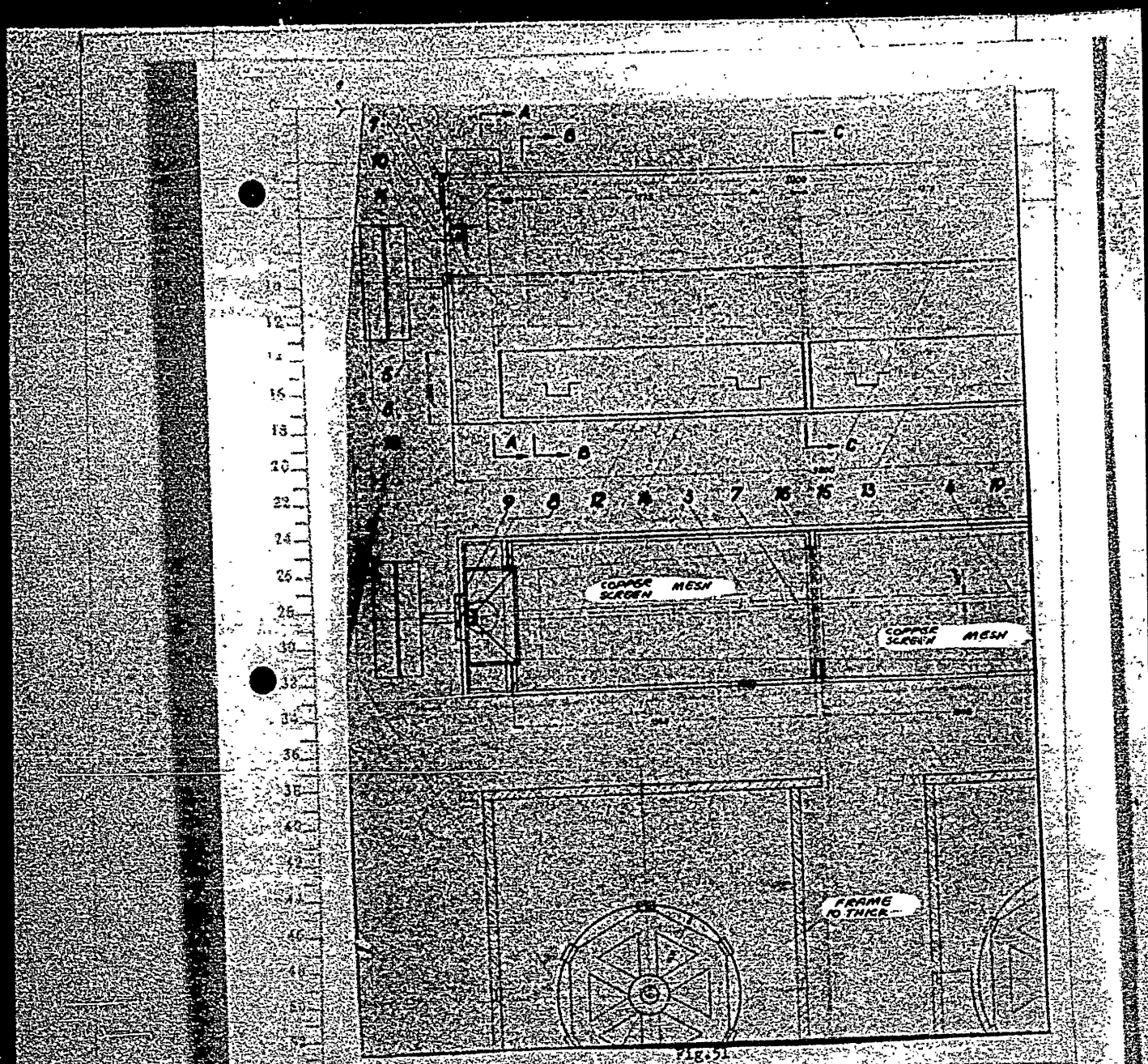

Fig. 51

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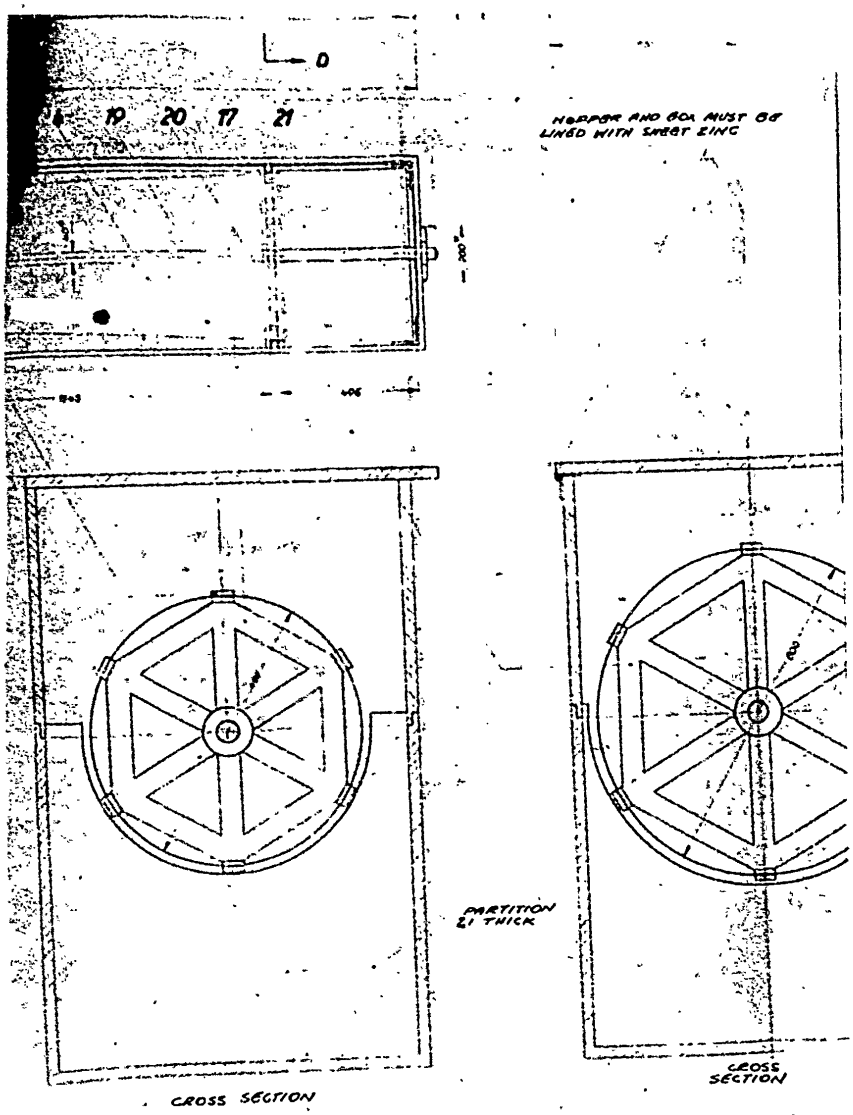

Fig.52

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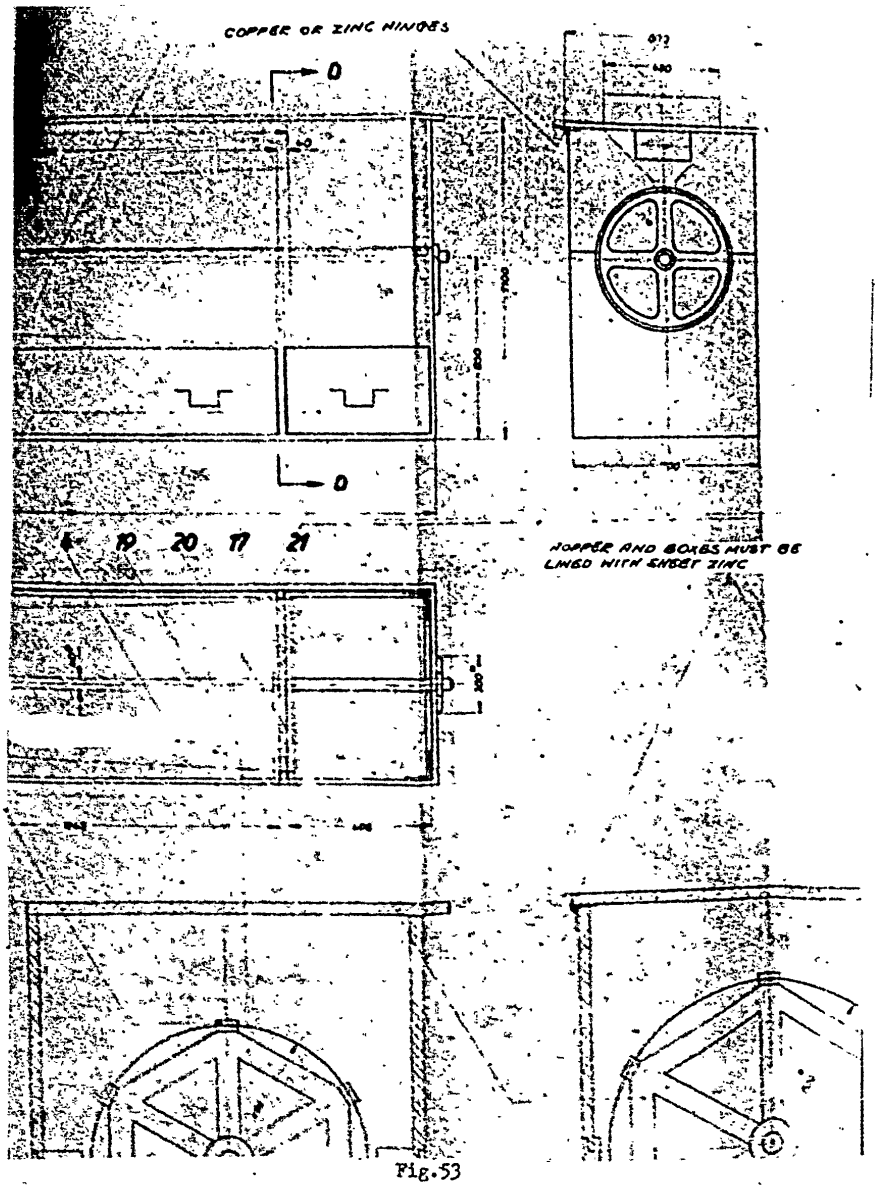

Fig. 53

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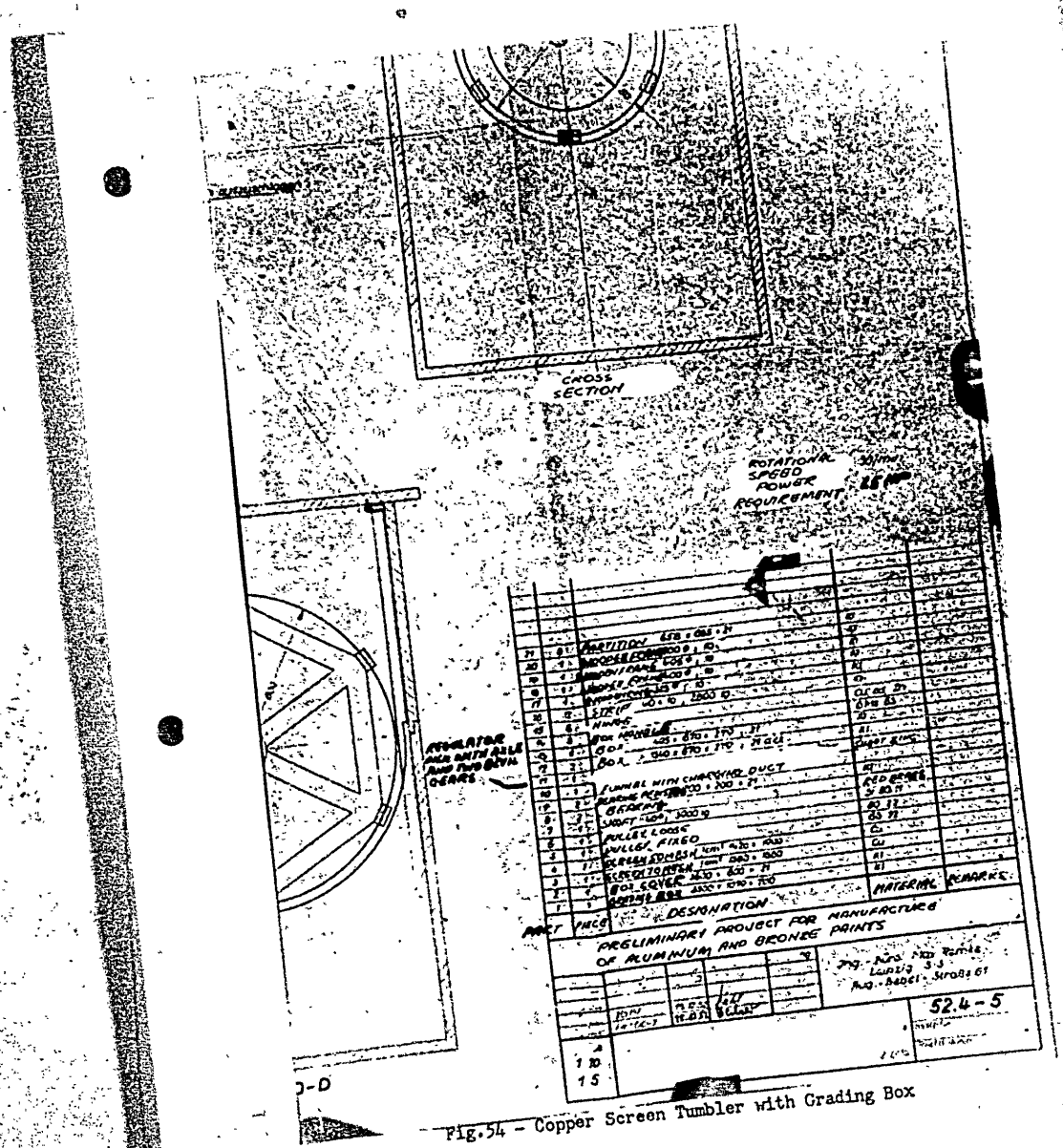

Fig.54 - Copper Screen Tumbler with Grading Box

STAT

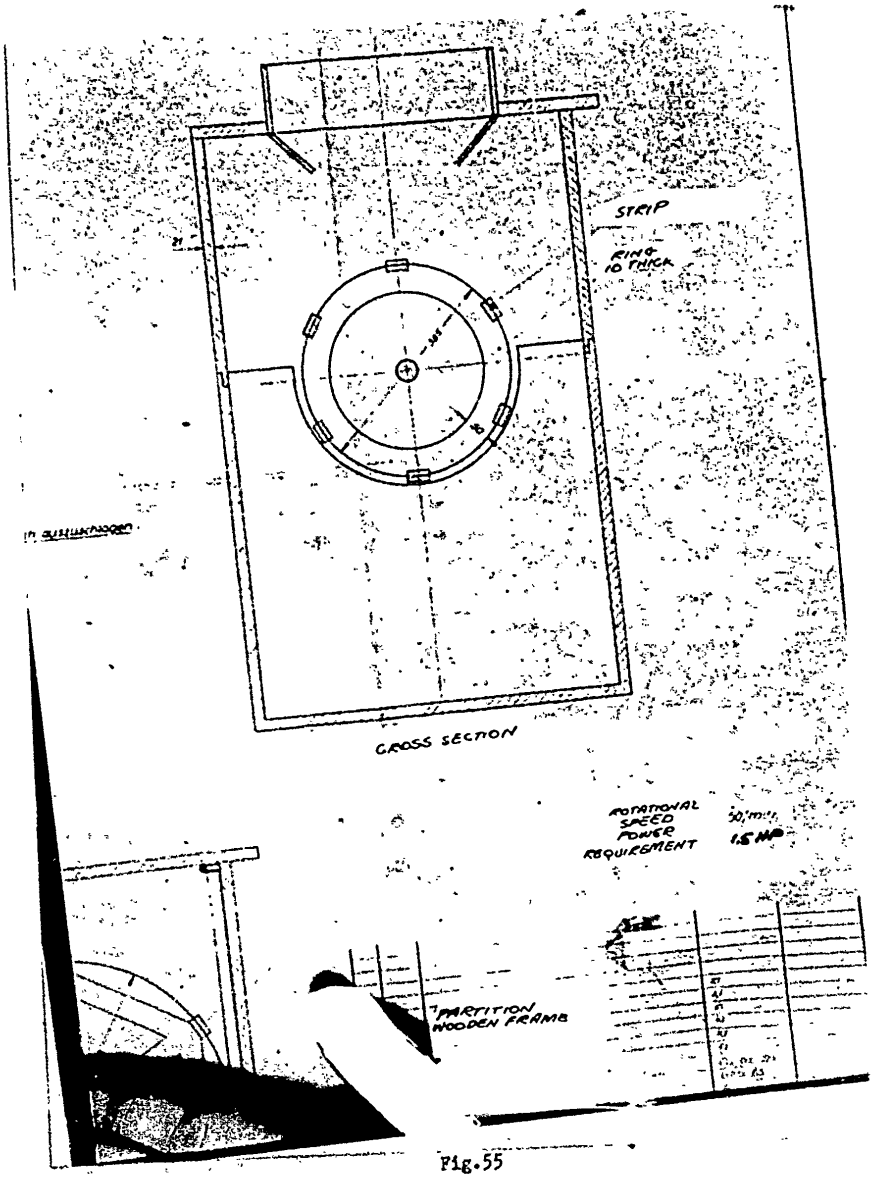

Fig.55

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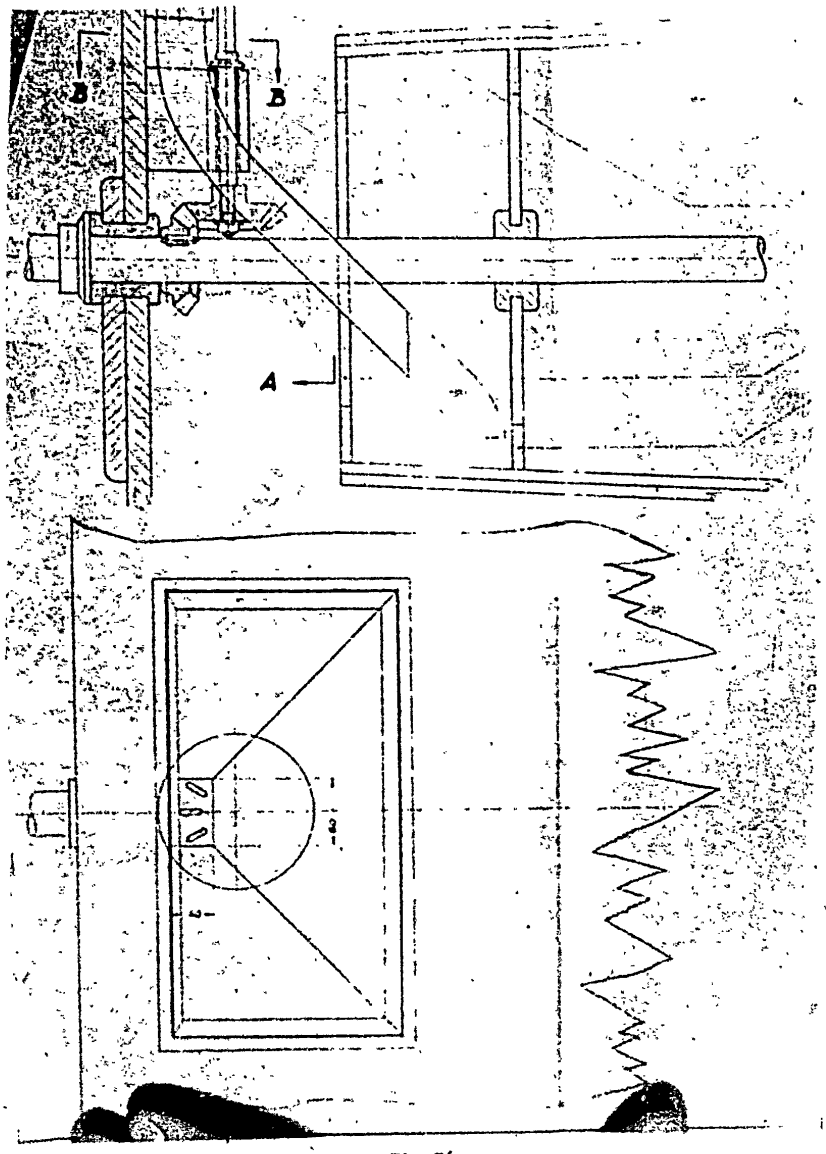

Fig.56

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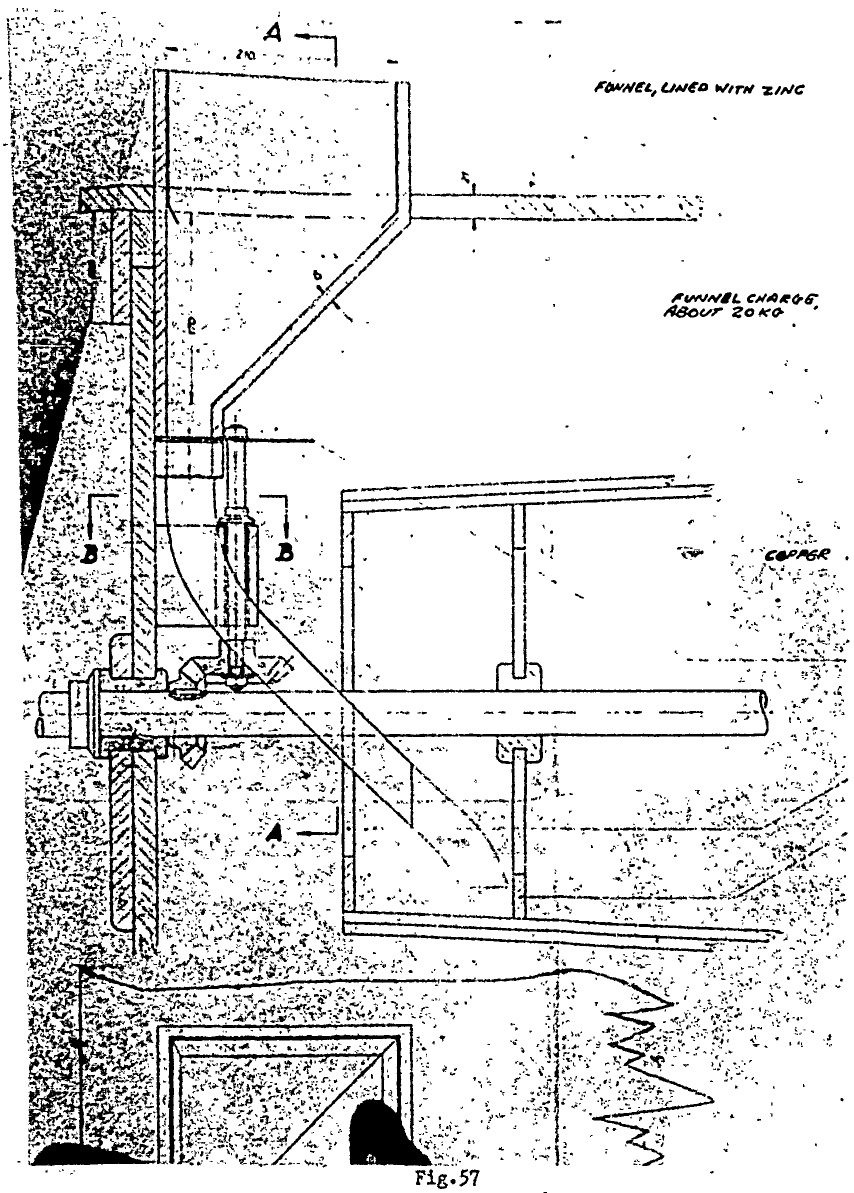

Fig.57

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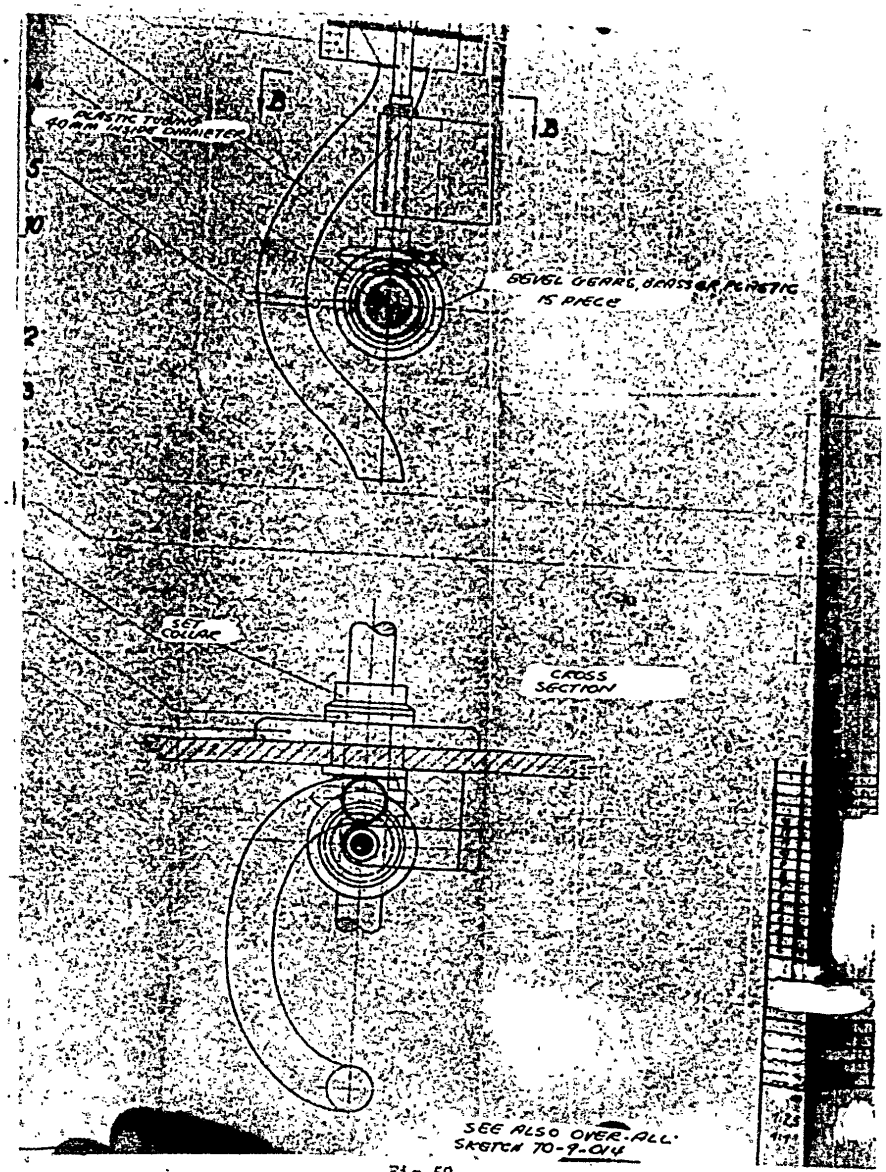

Fig. 58

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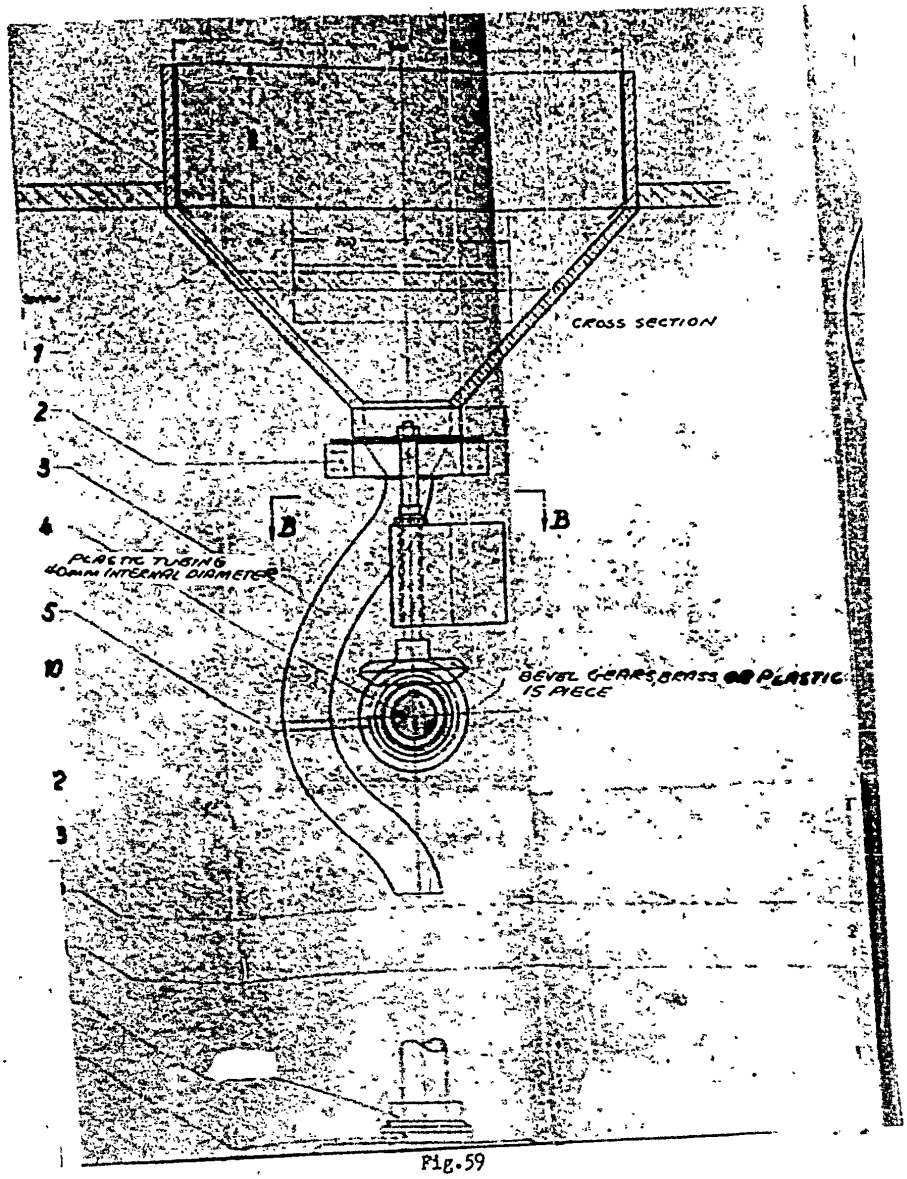

Fig.59

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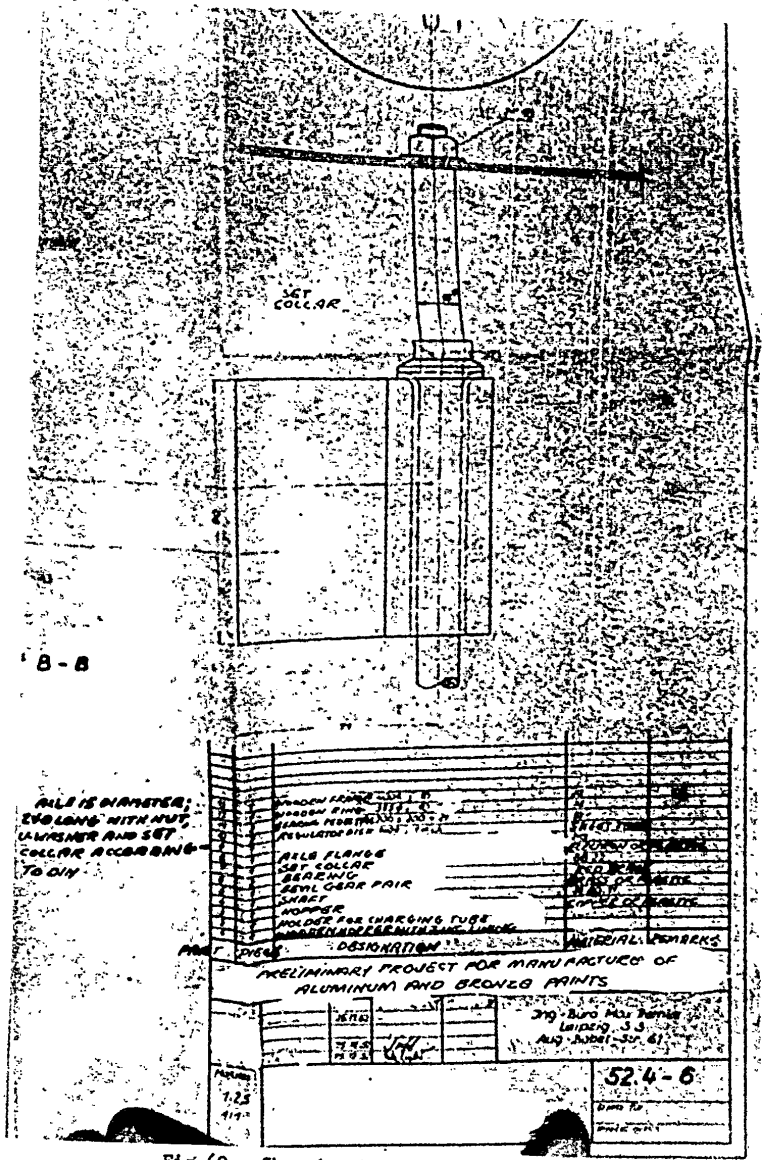

Fig.60 - Charging the Copper Screen Tumbler

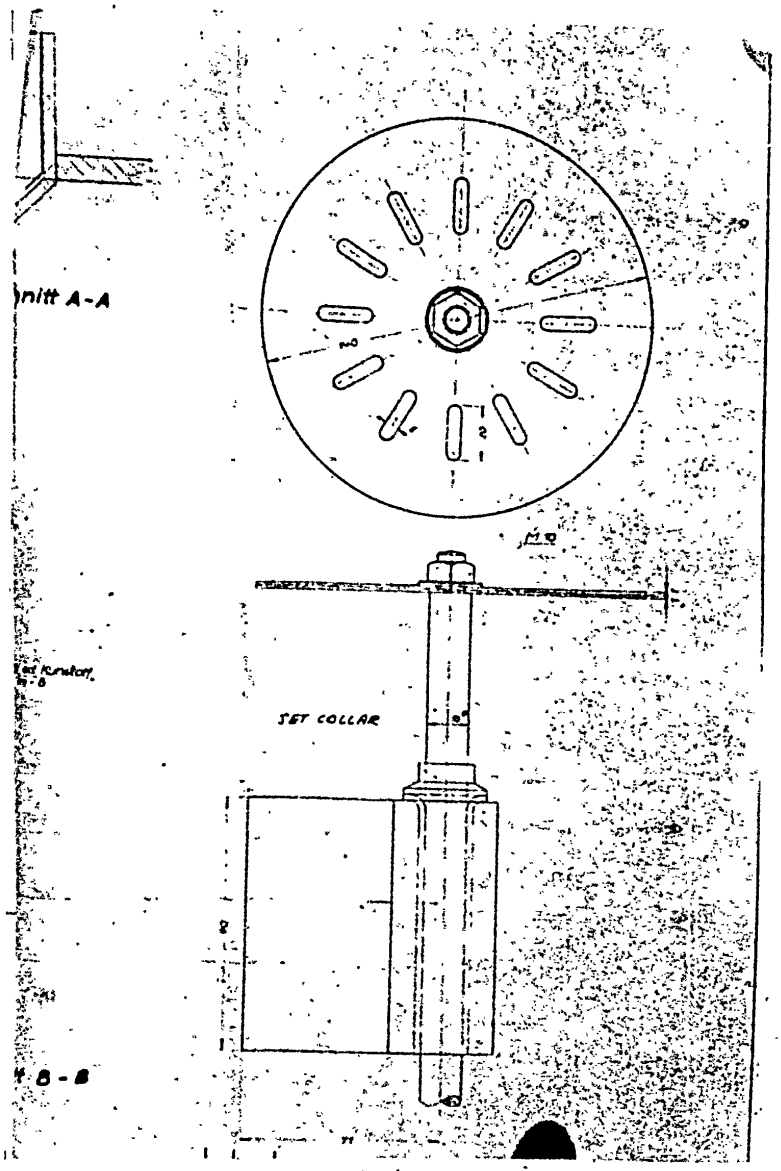

Fig.61

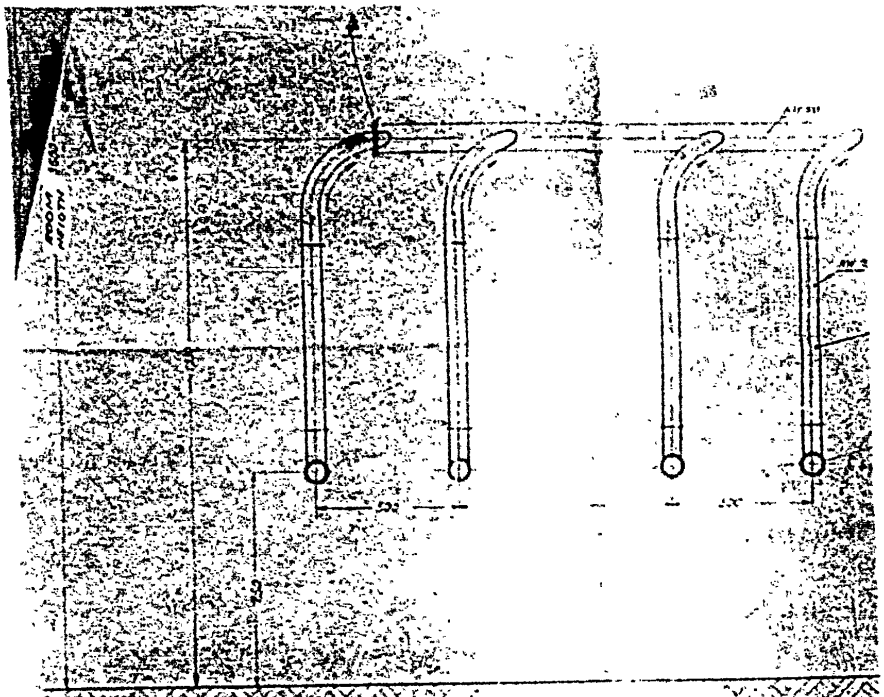

FIG. 62

STAT

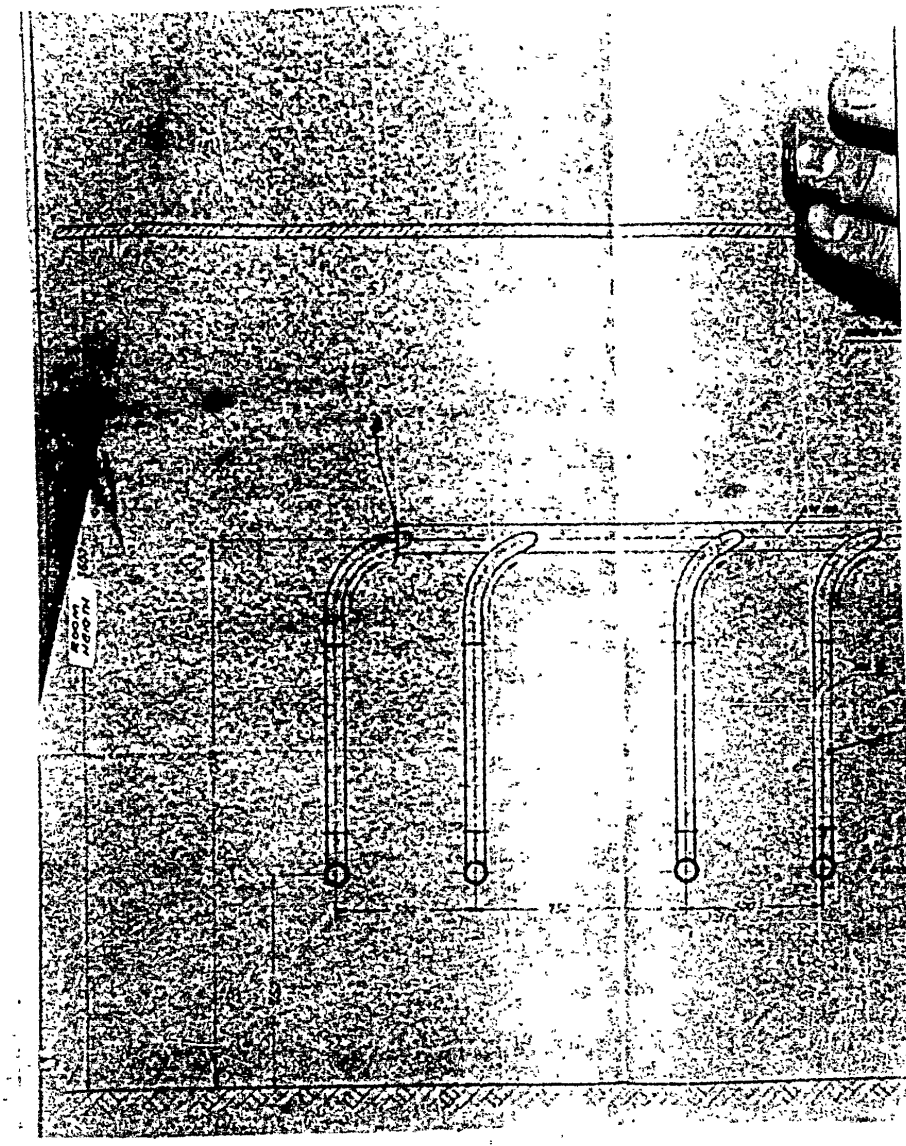

Fig.63

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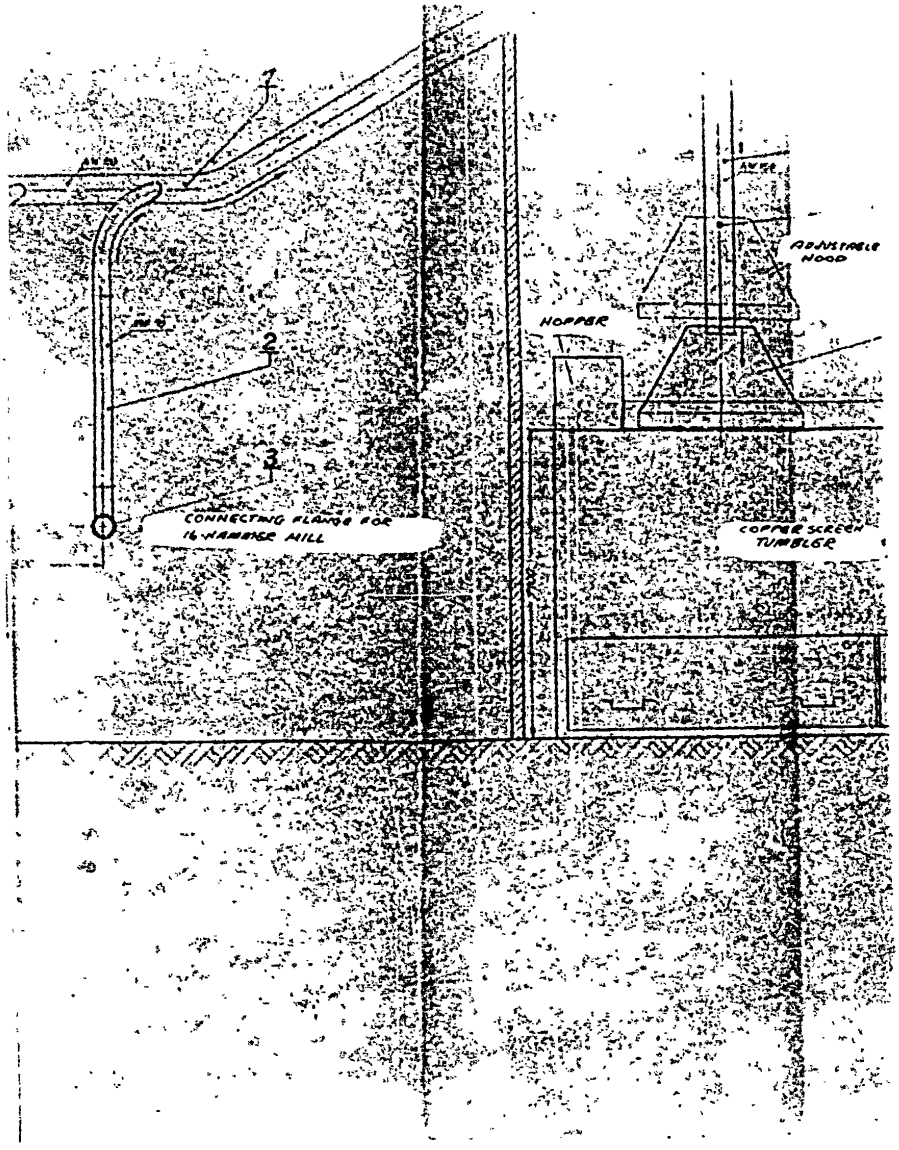

Fig.64

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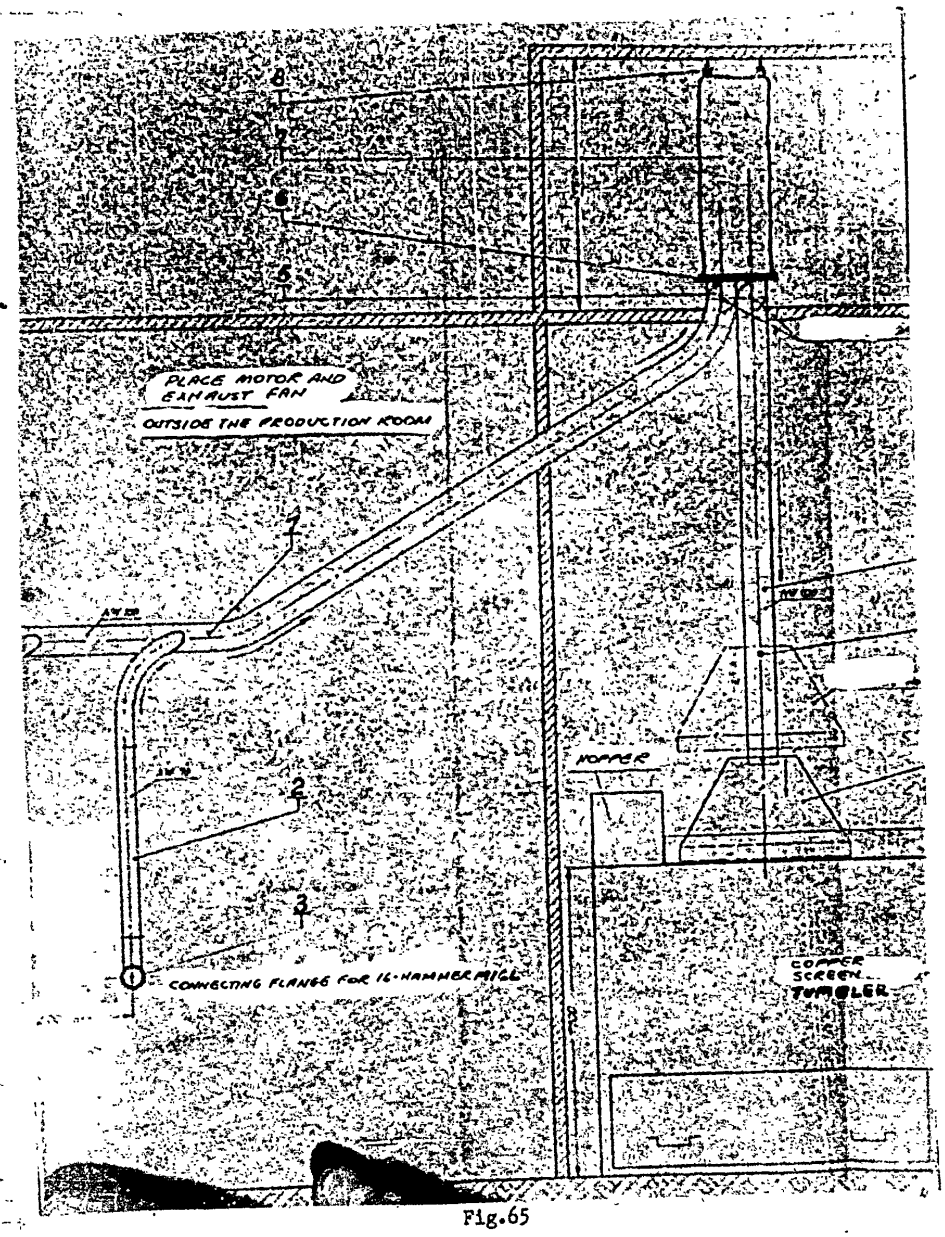

Fig.65

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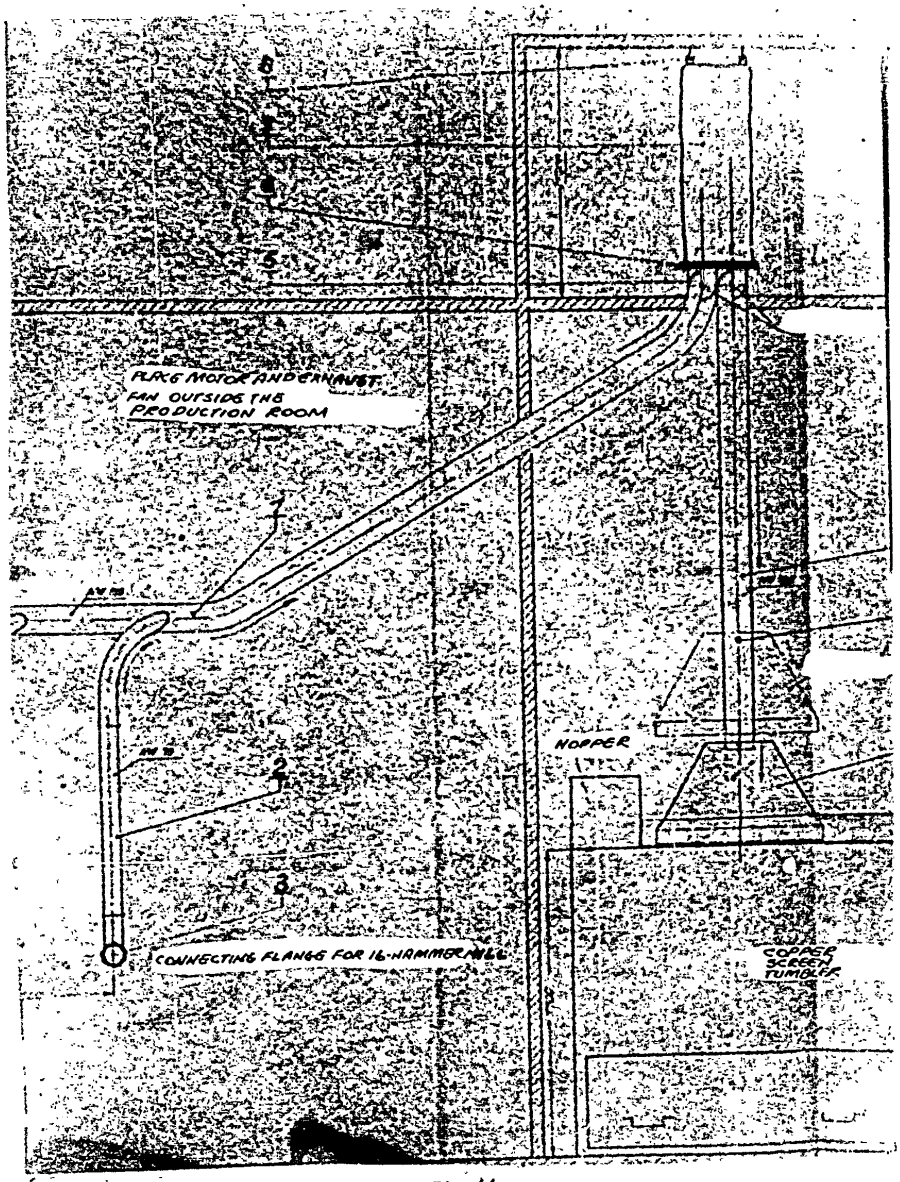

Fig.66

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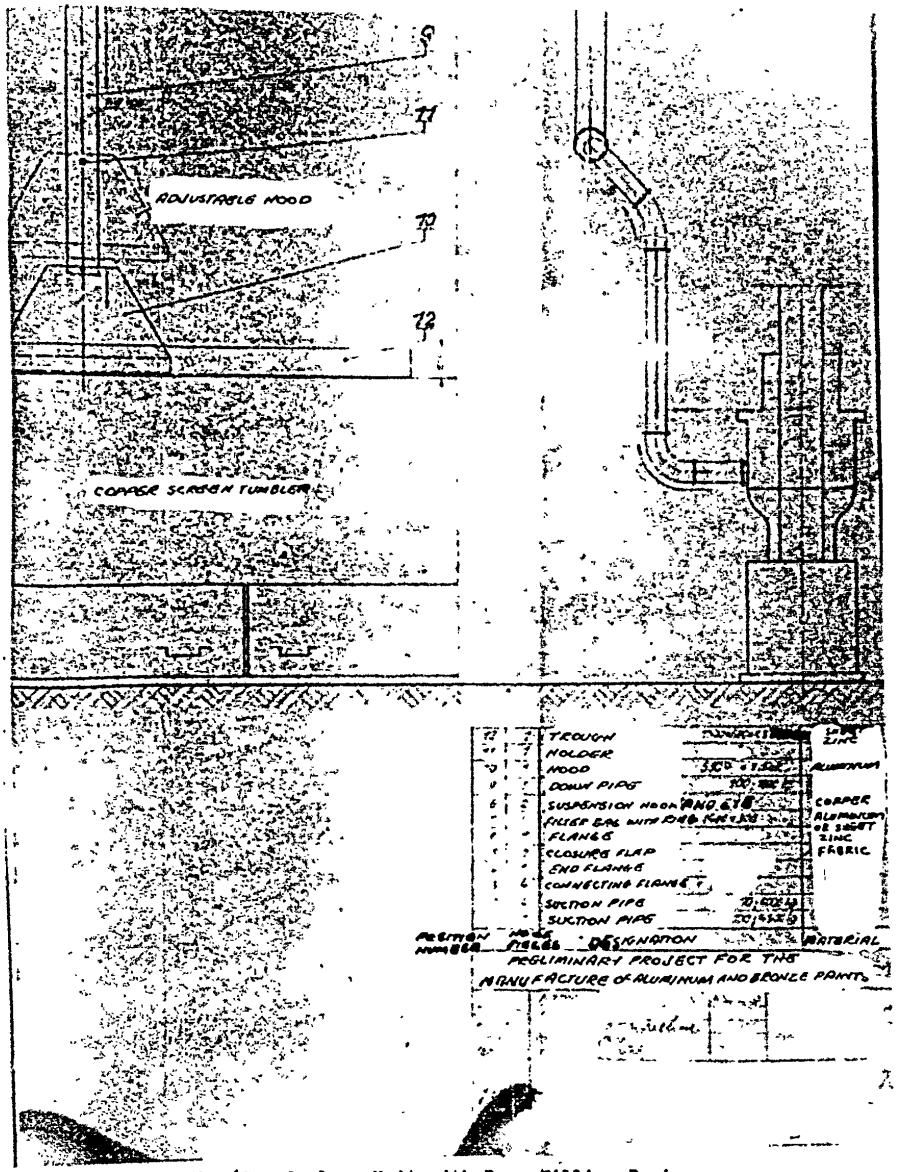

Fig.67 - Cyclone Unit with Drum-Filling Device

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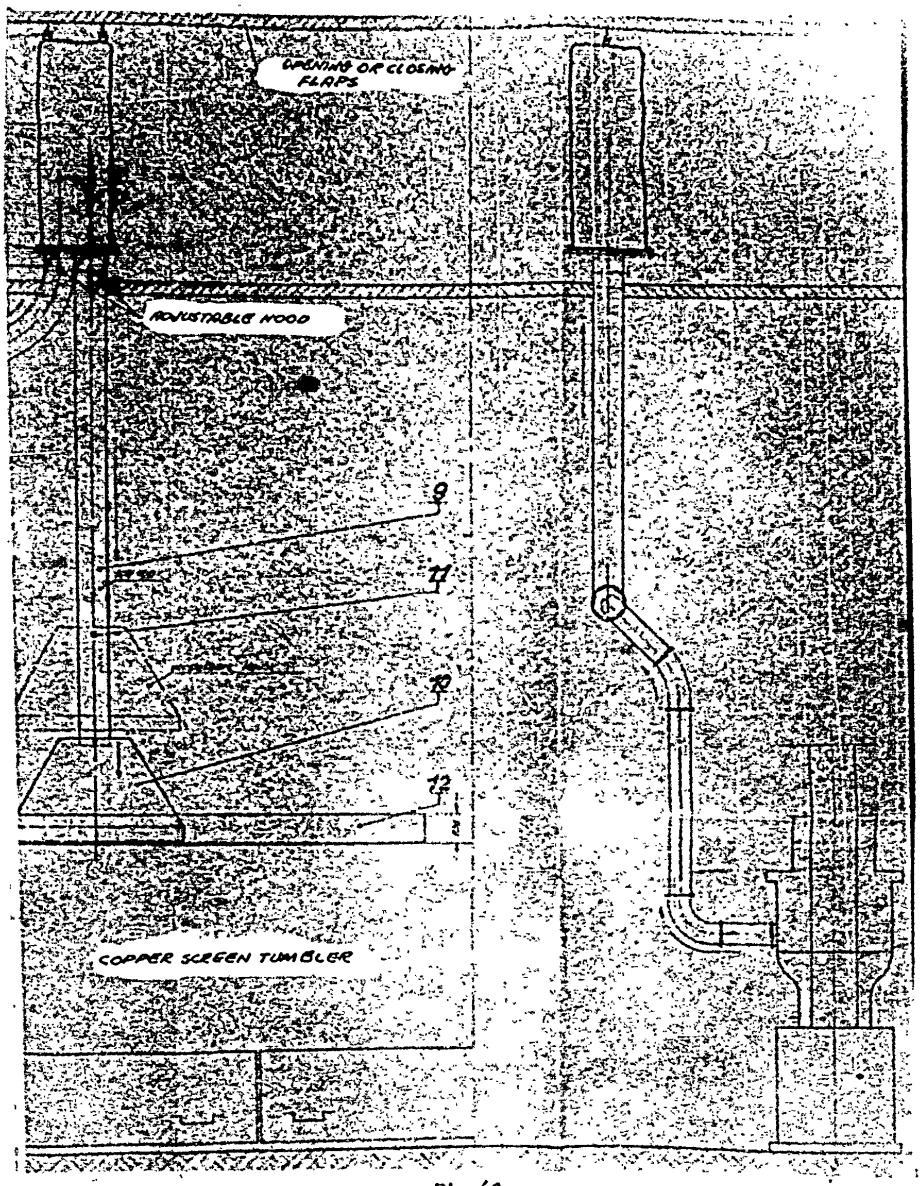

Fig.68

STAT

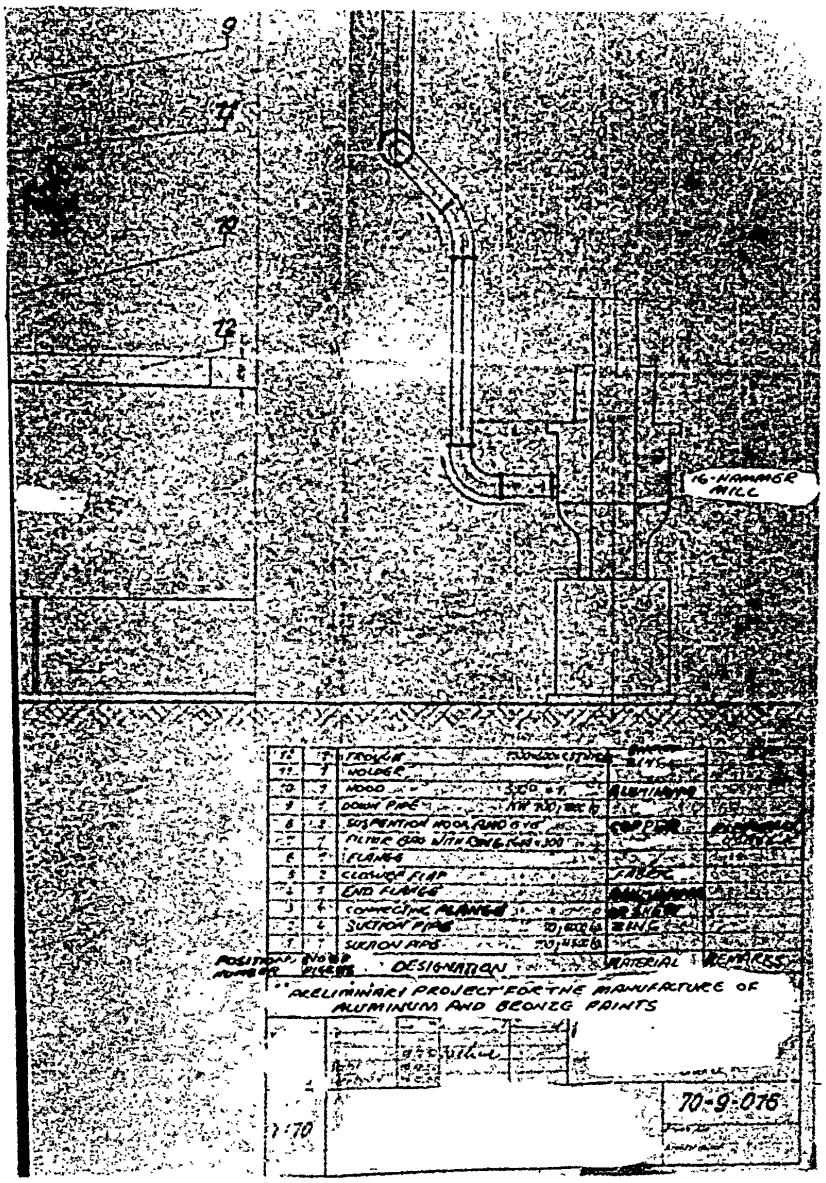

Fig.69 - Cyclone Unit with Drum-Filling Device

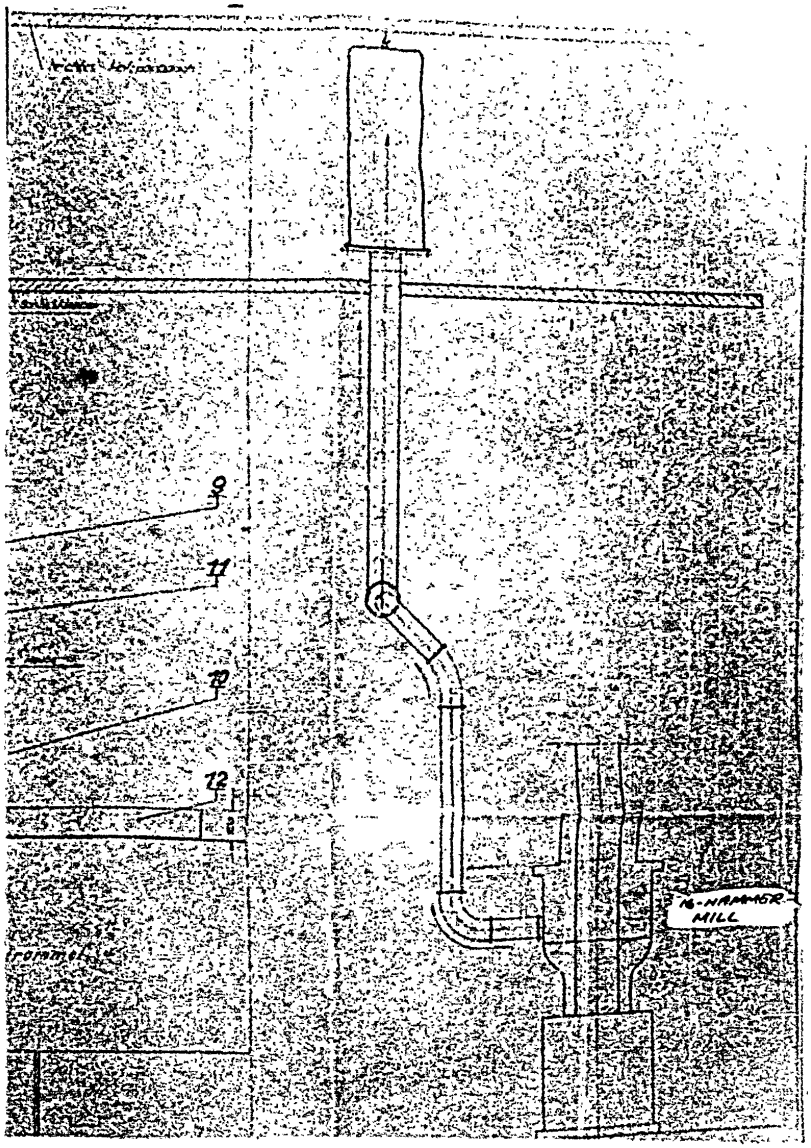

Fig.70

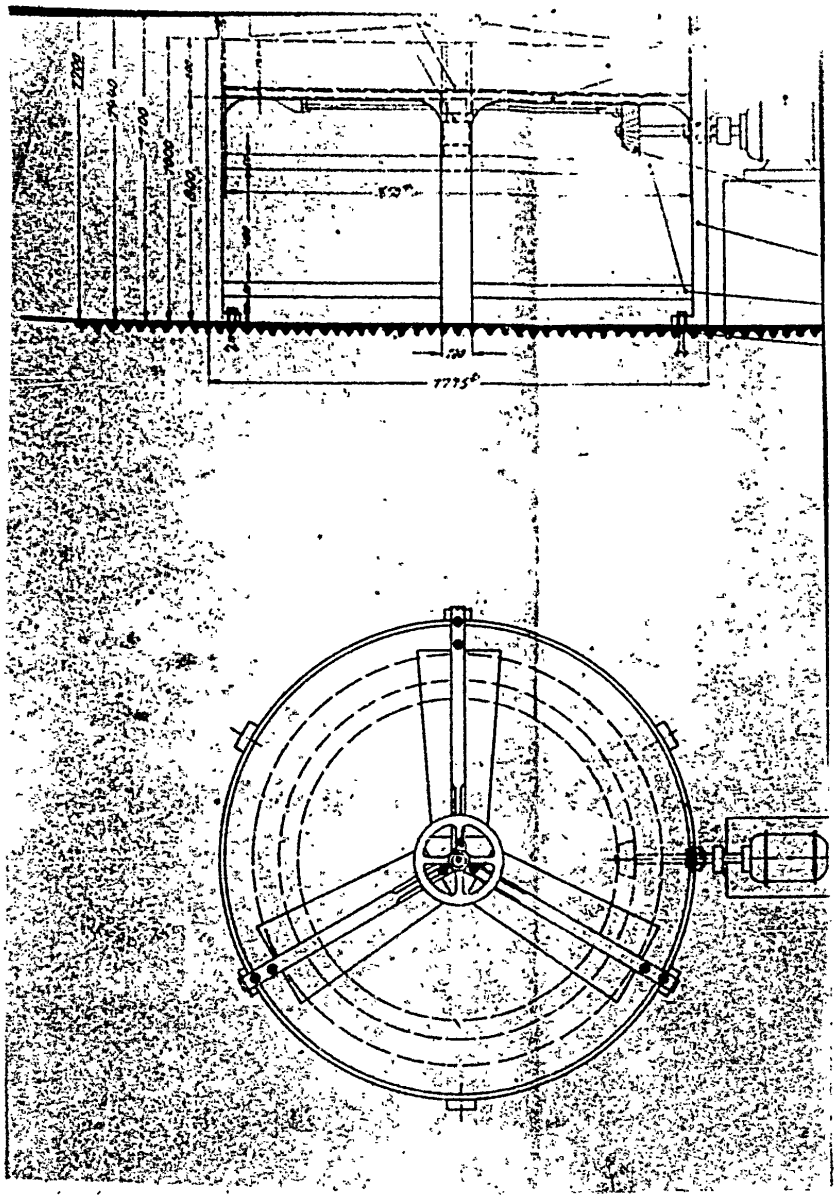

Fig.71

STAT

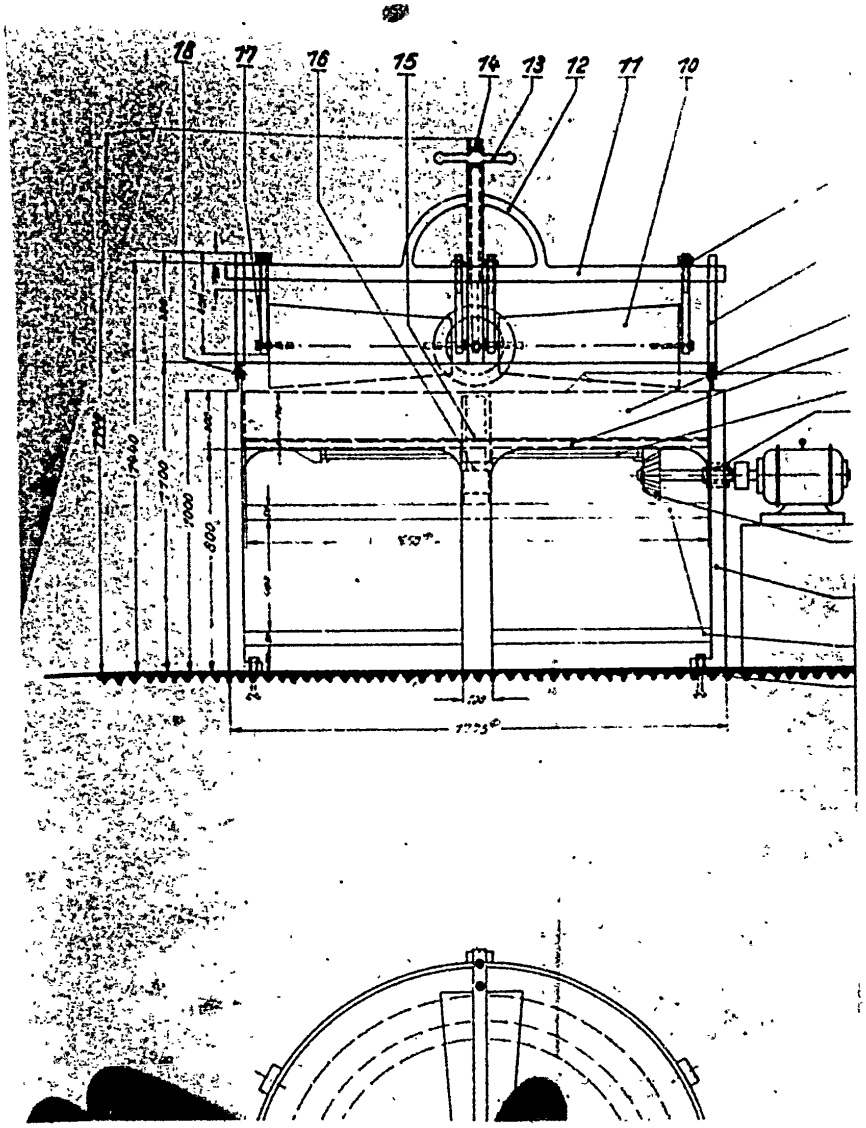

Fig.72

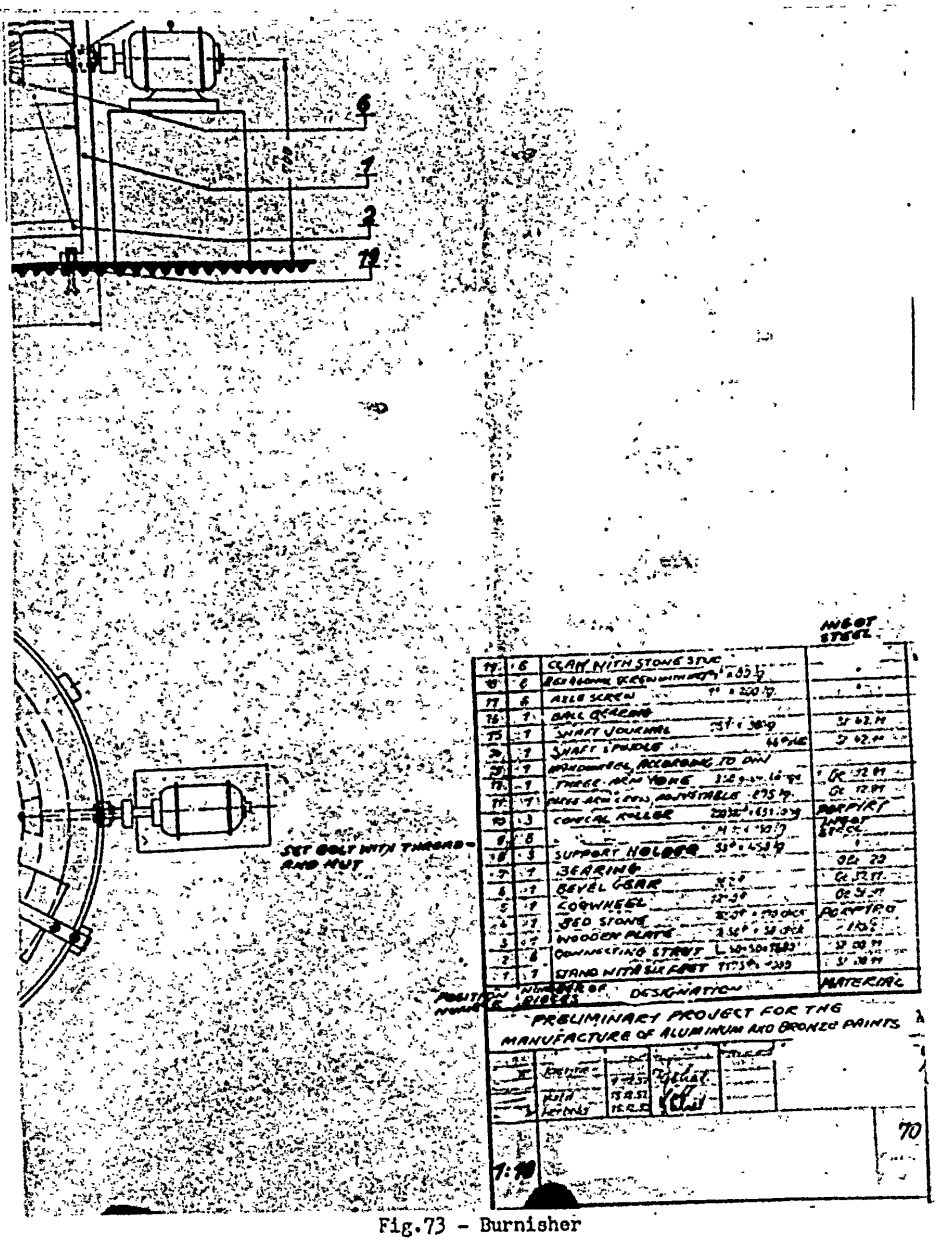

Fig.73 - Burnisher

STAT

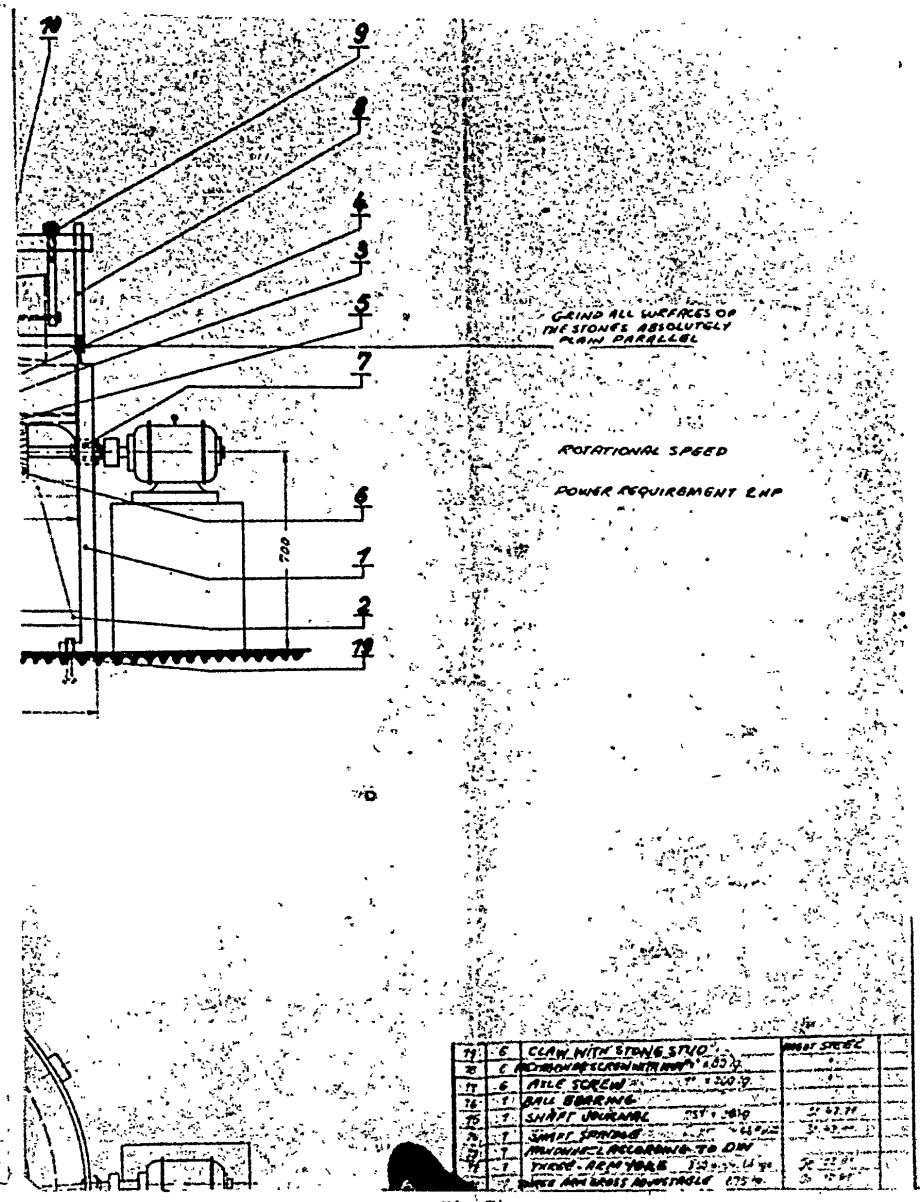

Fig. 74

57

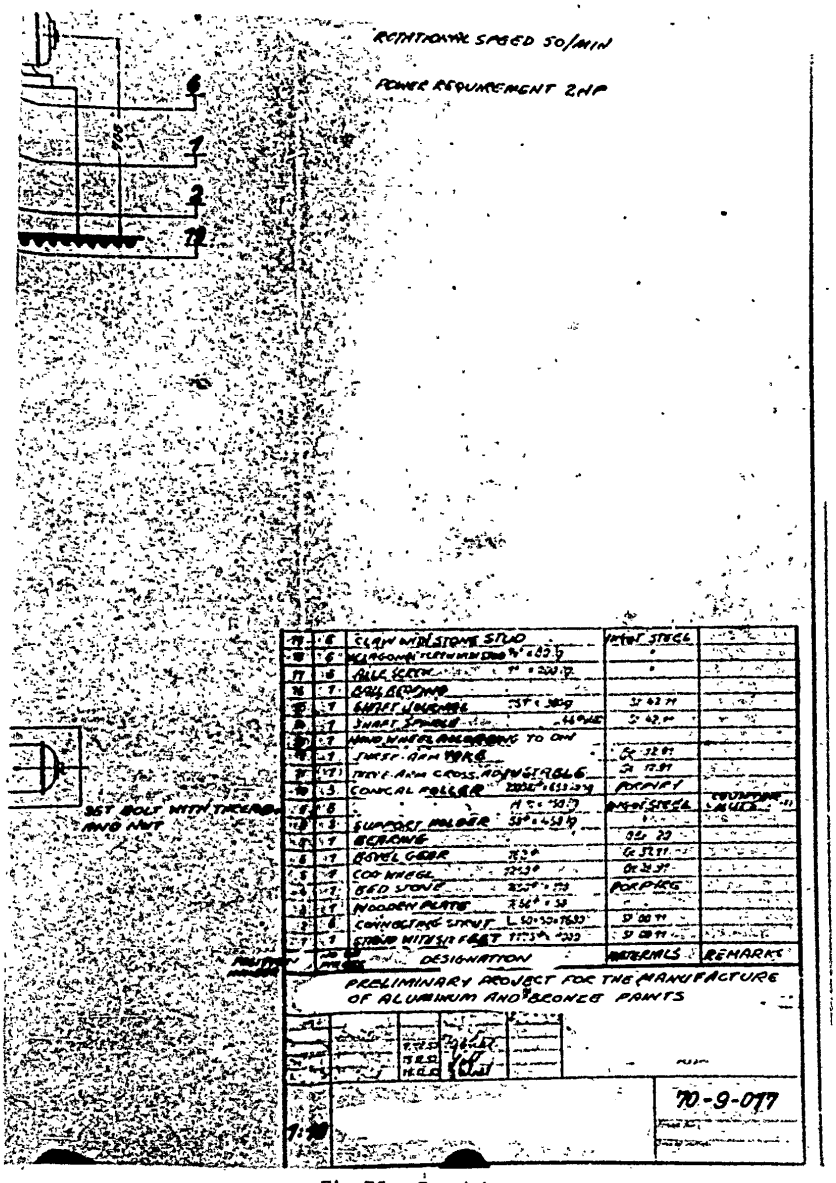

Fig.75 - Burnisher

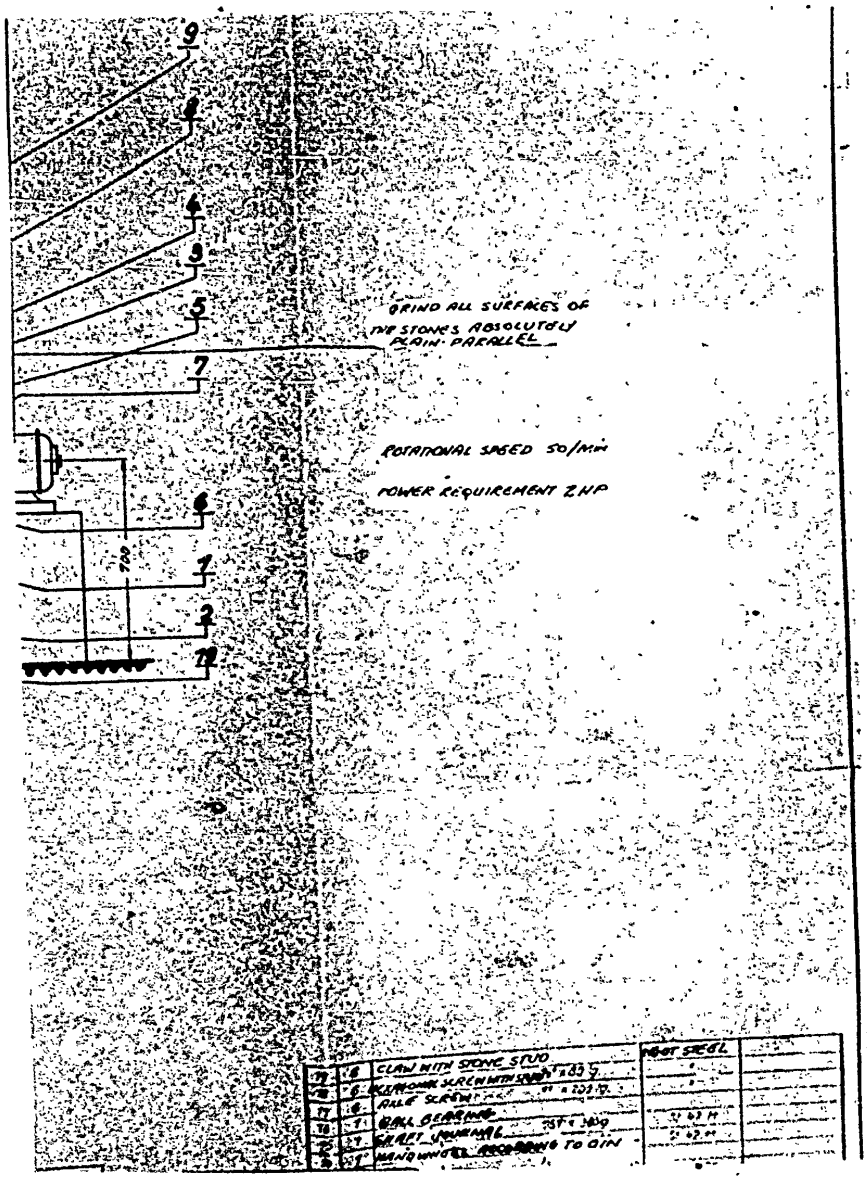

Fig.76

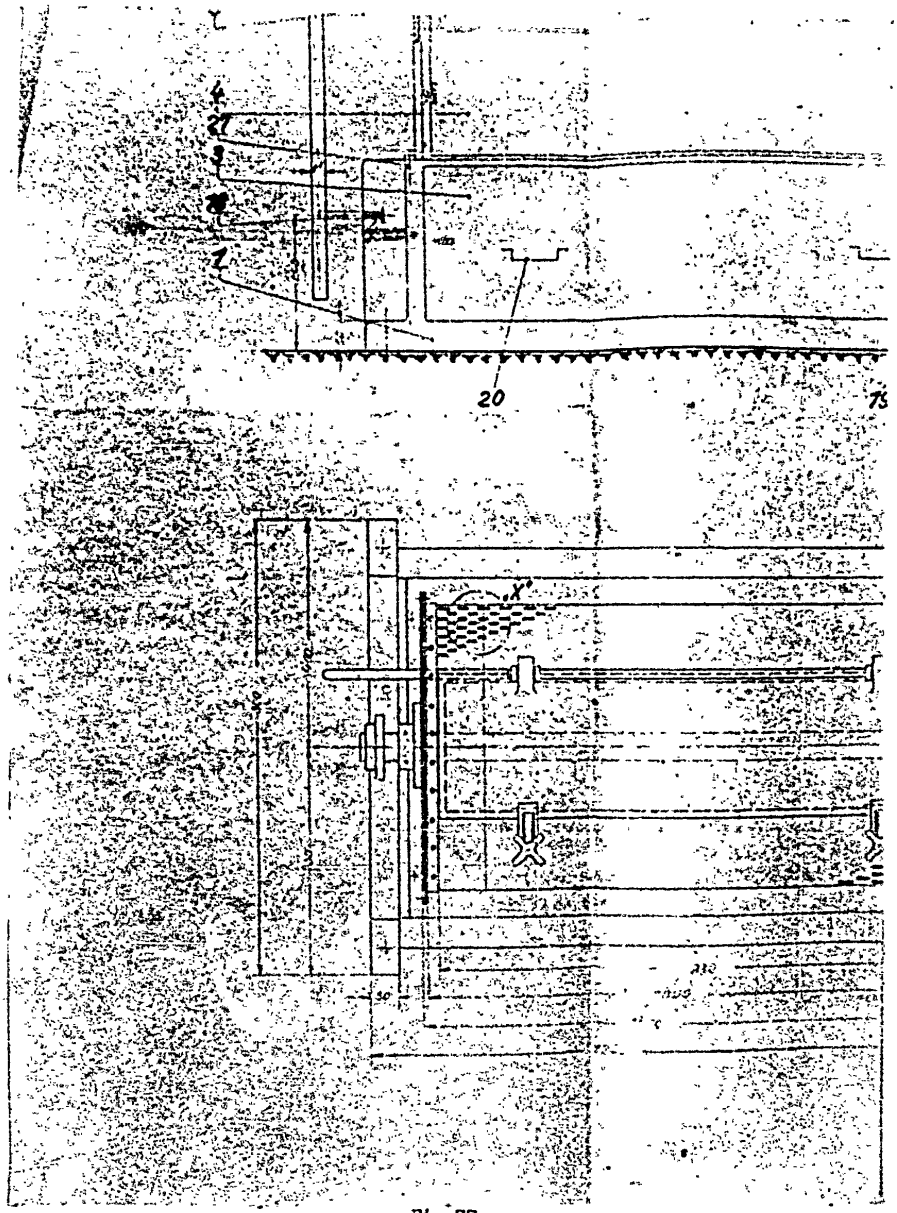

Fig.77

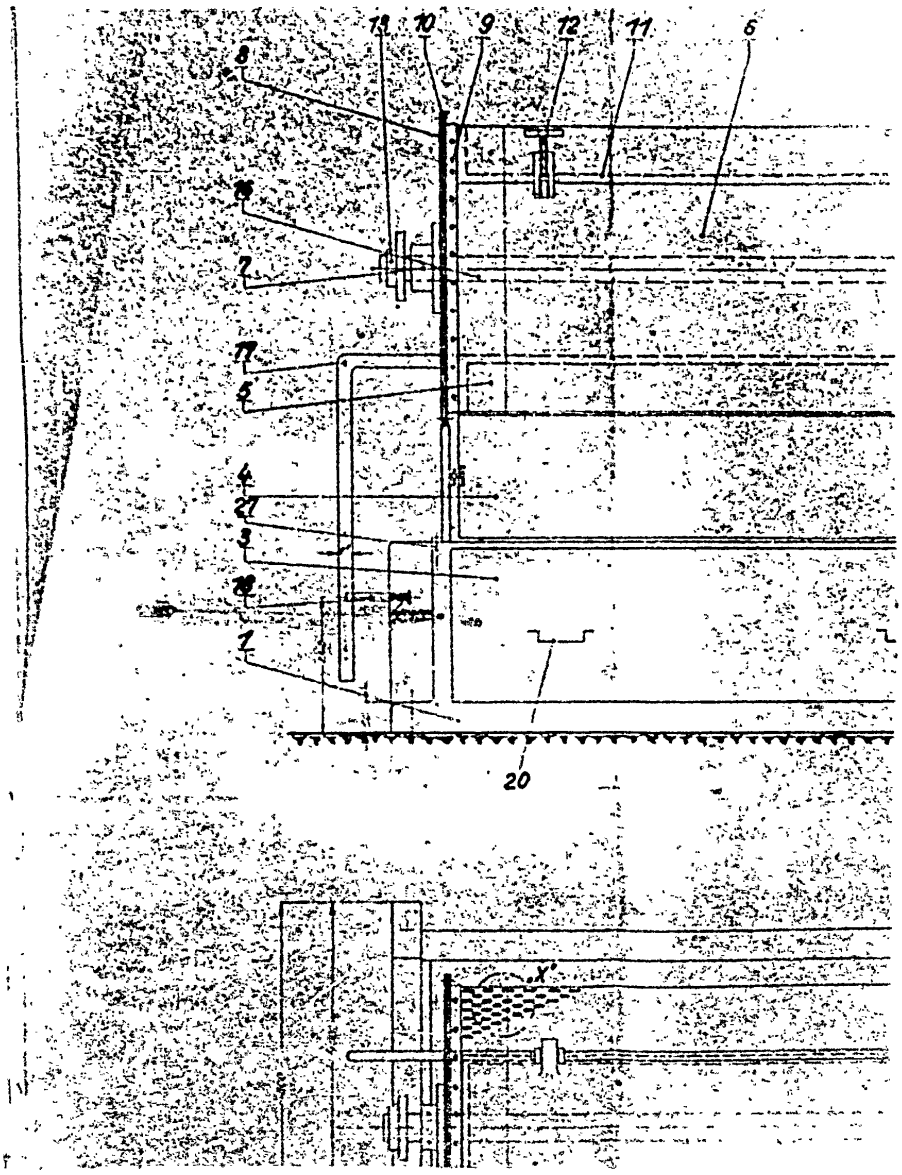

Fig.78

STAT

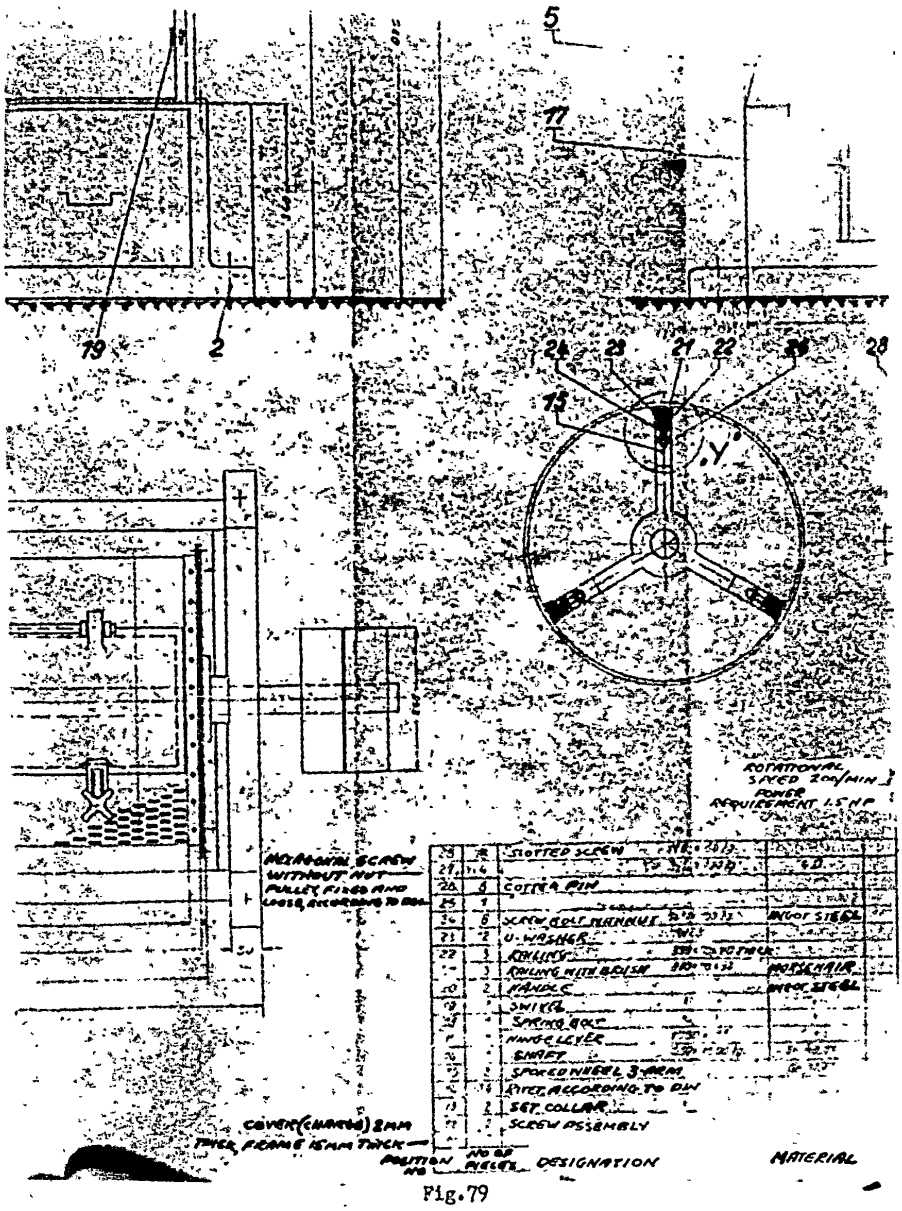

Fig.79

STAT

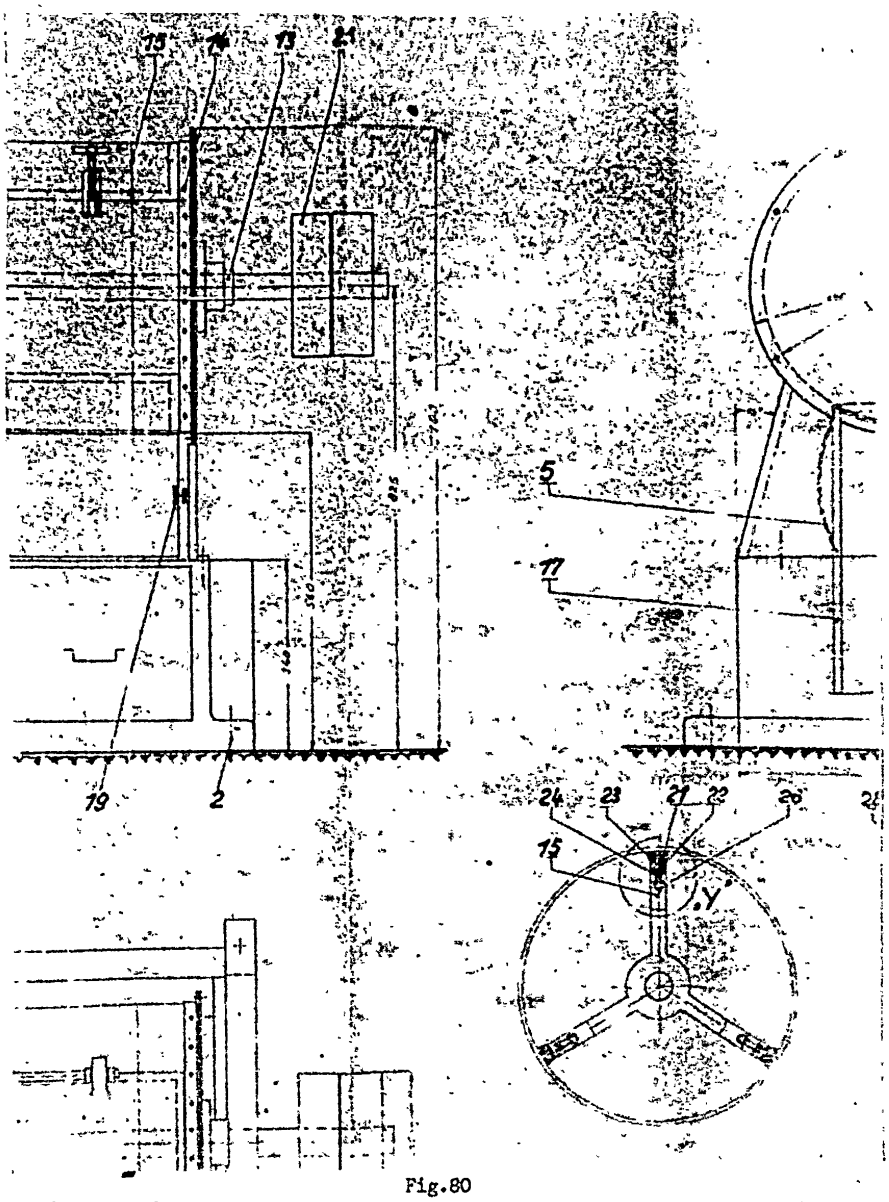

Fig.80

STAT

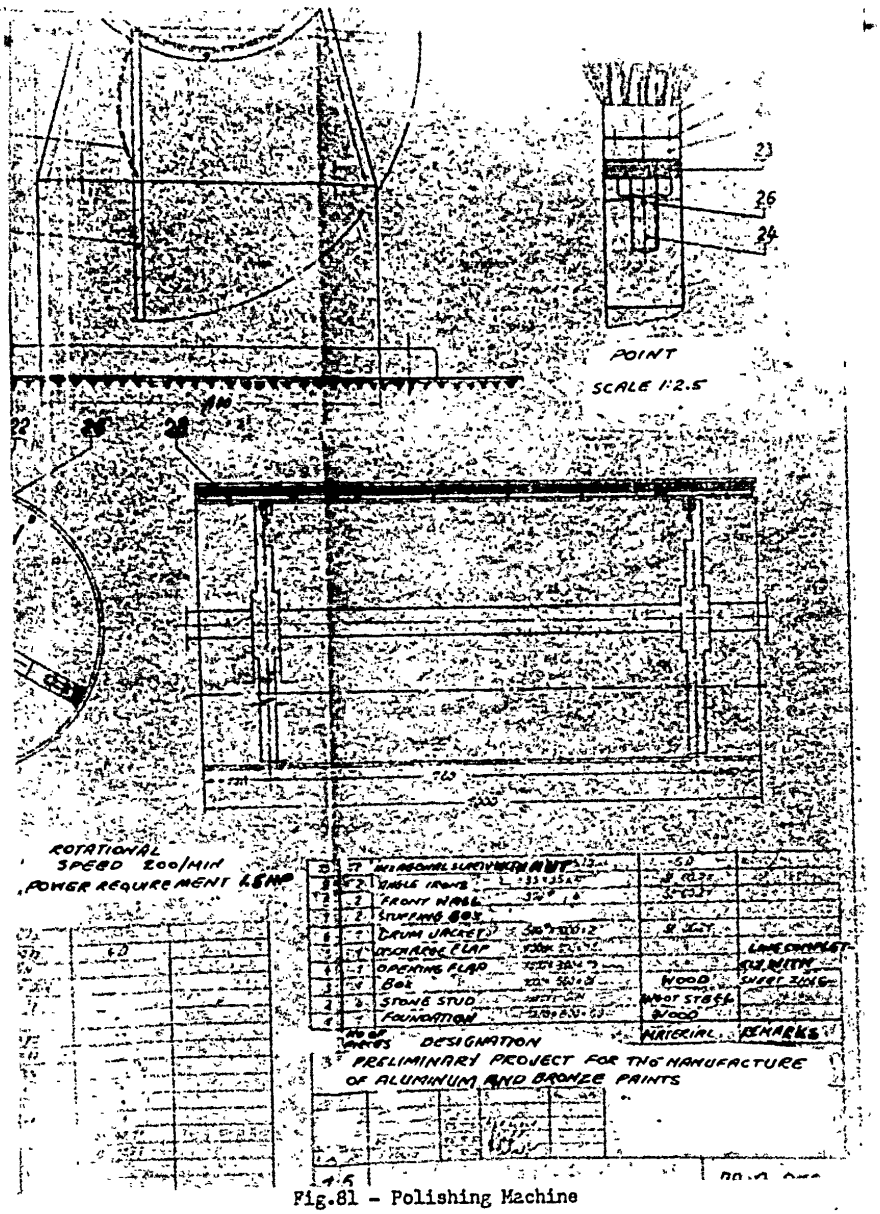

Fig.81 - Polishing Machine

STAT

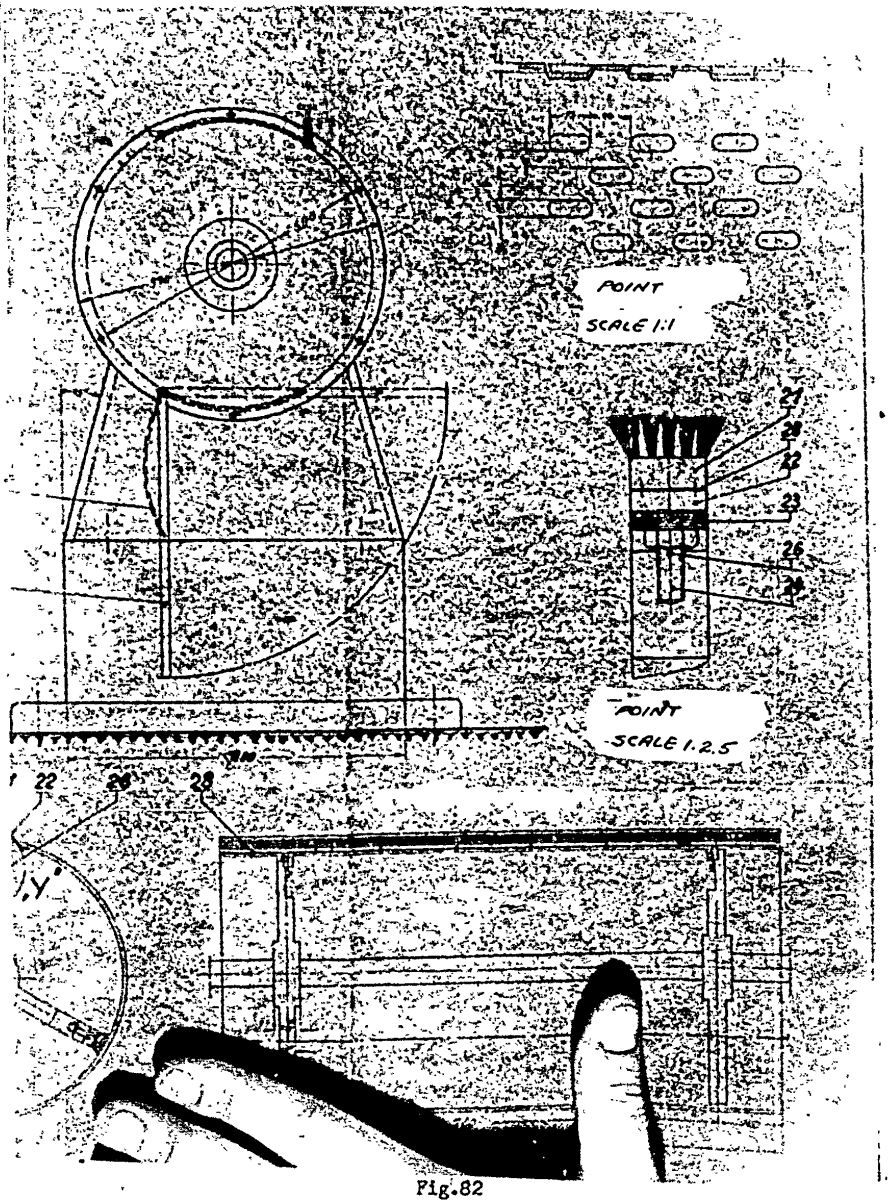

Fig.82

STAT

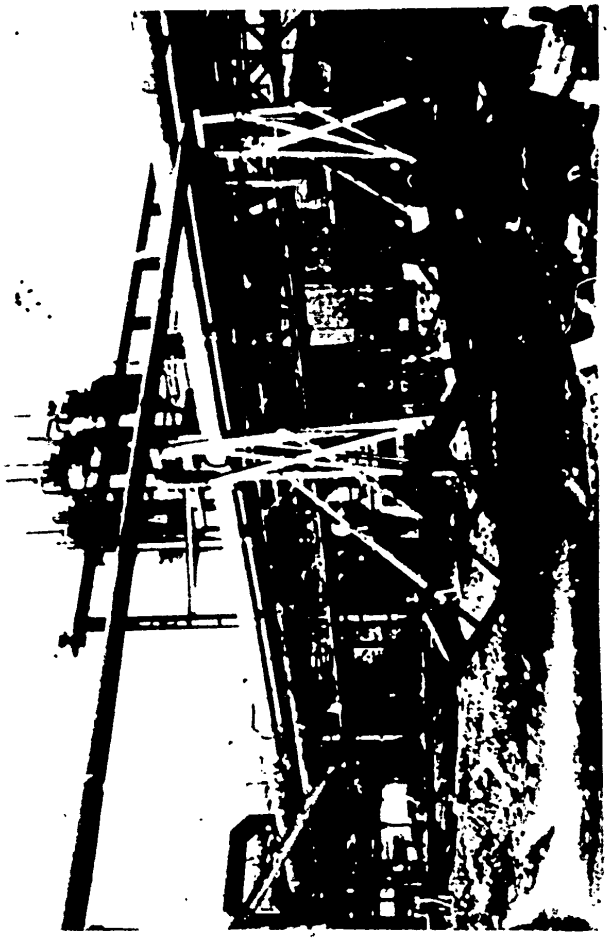

Fig.83

STAT

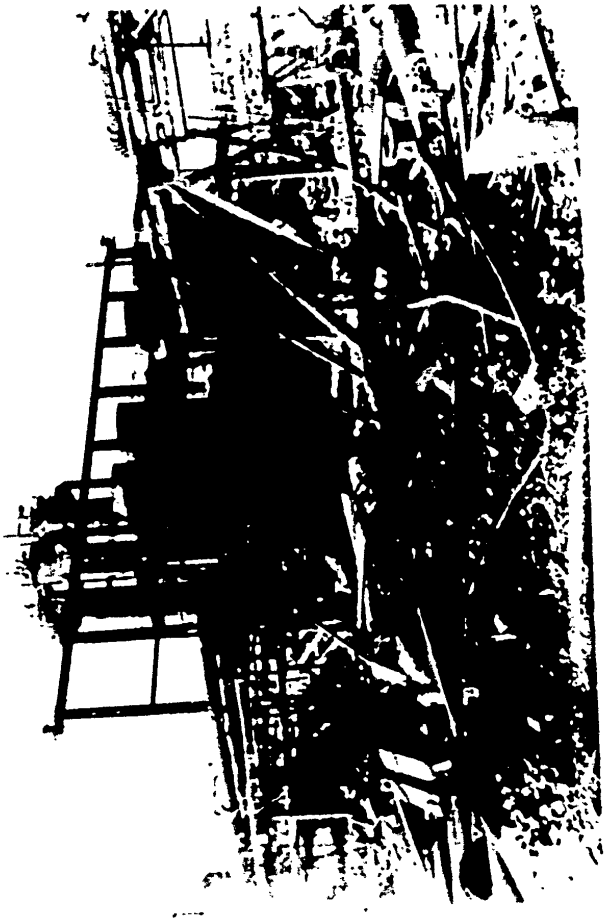

Fig.84

STAT

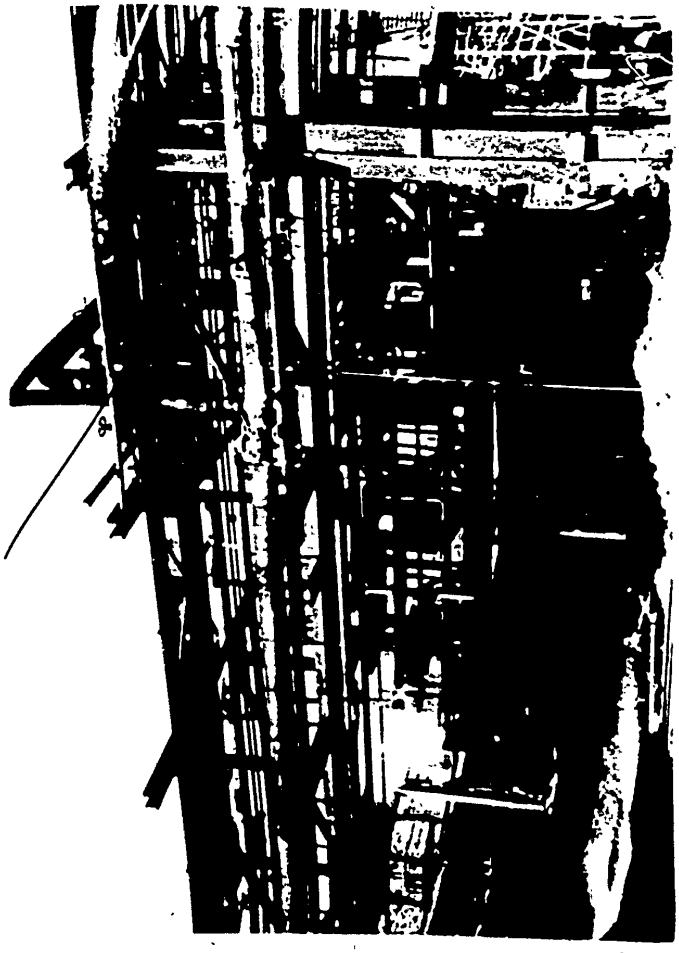

Fig.85

STAT

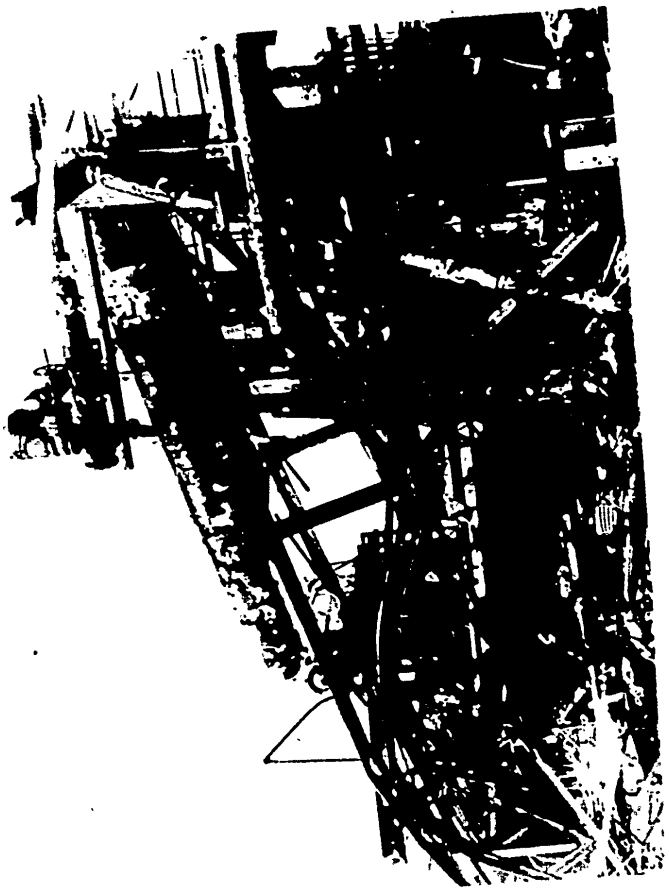

Fig.86

STAT

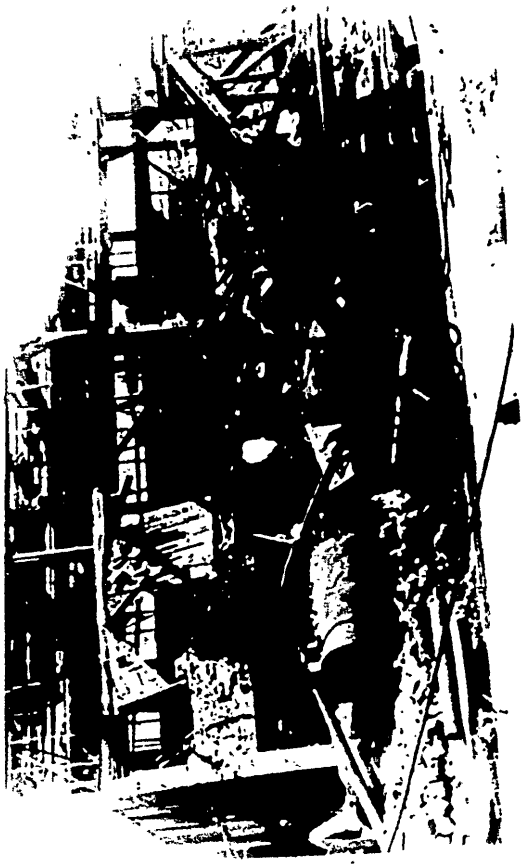

Fig.87

STAT

Fig.88

STAT

Fig.89

Fig. 90

Fig. 91

STAT

Fig.92

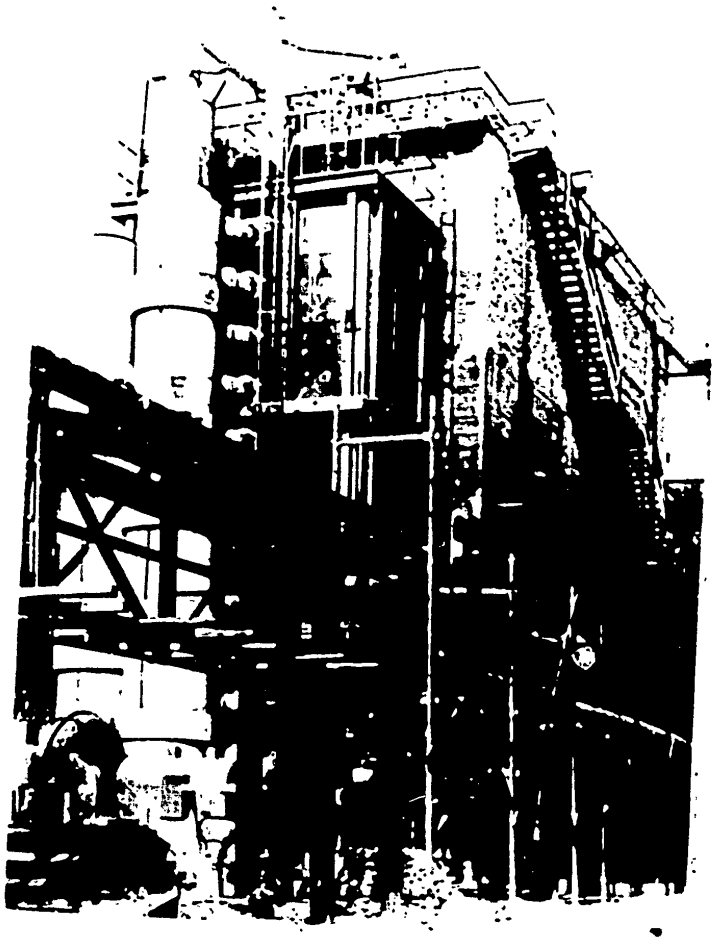

Fig.93

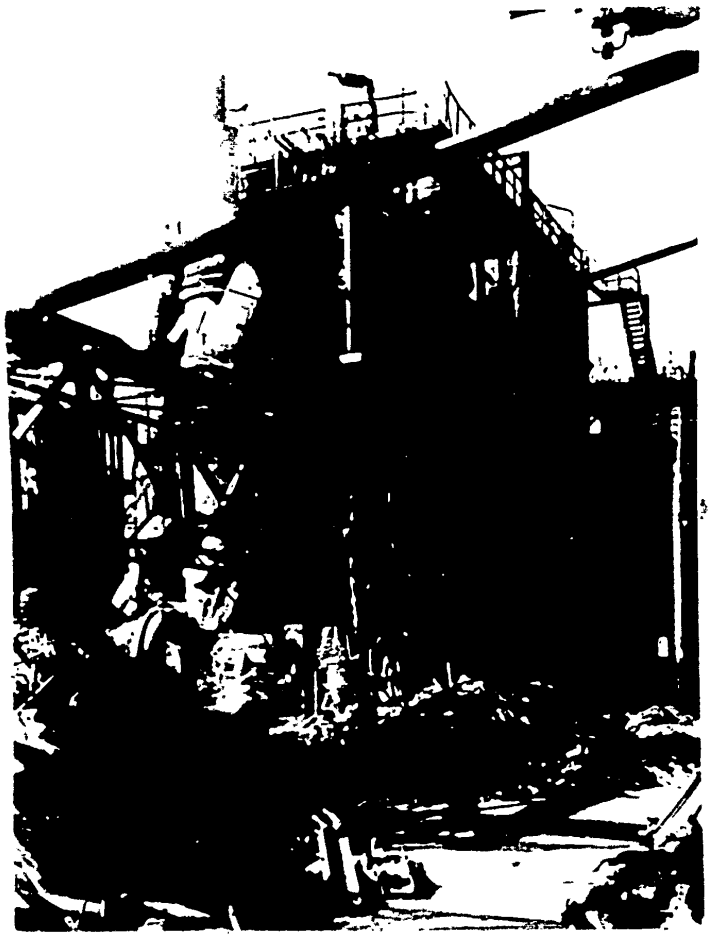

Fig.94