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DEVELOPMENT OF THE CHARACTERISTICS AND PRODUCTION OF MACHINE TOOLS IN ARGENTINA 1962 - 1972 1/

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Corrigendum

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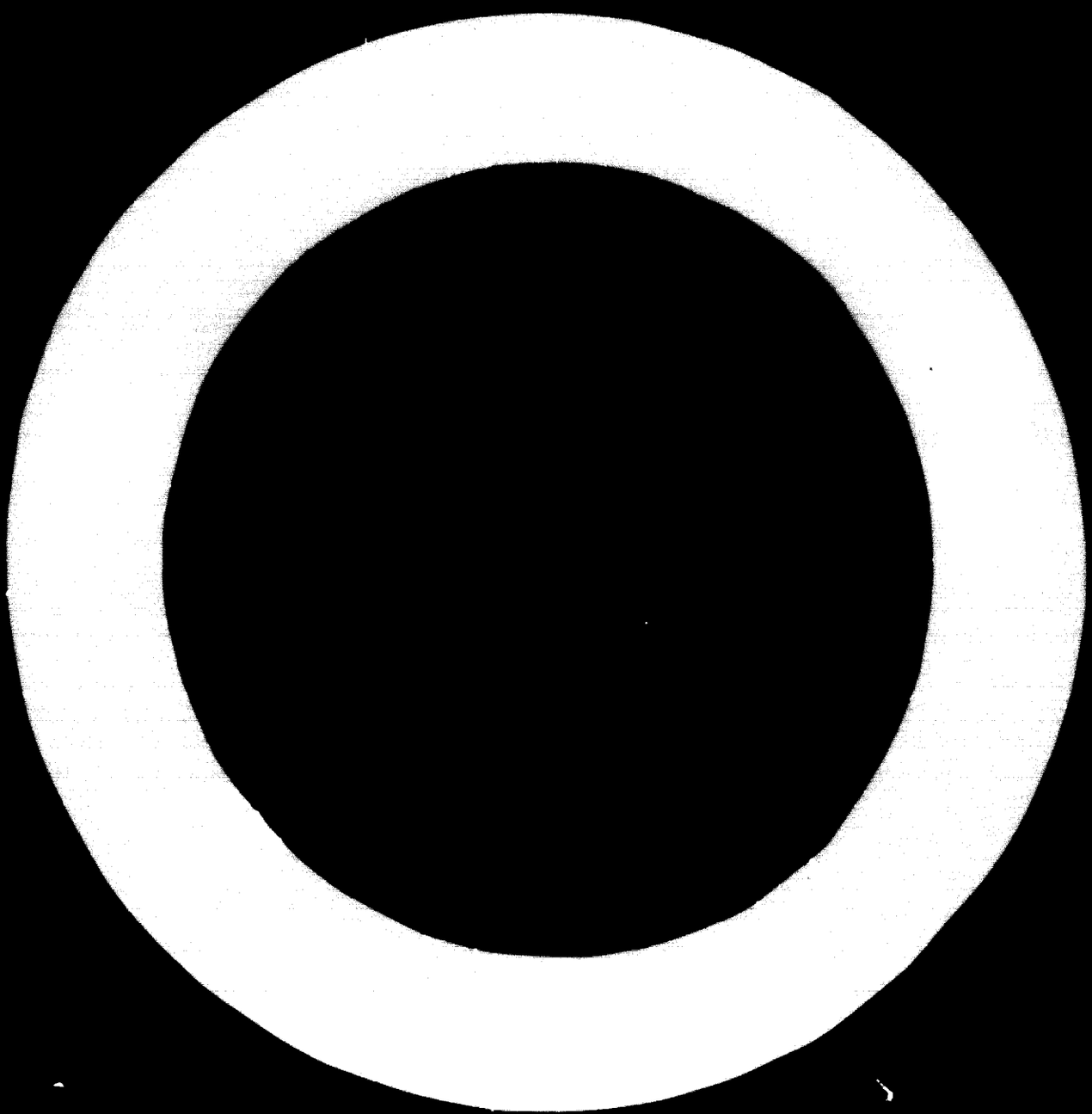


CONTENTS

1. PURPOSE

The purpose of this paper is to give an orderly description of the most outstanding features of the evolution in the characteristics of Argentine machine tools between 1962 and 1972.

The intention has not been to present a detailed and systematic catalogue of all developments, but rather to describe the main lines of development and probable future trends.

This general description concerning the period in question covers the number and type of new or modified machines which have entered the market, their main characteristics and, in addition, an overall evaluation of manufacturing means and methods used.

Throughout, the parallel evaluation prepared in 1962 by ECLA[1/] is used to demonstrate the relative situations in each case.

The conclusion contains an assessment of possible future development, in the light of local and regional market prospects.

2. EVOLUTION OF TYPES AND MODELS - CHARACTERISTICS AND PARAMETERS

2.1. Lathes

The manufacture of turning machines in the decade under consideration comprised centre, copying, turret and automatic lathes.

2.1.1. Centre and copying lathes

"...current...requirements make indispensable...some types...up to 2,000 - 3,000 rpm...differentiated even more from the...machines intended for general servicing and maintenance..."

"...manufacturing more powerful and highly diversified models..."

"...the range of...copying lathes (should be expanded) to include more powerful units with increased capacity..."

(ECLA, 1962)

1/ ECLA: Las Máquinas-Herramientas en la Argentina, 1963.

(i) Range

During the decade, the range of centre lathes was expanded substantially over that which was available in 1962.

The manufacture of heavy lathes, which has been rapidly expanding in the last few years, has firmly established itself, and machines with weights up to 10 tonnes, a swing into the gap of more than 1,700 mm and slow speeds starting at one-half rpm are being supplied.

The range covers small and medium-sized lathes with speeds up to 3,000 rpm.

As regards integral copying machines, manufacture of which was begun as early as 1964, two models of lathes, one two-tonne and one four-tonne, have been perfected, one under licence and the other completely locally.

(ii) Characteristics and performance

The observations made in 1963 concerning the types and characteristics of centre lathes can be considered to have been heeded in the intervening times, and especially in the last five years. Thus, there has been a trend towards specialization of the various types of machine as regards their average weight, structural features and performance.

For example, the weight of a representative centre lathe with a distance of 1 m between centres has increased by 66 per cent from 1,500 kg to 2,500 kg.

The static and functional characteristics have gone hand-in-hand with this development. The design of beds, the speed ranges and limits, the fabrication of moving components, electrical controls, threading capacity and programming stops have undergone basic changes.

The range of speeds extends from one-half rpm to 2,800 rpm (depending on the model).

There is specialization in ranges based on the purposes for which the machine is to be used. On the whole, the range has been expanded at both the top and the bottom of the scale.

The range of types includes lathes with gap beds and sliding beds with a swing of up to 1,700 mm.

Bed design has developed, as shown in part by the substantial increase in unit weight; the bed guideways are much sturdier and are supplied either treated or untreated; there are models with detachable steel guideways on cast and welded steel plate frames (see 2.11 concerning casting).

The design and construction of the main moving components have also undergone substantial changes.

The increase of the maximum-minimum range has led to a redimensioning of the moving and supporting components.

In this connexion, forged spindles and treated and ground gear trains are becoming frequent, and the use of multiple-disc clutches and brakes is becoming widespread in all the main moving components.

In this connexion, the results obtained with independent brakes and electro-magnetic clutches have made it possible to simplify design without reducing the efficiency of the machine, while using resources available on the spot.

During this period, accessories which have steadily reduced idle time and consequently increased machine efficiency were developed. Hydraulic tailstocks and automatic threading devices using a simple tool are being produced as standard equipment on some models, and controls and end-of-stroke stops making possible increasing automation in the operation of turning machines are being used.

With regard to electric controls and lubrication, see points 2.11 and 2.9.3.

2.1.2. Turret and automatic lathes

"...the poor variety of types is surprising..."

"...performances (should be improved)...both with respect to operational sizes and...the degree of...automation..."

(ECLA, 1962)

Range

The range and variety of turret lathes has not changed in the period under consideration.

Turret lathes with a bar capacity of up to 2" in diameter are being manufactured.

On the other hand, their performance and operational sizes have developed.

The weight of the largest machines has increased from 1,500 to 2,400 kg, and their dimensions and structural characteristics have changed accordingly.

The beds are treated; speeds range up to 3,000 rpm, and shifts in speed are brought about by levers and multiple-disc clutches and 2-speed and 3-speed engines.

All the types of accessories required for efficient utilization of these machines are manufactured, and this fills an important gap.

The range of single-spindle automatic lathes expanded considerably in the period under consideration.

Fixed headstock lathes are being manufactured with a bar capacity of from 15 mm to 60 mm in diameter, with as much as 5 tool holders.

Production of a model with a movable headstock having a bar capacity of 12.7 mm is beginning.

It is interesting to note that other models of turret lathes have not appeared. This fact, which was already referred to in 1962, would appear to reflect a special situation in the metalworking and mechanical engineering market, which, encountering an expansion of the production of articles of mass consumption and automobile parts, would appear to have progressed directly to copying machines, special machines composed of units and automatic front-operated lathes, as appropriate, in the case of parts too large for current turret lathes.

2.2. Milling machines

"...are currently in the developing stage..."

"...few types are manufactured...the revision of some designs...and the introduction...of...semi-automatic (machines)..., including production machines should be continued..."

"...there are not many models which can function...under demanding operating conditions..."

"Programmed feed cycles..., including...(uni-directional) feed should be improved and/or adapted..."

(EWLA, 1962)

The variety of milling machine models increased during the period under consideration, especially the second half of it.

The first development was based on the universal and vertical machines which were already present in 1962.

This development involved variants of the basic machines, which preserved their original structure, but were converted into more versatile milling machines. For example, in 1966, a copying version was brought out, and shortly afterwards several versions with a universal headstock or a turret suitable for various dieing or individual production operations appeared.

The existing universal-type models were at the same time increasing in weight (for example, a No. 3 increased from 1,500 kg to nearly 2,900 kg), and the range of possibilities of moving components was expanded (2,000 rpm, single-direction milling, rapid feed and return movement in 3 dimensions).

Already at the beginning of the period under consideration, the range of models extended to No. 5 sizes.

Independent engines are used for the feed, and machines with automatic operating cycles using electro-magnetic or electro-hydraulic circuits controlled by end-of-stop and/or card programmers are already being supplied.

On the other hand, the development of production milling machines has been lagging (with the exception of machines produced to order). For example, it was only in 1967 that the first (standard) production milling machines equipped with automatic operating cycles and hydraulic feed were series-produced in smaller sized models weighing one tonne.

It should be pointed out, as noted above, that many completely automatic production machines (with loader) were manufactured for special uses during the period under consideration.

2.3. Drilling machines

"...other machines of light-weight and heavy types need to be developed."

(ECLA, 1962)

The development of drilling machines was uneven during this period, depending on the type considered.

The manufacture of small bench drilling machines has been expanded to machines with a high number of revolutions.

A large number of models of mass-produced general-purpose pillar drilling machines (pillar and frame) with capacities of up to 40-50 mm and weights of 1.5 tonnes having a wide range of feeds and speeds, and equipped with gear boxes, have been developed.

However, there has been little development of intermediate series-produced machines intended exclusively for production work.

Just as with turret lathes, it would appear that the failure of medium-capacity production models to be brought out could be attributed to the massive introduction of special machines consisting of units.

On the other hand, heavy single and multiple spindle production machines with weights up to 10 tonnes, capacities (in one spindle) of 110-130 mm, areas of utilization of approximately 650 x 500 mm (in the case of multiple spindle machines), power of up to 20 hp and automatic cycles operated by cams which activate the components of the hydraulic feed circuit are being supplied.

There has been considerable progress in the design and quality of execution of radial and semi-radial machines. Machines with travel of 1,500 mm and capacities of up to 50-60 mm equipped with treated and ground gear trains and speed pre-selectors, with speeds ranging up to 2,000 rpm are being supplied.

There are models of both radial and semi-radial machines which have an auxiliary pillar.

2.4. Tool & cutter and other grinding machines

"...there have...been some initiatives by...craftsmen..."

"...(and) there have been others which are better structured...under licence... better meeting demands..."

"...production grinders are not manufactured...and only one, still imperfect, centreless grinder is produced..."

"...the hydraulic circuits of grinding machines should be perfected with a view to...a higher degree of automation...(and) the improvement of the centreless model should be accelerated..."

The manufacture of grinding machines was represented at the beginning of 1962 by one universal model, two surface models and one centreless model.

The parameters for the surface-grinding and centreless models are virtually the same as at the beginning of the period under consideration, although the operational characteristics and dimensions have changed considerably.

One internal-grinding model is also manufactured.

During this period, the universal grinding machines produced by three manufacturers have been developed to the point where there are production grinders with automatic cycles, even equipped with direct measuring devices.

The weight of the 500-600 mm centre machines has increased from 1,700 kg to 2,500 kg, and the distance between centres, in series production, ranges to 2,000 mm.

By the end of the period, for example, special grinding machines with two heads and a distance of 2,500 mm between centres for grinding coupling shafts, with a slanted head for grinding crank-shafts, etc. were being manufactured.

The machines are produced in universal and production versions with grinding wheels up to 2½", which allow for infeed work and have an automatic cycle with direct measurement incorporated.

It is significant that the most important progress has been connected with the development of feed hydraulics, which had already been mastered, making possible feeds adjustable to 5 m/min., and with the dimensioning of the critical components such as the grinding wheel spindle, the workhead and lubrication systems using an independent pump. All these developments have been carried out completely locally.

In the case of centreless grinding, the machines have automatic operating cycles, electro-hydraulic drive, constant regulation of grinding wheel speed and pressure lubrication incorporated into them and weigh nearly 4 tonnes. In addition, one type is manufactured under licence.

As regards surface grinders, during the period under consideration, domestic industry was producing various models with strokes of up to 600 mm and automatic transverse movement of the grinding wheel.

During this decade, supply remained within the same parameters, but the range of variants and sizes was expended.

For example, a full range of variants for production, die-making and maintenance work, affording possibilities for automatic vertical movement, rapid movement, performance of automatic cycles, continuous or intermittent feed, etc., with weights of nearly two tonnes, has been developed.

These models can already be used for template-truing and special diamond-surfacing of the grinding wheel.

At the same time, variants of the cup-wheel models which, around 1962, were confined to small machines with mobile heads and fixed tables, were developed with changeable tables, within the same parameters as described above.

In the past decade, a full range of magnetic face chucks was brought out.

2.5. Broaching machines (boring machines)

"...multiple-head light-weight broaching machines are not yet being manufactured..."

Production of universal broaching machines has remained limited to a few medium small models, without further development.

The manufacture of production broaching machines, on the other hand, has been rapidly developed through the efforts of the manufacturers of machining (operation) units.

For example, these manufacturers supply production broaching machines with one, two and four spindles, automatic cycles, hydraulic or hydro-pneumatic feed, and even air-cushioned spindles, as well as special-purpose broaching machines, produced to design. For example, boring machines are produced for the cylinder blocks of internal combustion engines (not only for cylinders, but also for crankshaft seats, etc.), which also perform operations requiring radial feed of tools with which the boring bar is equipped.

In summary, the problems of light and heavy boring can be effectively solved by domestic supply.

2.6. Other machines

2.6.1. Shaping and planing machines

The manufacture of shaping machines in the country extends to those with a travel of up to 820 mm and 100 strokes per minute, with mechanical drive.

In the period under consideration, the production was developed of models with a weight of nearly 3 tonnes (an increase of nearly 25 per cent in weight), fitted with hydraulic clutches, hydraulic servo table and tool feeds, pressure lubrication, rotation of the table by means of gear wheels and worm gears and sophisticated locking and safety mechanisms.

Manufacture to order of mechanical and hydraulic planing machines with tables of up to 5 to 6 m has continued. This production has benefited from the general development of control and drive mechanisms. The size of the market does not make possible normal series production.

2.6.2. Sawing machines

The types of circular, band and blade sawing machines produced have not changed radically since 1962.

Machines (hack sawing) with capacities of up to 1,000 mm are produced. Circular sawing machines generally have manual feed. Band saws are produced in vertical (do-all type) and inclinable models.

2.6.3. Tool and cutter grinders

In addition to tool grinders with single steel and carbide edges, universal grinders, including accessories, with guide pulleys and weights up to 1,000 kg are produced.

In addition, manual grinders for bars are supplied.

2.7. Machining units and special machines composed of units

"...up-to-date techniques for manufacturing special transfer or fixed-position machines using adapted drilling units or heads have...been acquired..."

The production of special machines composed of machining units was already in the starting stages at the beginning of the period under consideration.

This equipment has been greatly developed, as regards both the units themselves and the machines which are composed of them.

While in 1962 only one firm was producing units with a capacity of up to approximately 10 hp apiece, by the end of the period, five firms had developed the production to order of machines consisting of standard units having a capacity of 30 hp and an area of 1,000 x 1,200 mm.

This development was taking place at the same time in the design of machinery and the production of automation and operation components (considered separately).

During the decade, users and manufacturers quickly familiarized themselves with the engineering of automatic machining systems.

The present stage of development can be exemplified by the fact that nearly all the motor vehicle manufacturing firms and many of the firms producing durable and consumer goods are equipped with special machines designed and manufactured in the country, which are produced using units and operation and control mechanisms which are also domestic.

For example, machines with a total weight of 30 tonnes having three workheads, a capacity of 60 hp and an area of use of 1 x 1.20 metres, which machine workpieces weighing nearly 500 kg (diesel engine blocks) are being manufactured.

The heads produced are for boring, drilling, threading and milling operations.

The machines produced are of the type with transfer and fixed position of the workpiece.

Operation is based on cycles, the logic and structural features of which are in many cases extremely complex, generally using hydraulic and/or pneumatic and/or electronic control components.

Hydraulic operation mechanisms generally predominate over other types.

The technical characteristics of the units include spindles with pre-loaded bearings, sometimes with high revolving speeds, for fine boring operations.

Multiple-spindle heads are also supplied (with fixed or adjustable position), with or without an idler gear.

2.8. Metal-forming machines

"...on the whole (this production) appears to have reached a high level of development...(it is able to) meet...demanding requirements...and even, in some cases, those of heavy industry."

"...it will be necessary to strengthen the product engineering..."

2.8.1. Guillotines and bending machines

The development in the design and characteristics of these machines is exemplary of that for metal-forming machines in general.

Firstly, in 1961-1962 the limit for guillotines was 3,000 mm x 12.7 mm and for bending machines, 150-200 tonnes.

For several years now, guillotines with dimensions of 3,000 mm x 7/8" (mechanical drive) and 1" (hydraulic drive), and bending machines up to 600-700 tonnes with lengths up to 6,000 mm have been produced.

The design of frames has not changed substantially because it is basically acceptable; there have been improvements in guides and slideways, which are now detachable, and in drive and lubrication mechanisms.

For example, pneumatically operated friction clutches are now standard equipment, and centralized pressure lubrication is in some cases provided by suppliers.

Pneumatic or hydro-pneumatic compensators have been incorporated into the cushioning devices in heavy and larger models. Hydraulic fixtures for holding the plate are also standard equipment.

Improvements have been made in tables by making them independent and removable, and in tools by giving them rectangular cross sections, thus making available four useable edges.

Guillotines with motorized stop sets are supplied.

Another important innovation is the provision of special accessory equipment for handling the sheet metal. Feeders, stackers and handling devices to turn the workpieces are supplied in accordance with the requirements of customers.

About four years ago, hydraulic drives with domestically produced high-pressure rotary pumps and multiple pistons were introduced for the larger machines, making possible an increase in guillotine cutting capacities and considerable mechanical simplification at the expense of slower speeds.

The weight of the machines themselves has greatly changed since 1962. For example, the weight of a 60-tonne press has increased from four to nearly seven tonnes (+ 70 per cent), and that of a 120-tonne press has increased from 14 to 17 tonnes (+ 20 per cent); there has also been an average increase of 20 per cent for guillotines with dimensions of 3 m x 6.26 mm.

The larger machines weigh around 60 tonnes.

There have at the same time been substantial increases in the precision required by the industries related to the motor vehicle industry.

Plate bending machines

The production of plate bending machines, which was for a long time irregular and limited to smaller sizes for thin sheet, has substantially increased in recent years with respect to heavy models, with thicknesses of up to 40 mm, three adjustable rollers and provision for pre-setting curvature, and lengths of approximately 4,500 mm.

2.8.2. Mechanical eccentric presses

"...There should be greater specialization in...presses...up to 80 or 100 tonnes... (and the manufacture) of auxiliary equipment...such as...feeders, supports...etc. should be increased."

In this manufacturing activity, which has a long tradition in the country, the maximum capacities fluctuated around 200 tonnes in 1962 (throat and horizontal).

Since 1964, there have been efforts to expand to larger capacities. For example, beginning in 1966, frame and throat mechanical presses with capacities of up to 400 tonnes and tables with dimensions of approximately 1,500 x 1,000, themselves weighing up to 80 tonnes, were supplied.

It is interesting to note that this production is made possible on the one hand by the demand of the motor vehicle and industry, and on the other by the capacity of press manufacturers themselves, supplemented by the existing machining capacities of other firms manufacturing heavy capital goods.

Around 1967-1968, four internationally-known licences were granted in Argentina, but the production in the range mentioned has hitherto been locally developed. Some local developments such as the clutch and cushioning mechanisms in the transmission deserve special mention.

As regards other aspects of stamping, the supply of sheet metal feed equipment for conventional presses deserves mention.

The field of presses operating at more than 150 strokes per minute has not yet been locally explored.

2.8.3. Hydraulic presses

The manufacture of this type of machine, including models with automatic cycles, up to 1,000 tonnes, for use both in metalworking and mechanical engineering and also in a wide variety of industries, was already firmly established at the beginning of 1962.

The range has been very greatly diversified during the period under consideration, and covers the most varied uses.

Frame and column presses in standard models with capacities of up to 1,000 tonnes and tables with dimensions of 1,750 x 1,500 mm, automatic cycles and air and water cushioning are now being supplied.

However, the most important development in the period under consideration was in the field of special machines, and related not only to size and power, but also to design.

For example, presses with forces of 7,000 tonnes and dimensions of 1,500 x 1,500 mm; die-testing units with dimensions of 3,500 x 2,300 mm and weights of 100 tonnes; machines with forces of 3,500 tonnes and weights of 80 tonnes; carousel machines for continuous pressing of automobile doors; special transfer presses for the hot production of pressure pipes, etc. have been manufactured.

The development of hydraulic systems (engines, electro-valves and distribution blocks), which began precisely with the press manufacturers, has made possible this notable development, taking place at the same time as the development of the supplies of large castings and the introduction of large machine tools into workshops supplying the machine tool industry.

2.8.4. Other forming machines

The development in respect of motor vehicles and durable consumer goods, together with that of operation devices, has made possible new developments.

(1) Bending

For example, high-productivity pipe and profile bending machines for diameters of 50-60 mm, with automatic cycles, fully hydraulic drive, end-of-stroke stops and adjustable pressurestats are being manufactured.

Profile bending machines for circular forms are also manufactured for shipyards, railway workshops, etc., without limitations as to size.

(ii) Straighteners

The volume of sheet metal worked in response to the types of demand referred to above has resulted in the manufacture of high-productivity sheet metal straighteners.

For the same reason, the manufacture of multiple-blade rotary shears developed during the period under consideration.

(iii) Shears

The production of disc cutting machines for thicknesses up to 6.2 mm, with six cutting edges, installed capacities of 30 hp and speeds of 30 metres/minute was also developed during the period.

(iv) Cutting

In the field of mechanical cutting of sections, a much wider range is now being offered than in 1962.

Combination (universal) machines for cutting sections, bars, pipes, etc. with dimensions of 13 x 130 mm into sections, with a weight of 3.5 tonnes and a capacity of 8 hp, and multiple shears for sections with dimensions of 7 x 51 mm, weighing 5 tonnes.

During the period, the models of steel billet cutters made necessary by the spread of forges, which cut squares 95 to 130 mm on a side (depending on the quality of the material) using a 440 mm tool, and have a capacity of 55 hp and a weight of 22 tonnes have appeared.

The appropriate motorized roller trains with a length of 6 m, a weight of 4 tonnes and an installed capacity of 18 hp, are also supplied.

(v) The production (under licence) of a full range of vertical and horizontal dynamic balancers for industrial use, up to 3 tonnes and equipped with mechanical or electronic feed variators, has developed out of the manufacture of equipment for wheel balancing.

The devices indicate imbalance in 2 planes and automatically indicate its magnitude and direction.

(vi) Electro-erosion

Machines are supplied with a capacity of up to

(vii) Thread rolling

This line of machinery, which has a long local tradition, was expanded during the period under consideration to include units with an automatic cycle (including automatic feed). Units with diameters of up to 40-50 mm and weights of 5 tonnes are manufactured.

(viii) Forging machinery

Considerable progress has been made during the decade in forging machines.

The pneumatic hammers with a drop of up to 600 kg which were manufactured in 1962 have developed into a full line of double-acting drop hammers (lift and thrust using air or steam), with drops of up to 1,500 kg and weighing 50 tonnes, as required by the enlargement of the automobile industry forges.

These machines have removable tempered guides and can be used as drop-hammers or, by means of an additional pedal, to deliver multiple blows.

A power press with jaws ("Hamuco" type) and the forging rollers for it have also been developed.

In conclusion, the machinery required for medium-sized production forges and for maintenance and forging work are produced.

The traditional line of friction presses and hydraulic dicing presses has continued to be produced with the usual parameters (700 tonnes and 1,500 tonnes, respectively), but with the incorporation of improvements with respect to slides, pressure lubrication and command servos.

2.9. Operation and control systems and devices

"...there are a number of...hydraulic and pneumatic components...in the market with which it is possible to fit out...automatic systems of some complexity..."

"...the mass production of these under...exacting standards should be stimulated..."

The manufacture of automatic operation and control devices and the development of their application in machine tools have been among the most dynamic aspects of the sector in the period under consideration.

The manufacture of hydraulic operation devices began in the 1950s with hydraulic piston pumps. Pneumatic parts, designed to replace parts of imported equipment, put in an active appearance later on, around 1955 or 1956.

2.9.1. Hydraulic operation

Already in 1960, at least three firms producing machine tools were manufacturing their own pumps and valves, and this self-supply situation predominated until 1965.

During this period, the parallel demand by the manufacturers of road and agricultural machinery and motor vehicles promoted the growth of independent manufacturers of vane, clutch, fixed and variable flow piston and cam pumps and also manufacturers of electro-valves.

As a result of the introduction of new elastomers, the local manufacture of special units, the improvement of shell casting and the utilization of new manufacturing techniques, virtually the full range of electro-valve pumps, connexions and hose pipe was being marketed in 1968.

Only small valves for handling flows of less than 20 litres/minute and hydraulic logical control units are not manufactured for marketing reasons.

Accessories, filters and inter-changers are locally manufactured in full.

Axial piston variable flow pumps are currently undergoing commercial development.

2.9.2. Pneumatic operation and control

The manufacture of pneumatic parts was started in 1956-1957 with replacement parts for imported circuits.

Full manufacturing began between 1962 and 1964 on the basis of entirely local development, without licences (as in the case of the development of hydraulic systems).

The year 1964 was critical because, in the context of LAFTA, Uruguay was authorized to install a factory for pneumatic automation components which did not prosper.

The first local electro-valves were produced in the same year and the gradual progress towards their manufacture for and use in all industries started. These products have from the beginning been based on a modular principle in all industries.

Just as in the field of hydraulic systems, 1968 marks a final dividing line. At this time, new and more modern models and new materials were introduced (modular valves, new elastomer seals, separate bed plates, aluminium casting).

Locally developed modular fluidic control units were introduced into the market and the first logical circuits of local origin were installed in industry.

Around 1970, the manufacture of operation components (valves, cylinders) and control parts (gates) was considerably changed by mass manufacturing techniques.

Work on the development of fluid control units has been carried on simultaneously in universities (low and medium pressure) and in industry (high pressure).

The most outstanding current developments in the latter field are constituted by plug-in plastic modular-panel fluidic control units, which are to appear at the end of the year, and a pulse motor coupled with a hydraulic pump activated through digital control units.

The most recent application of pneumatic operation is in machining units with hydro-pneumatic feed (1971), which are mass produced on a modular basis.

2.9.3. Electro-mechanical and electronic operation and control

There has been considerable progress in the electrical operation and control of machine tools.

There has been a large-scale shift during the last decade from direct control of machinery by switches to control by low-voltage servo circuits operating through contactors.

At the same time, integrated electric circuits using either motors with up to three timer speeds, thyratron speed regulators or mechanical speed variators have made possible control systems for feeds, slides and heads, rotating and linear speeds and operation of high-capacity engines.

The manufacture of pulsators, contactors, terminals and micro-switches started in this period and has developed satisfactorily.

2.10. The use of licences

In the last decade, the use of foreign licences has considerably increased.

The number of models manufactured under licence has increased from two or three to nearly ten.

This situation has several peculiar features. It is very seldom that the licence is used to initiate manufacture of a family of machines from scratch. In most cases, the manufacturer uses it to produce a model belonging to a family of machines which he was already producing on the basis of his own development work, generally successfully.

This points to one of the reasons for using licences and advantages sought in doing so. This is the shortening of the development period for the model, combined with considerable promotion effect connected with the name of the licenser.

It also goes without saying - and this has been confirmed by the facts - that licences are not - and were not in the period under consideration - a panacea making it possible to move from one stage of development in which inadequate or unsatisfactory models are being produced to a satisfactory stage; on the contrary, the production of good locally developed machines would appear to be a prerequisite for the efficient use of a licence.

Experience gained has also shown that, apart from the advantages described above, the use of foreign know-how has entailed some distinct difficulties which should be taken into account.

The information obtained is often incomplete or inadequate; the user of the licence has to fill this gap with his own experience, sometimes even providing his own solutions, and this reduces the value of the licence purchased.

The models are frequently not completely suited to local use and/or production, and this also makes appropriate adaptations necessary.

Consequently, it can be concluded that this approach has constituted a means for the development of design and, sometimes, of the production of machine tools of a supplementary type - a term which is not intended to disparage their value in well-defined situations.

2.11. Remarks on the development of manufacturing processes

The methods and conditions of manufacture and the equipment used by manufacturers of machine tools have developed favourably during the period under consideration, as shown by certain relevant facts.

(i) First of all, examination of the equipment available in machine tool factories indicates that this equipment has substantially improved in many establishments (see table 1).

In particular, the size and type of basic machinery has been brought considerably more into line with the type of production.

Although it is clear that this improvement has varied from enterprise to enterprise for understandable reasons, developments with regard to the manufacturers of the heaviest machinery should be mentioned as a general example. These firms are now fitted out with a complex of basic equipment: planing machines, planing and milling machines, boring machines and milling machines of a size and capacity more than adequate for their production, a situation which is very different from that in 1961.

Among the types of equipment being used, mention should be made of the installation of a numerical control (NC) boring machine in one of the most important factories and the equipment of many production machines with digital measuring devices.

The same, with identical limitations, is true of available finishing machines.

It is true that this assertion does not hold to the same extent with regard to the grinding of gears and serrated shafts. Capacity in this respect is concentrated in two firms which serve three others. The absence of an independent supplier makes itself felt.

(ii) Secondly, mention should be made of the primary services now available to manufacturers, which made it possible to manufacture certain types of machinery and meet certain requirements during the decade.

Extra-heavy mechanized equipment produced by the manufacturers of other capital goods (shipyards, electrical equipment) are available and are used, and have made it possible to produce articles of an exceptional size (20-25 tonnes).

Another service which is frequently used, although not affording an optimum solution, is provided by the jig borers in the mechanical engineering industry (apart from those installed in the manufacturing plants themselves).

The number of these available was increased as a result of the expansion of jig and die making required by the motor vehicle industry, and they are taken advantage of by the machine tool industry for the production of its manufacturing fixtures.

(iii) The increase in number, variety and quality of suppliers has been a distinctive - and perhaps the most outstanding - characteristic of the period under consideration.

Mention has already been made in another chapter of the importance of the manufacture of operating and control parts (pumps, electro-valves, pipes, engines, key switches, contactors, terminals, ordinary switches, etc.), many of which only appeared during the period under consideration.

A second factor which has had a fundamental influence on product quality and improvement should be mentioned here.

This is the development of casting and heat treatment in the country. In 1961, high-quality castings for small batches of complicated articles were provided by only a few suppliers and, in practice, this meant that many manufacturers were often unable to obtain these castings.

Beginning at that time, the development of the requirements of the motor vehicle industry resulted in an enrichment of the supply of castings produced under quality control and to stringent specifications at reasonable prices.

This possibility has even become available to specialized suppliers of alloy castings as small as 100-500 kg produced to strict specifications.

Shell moulding began in the country before it did anywhere else in South America and developed at a very rapid pace (as did the manufacture of machinery for this moulding).

The heat treatment of large castings by foundries, enterprises producing other capital goods and other suppliers developed simultaneously.

All this has resulted in a situation with respect to the supply of castings produced to specifications which could be regarded as very good.

Lastly, this development has made possible the regular supply of machines with treated beds.

The second important and significant development has consisted in the manufacture of local measuring and control instruments, e.g. for pneumatic and, recently, electronic measurement of linear parameters.

In fact, in the last ten years, the manufacture of such equipment, both under licence and without licence, has developed, and this equipment is supplied in all types, both ordinary and special (exported in substantial volumes).

It should also be pointed out that the first of four digital measuring machines has been manufactured.

2.12. Other developments: numerical control (NC)

In addition to the past and current developments in the field of conventional machinery and its components and accessories, the development which has started in the field of digital control should be mentioned.

The developments which have taken place in the field of fluidic components and their application to the control of machine tools have made it possible to train both users and manufacturers in the design and use of digital control.

Progress in the field of electronic control circuits has taken place at the same time.

At present, two universities[2/] are carrying out separate programmes for the development of a sensor machine and electronic digital control units.

Measuring instruments and actuators and control units, respectively, are also being developed in two private enterprises.

In view of this development situation and of the substantial resources available with respect to electronic engineering in the country, production of numerical control units for measurement and control will be possible in the short term.

An important item remaining is the development of the mechanical components, in particular the sliding parts and the structure per se of the machine or machines to be linked up to this control.

2.13. Summary and development prospects

The development during the decade could be summed up in the following main points:

- There has been a positive development as regards varieties of machinery (models and varients) in the main families of machinery which were already being produced in 1962, and a better selection is being offered for production and maintenance work;

- The weight, strength, power and speeds have substantially increased;

2/ National Technological University, Cordoba, Numerical Control Unit, Technological Research Centre; Electronics Unit, National Geoheliophysics Studies Commission, San Miguel.

- The manufacture of special machinery composed of units, with a high degree of automation, is expanding rapidly at all levels of size and utilization;
- The supply of components for hydraulic, pneumatic, electrical and electronic automation systems has achieved very satisfactory levels of flexibility, making possible the above developments;
- The manufacture of accessories (plates, dividers) has substantially expanded;
- The machines generally have centralized pressure lubrication installations, low-voltage electrical controls and adequate clutch and brake devices.

The prospects for future development which an examination of development in the decade under consideration gives grounds to regard as possible and acceptable would include:

- The improvement and refinement of mass-produced models currently being manufactured;
- The continued expension of the manufacture of special machines composed of units (intended for the automation of mass-production);
- The introduction of the manufacture of numerical control devices (designed for the automation of small-scale production) for measurement and machine tools.

For a number of reasons, the two latter fields of application appear to be most favourable for national expansion.

This is because there are specific resources and a favourable situation in the country:

(a) Sufficiently experienced university, technical and operative personnel in adequate numbers.

(b) The products included in these families of machines comprise the highest skilled labour and technology input, and their manufacture does not involve a very great economy of scale effect.

Also, development in this sphere does not require unusually high capital intensity, but rather intensity of skill (calculations, planning, design, testing).

(c) The production of NC machines applies very well to the capital goods manufactured on a small scale which, precisely for the reasons described under (a) and (b), are very suitable for production in the country.

Table 1

ARGENTINA

STOCK OF MACHINE TOOLS

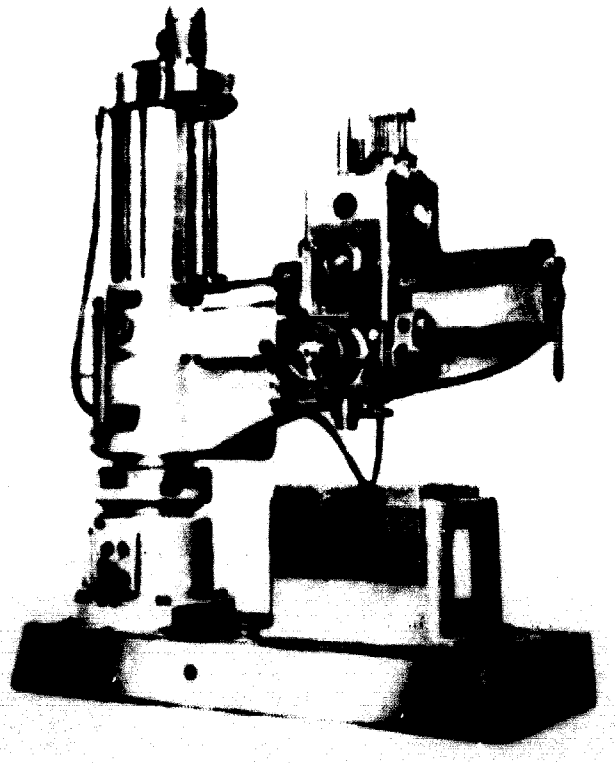
Manufacturers

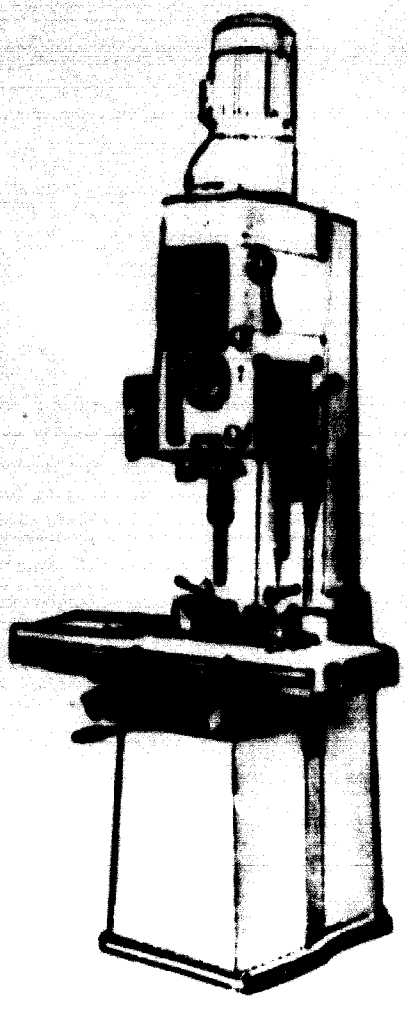
Type	86 firms (1962) No.	%	17 firms (1972) No.	%
Lathes	508	27.1	222	23.0
Milling machines	137	7.3	91	9.0
Drilling machines	453	24.1	227 a/	23.0
Boring machines	75	4.0	46 a/	4.5
Planing machines	277	14.8	113 b/	12.0
Threading machines	8	0.4	12	1.2
Broaching machines	9	0.5	5	0.6
Machine for gears	71	3.8	46	4.5
Sawing machines	123	6.5	40	4.3
Grinding machines	140	7.5	71	7.0
Tool cutters and grinders	76	4.0	37	3.0
	1,877	100.0	928	100.0

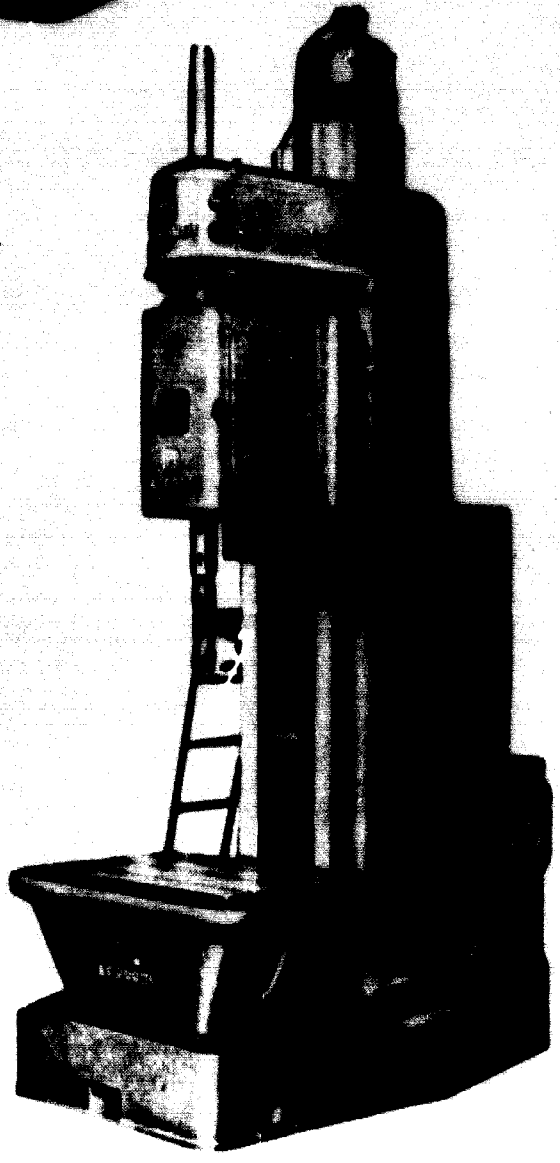
a/ 6 Jig borer

b/ 41 Double column planers or millers

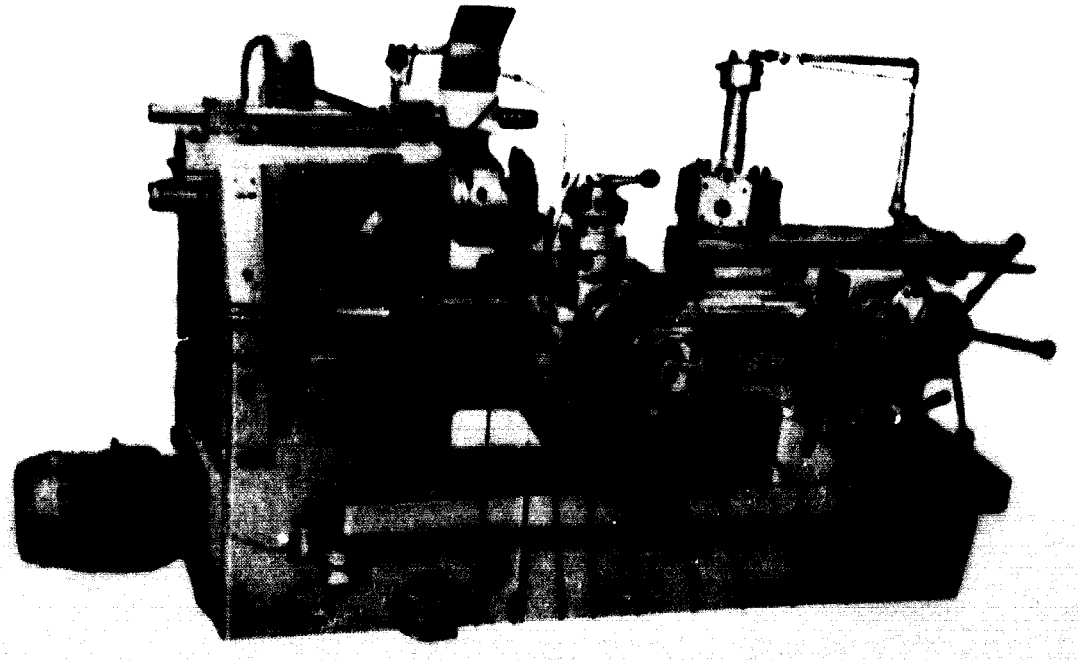
c/ 33 Radial



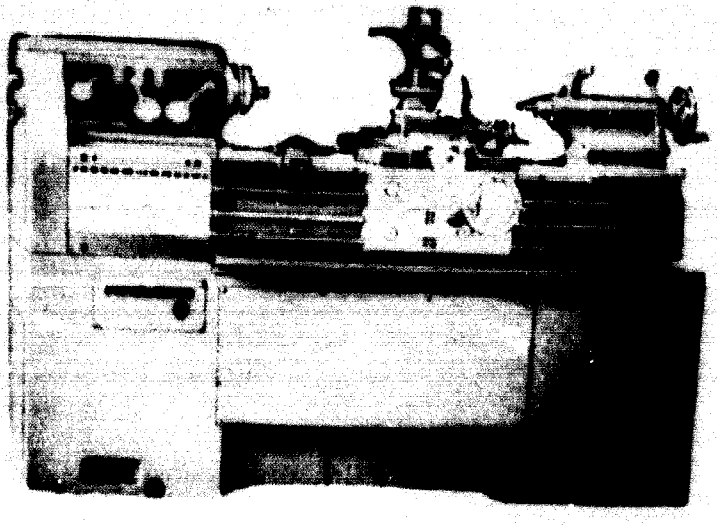




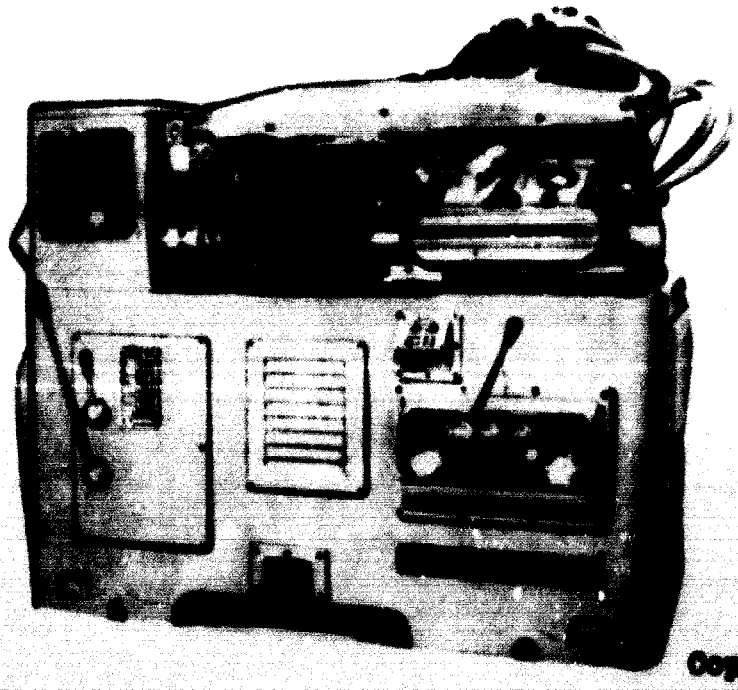
Lathes



Turret



Lathes



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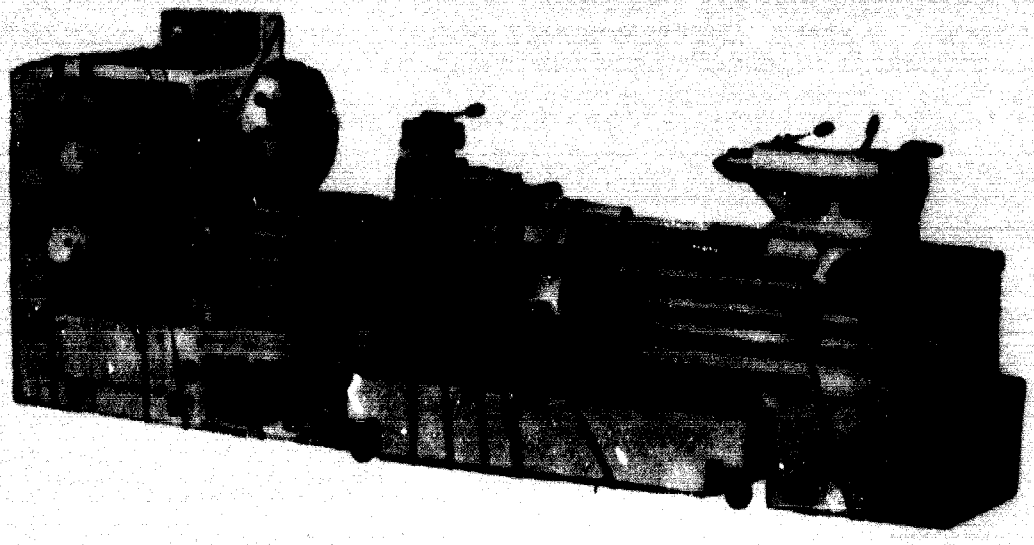
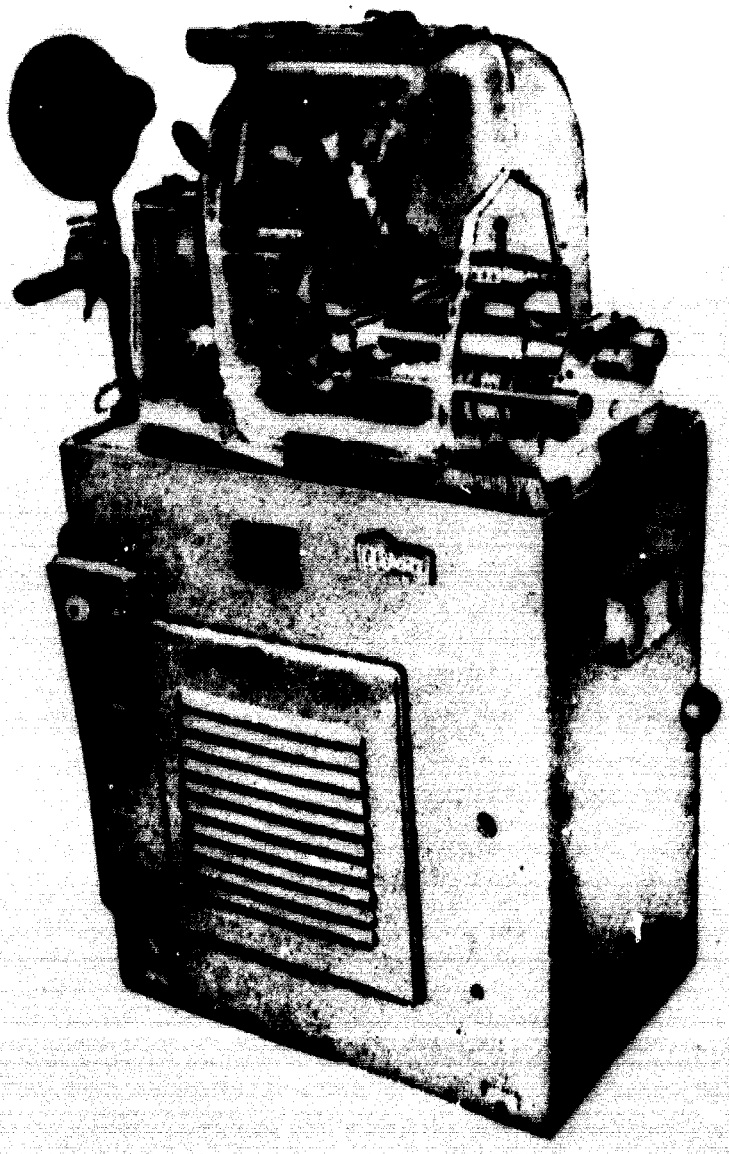
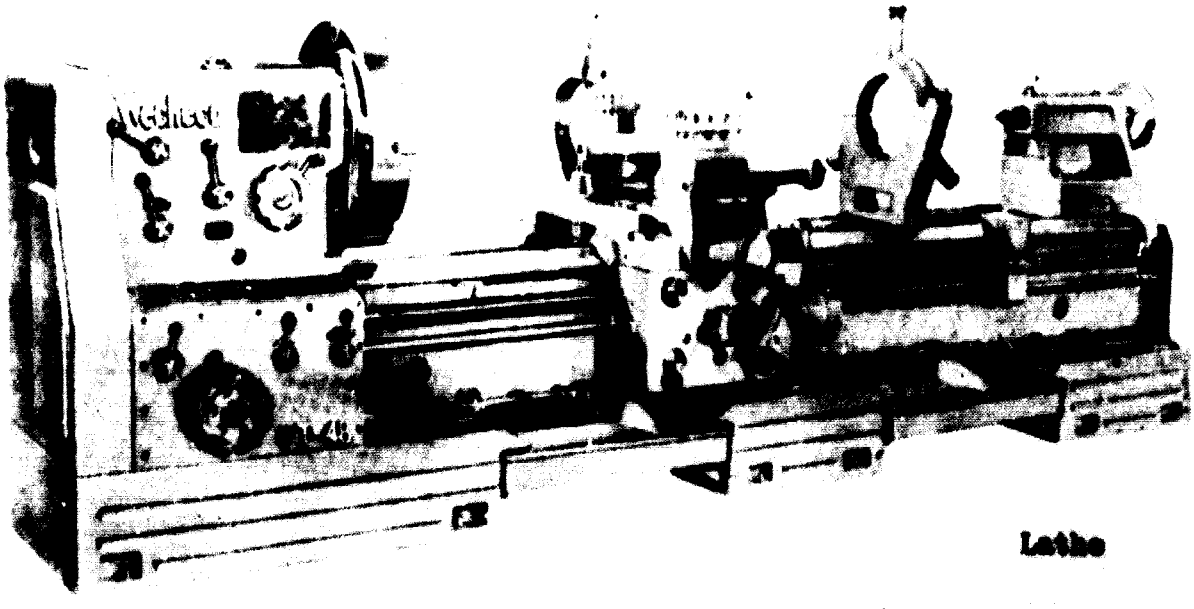


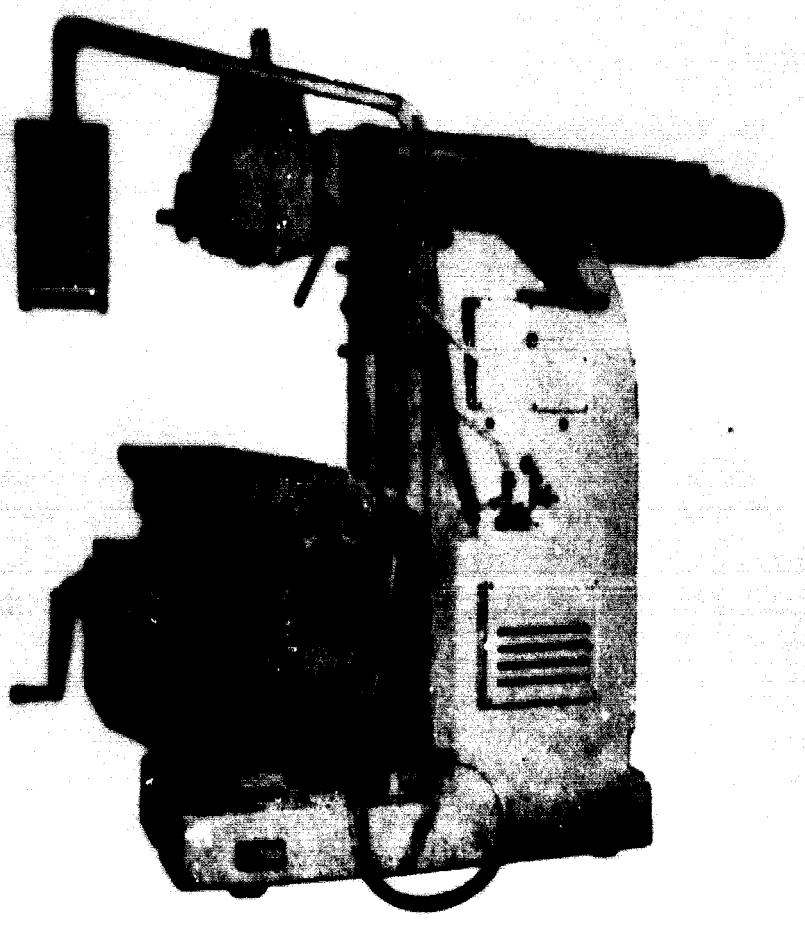


Automatic lathe

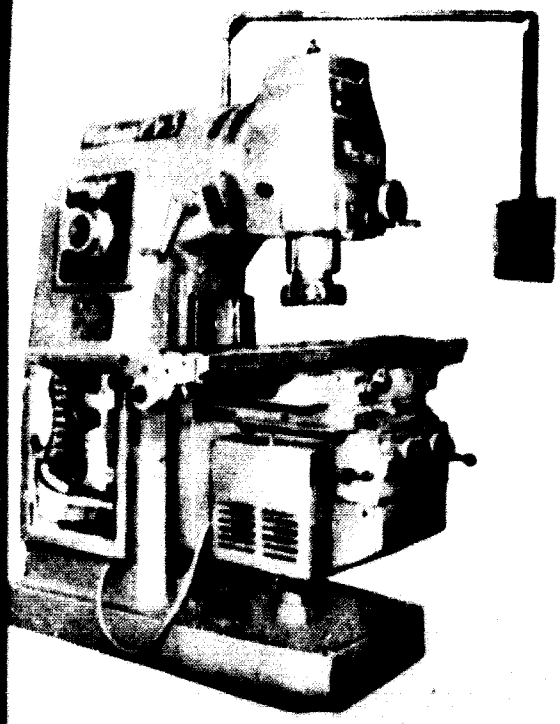


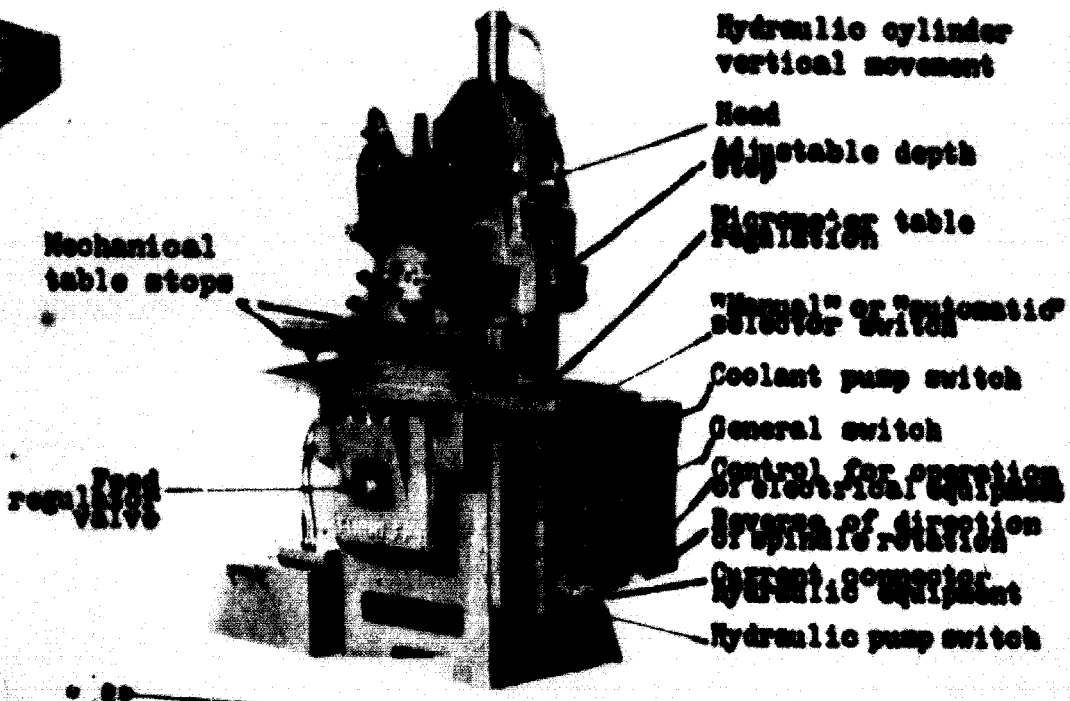
Lathe

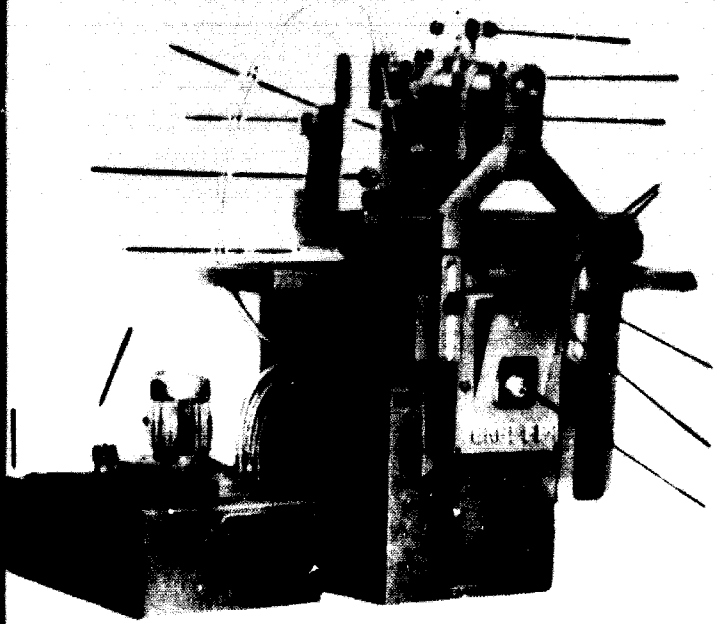
Milling machine

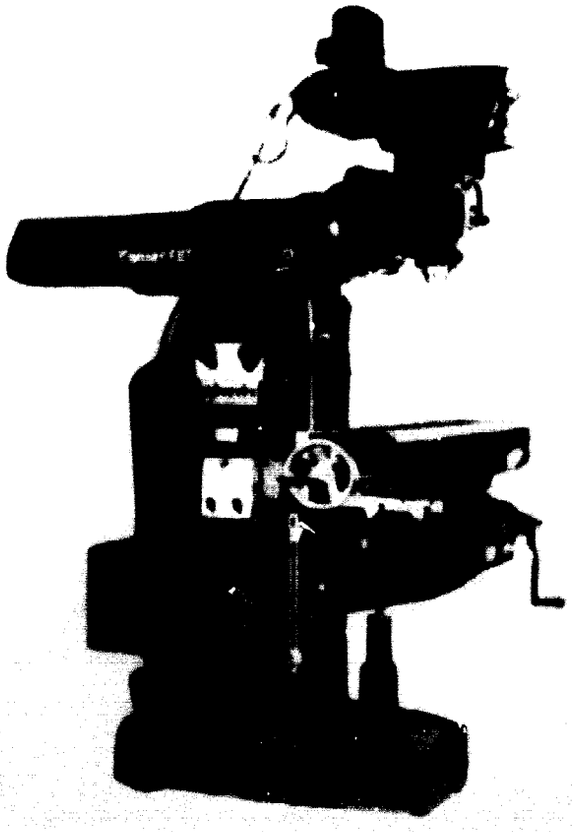


Milling machines

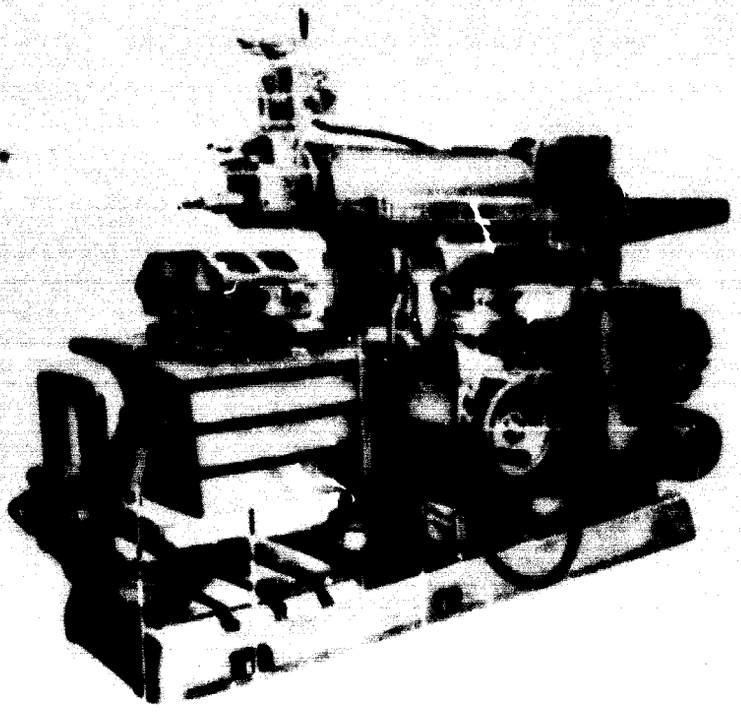




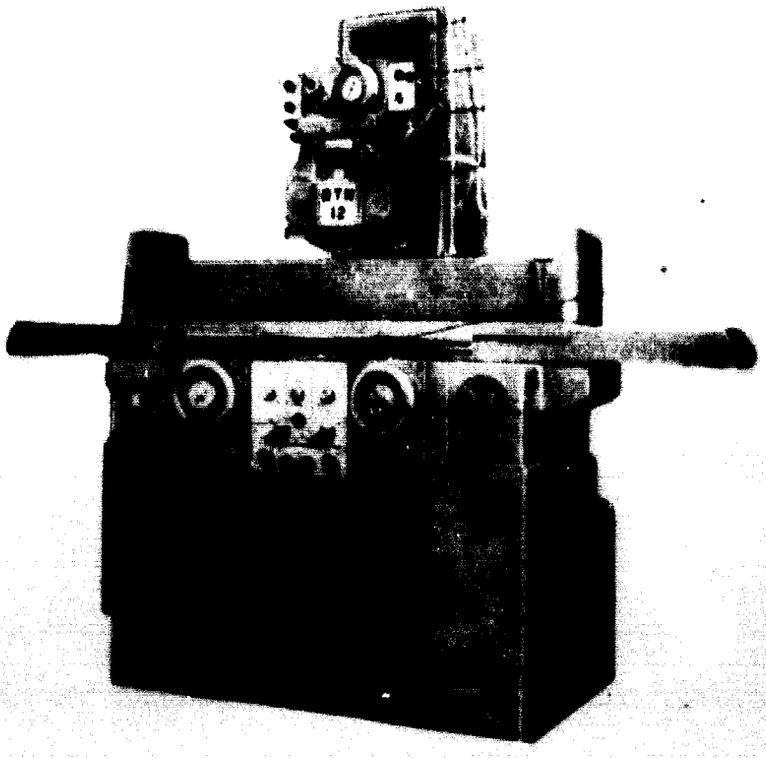




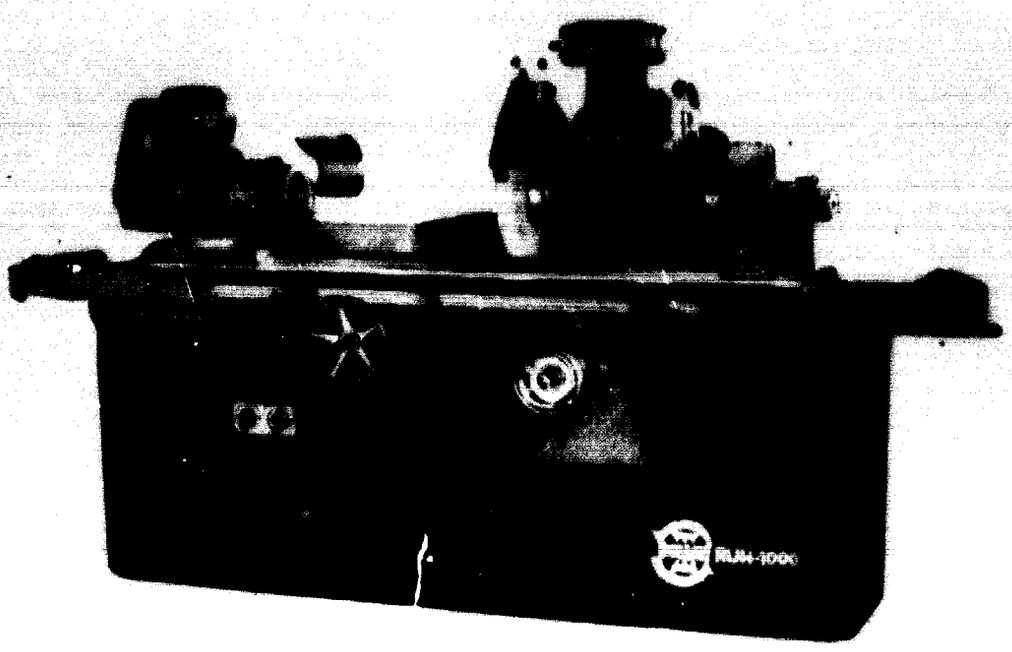
Milling machine

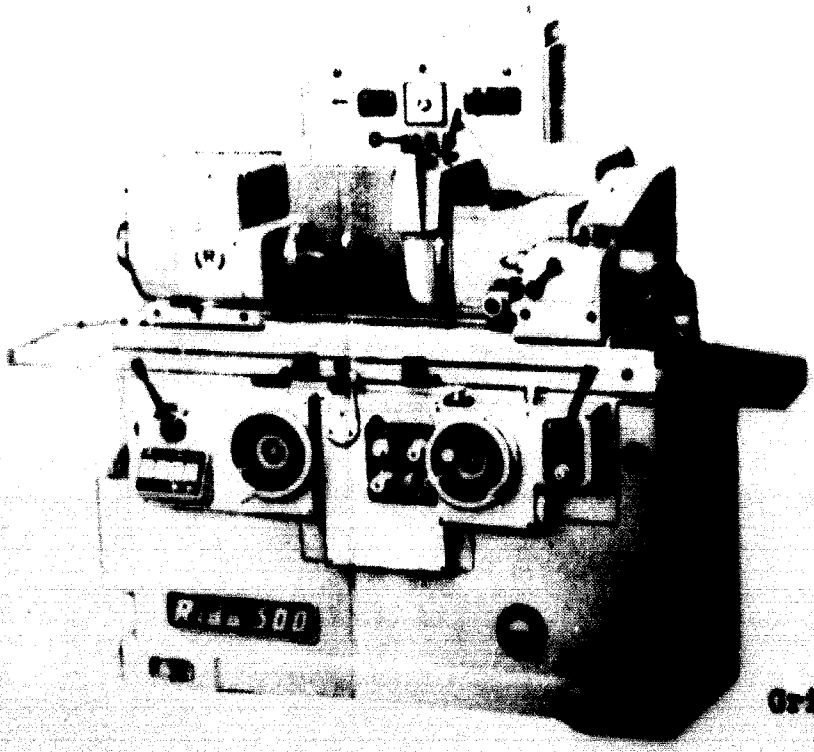


Shaping machin

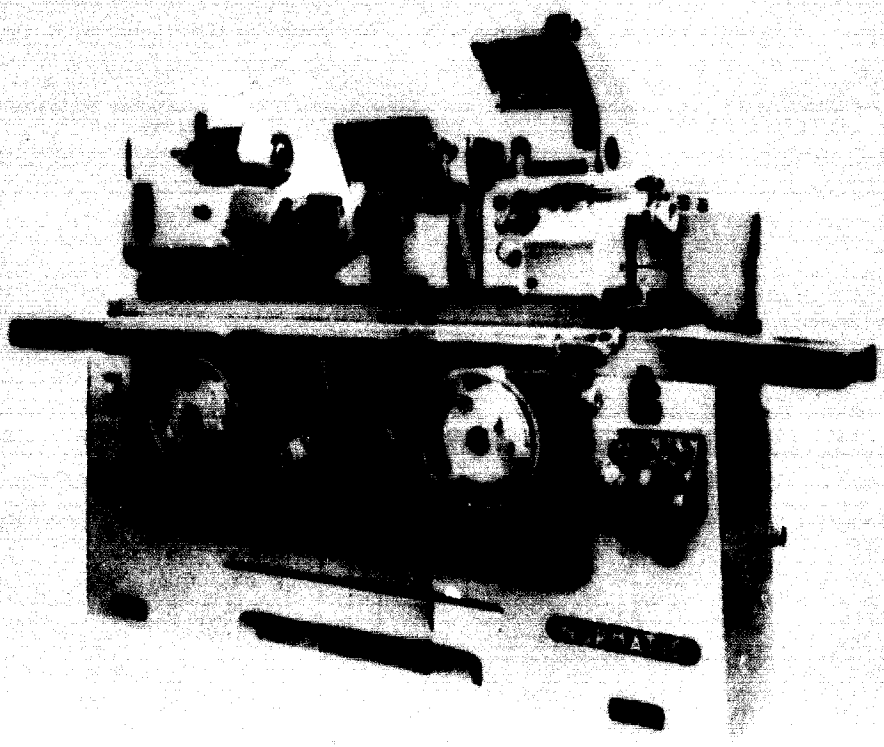


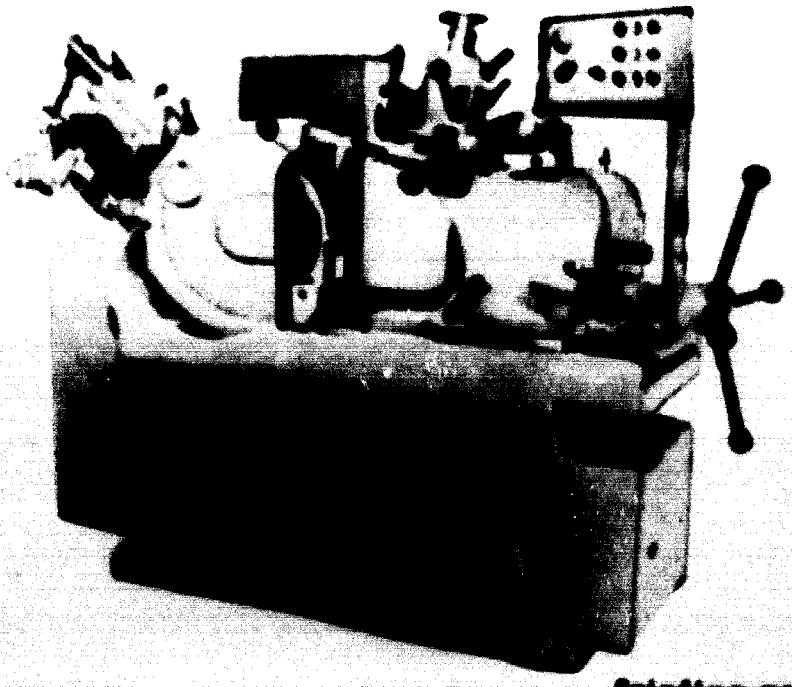
Grinding machines



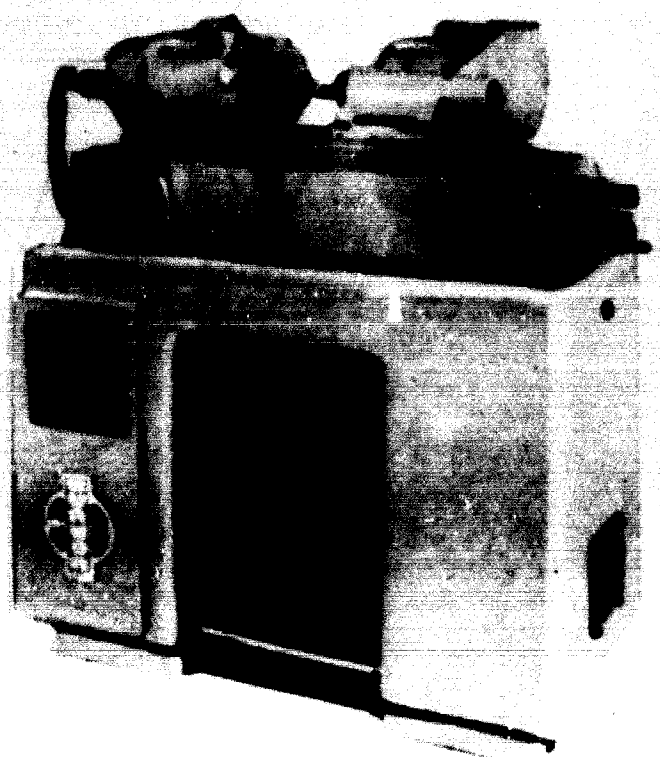


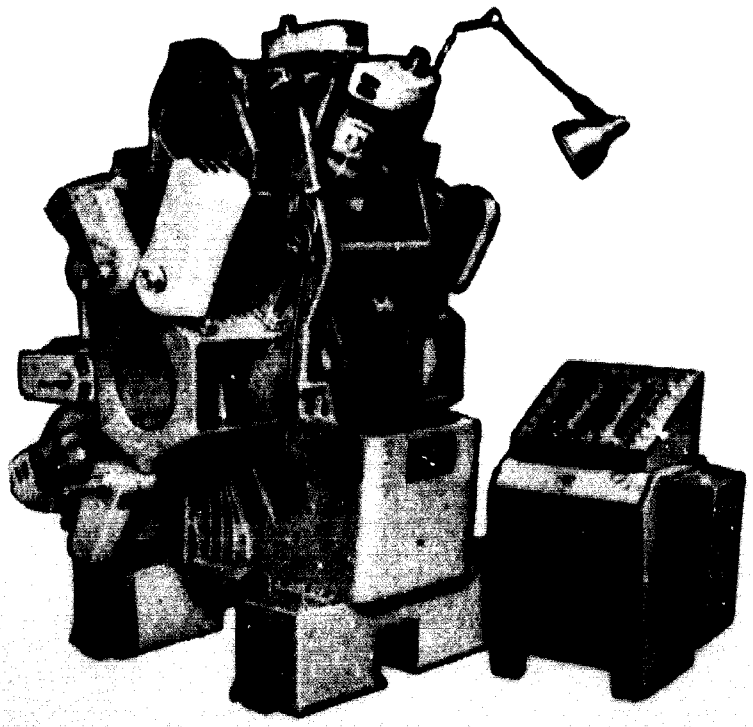
Grinding machine



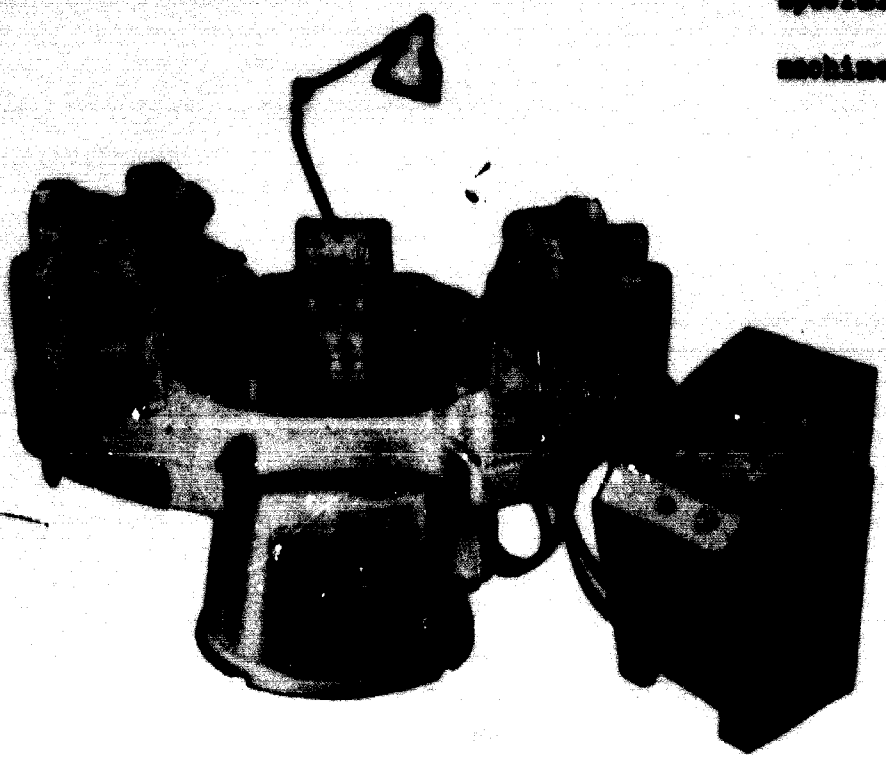


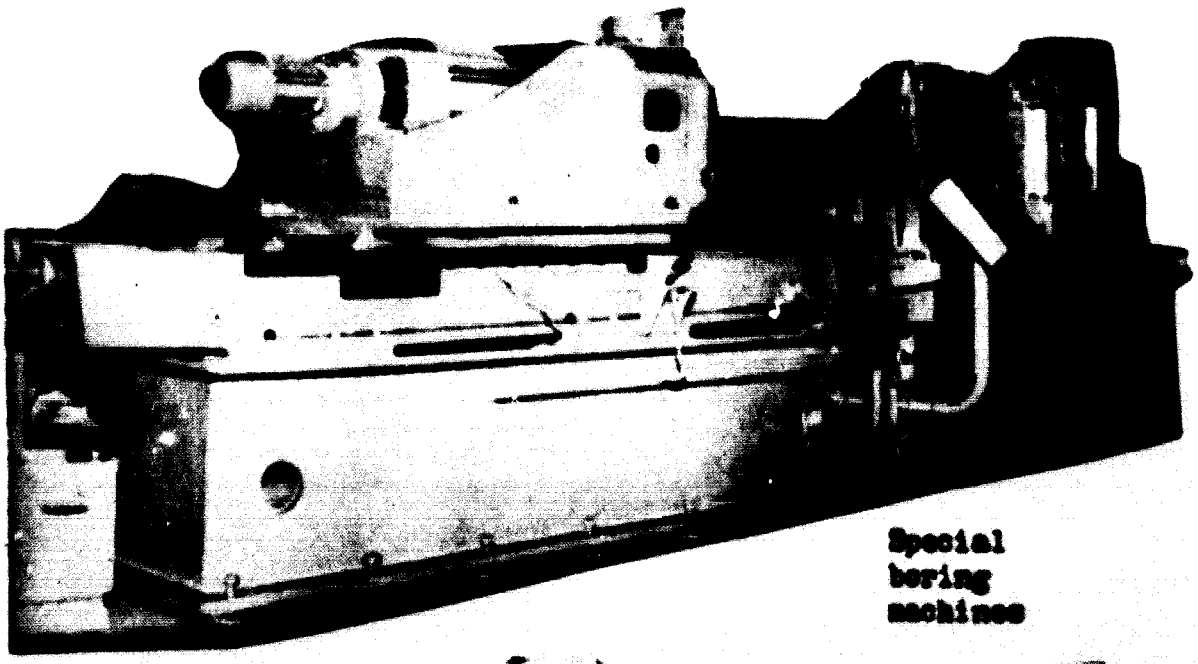
Grinding machines



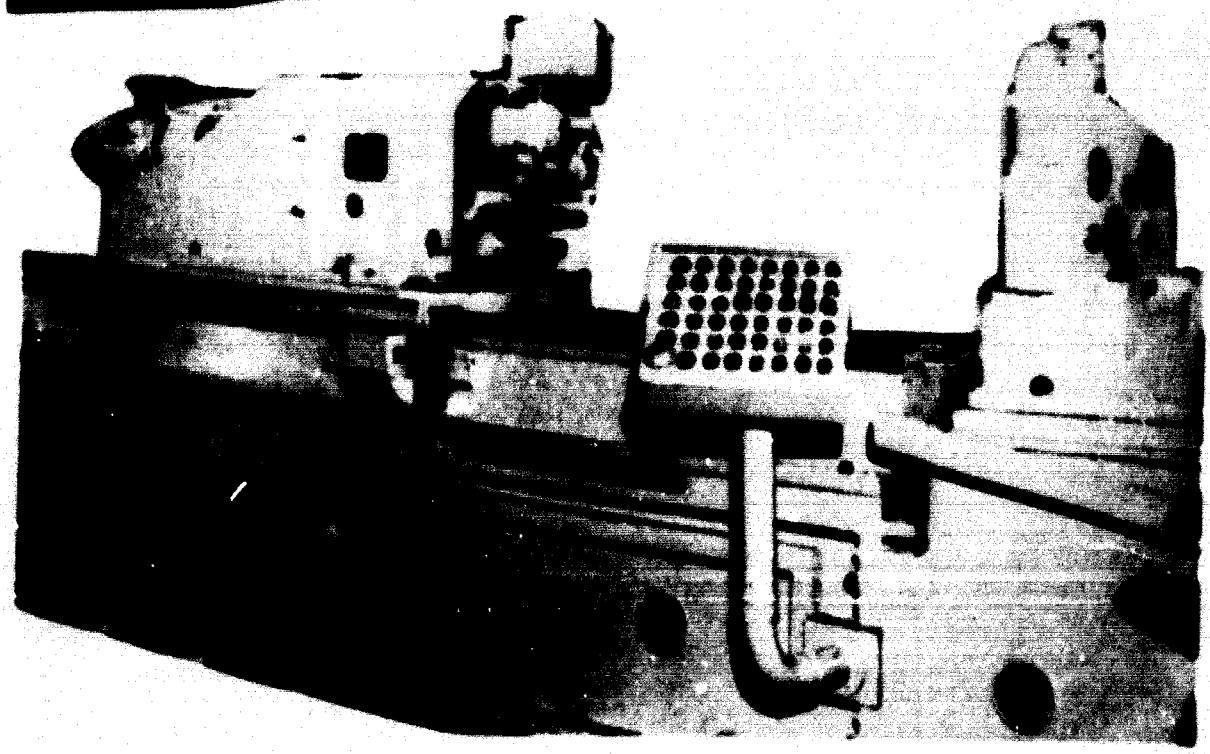


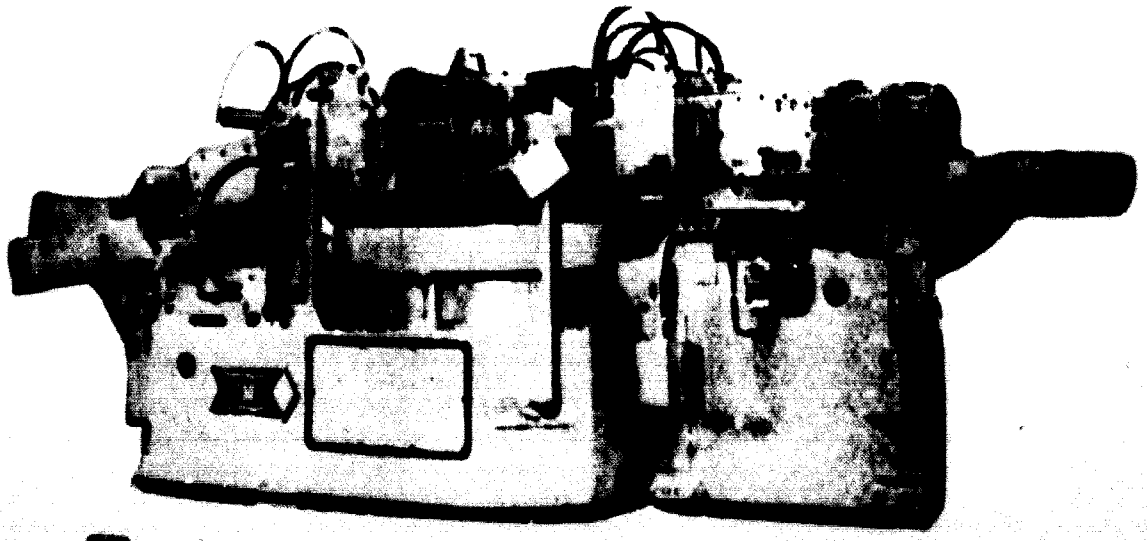
Special
machines

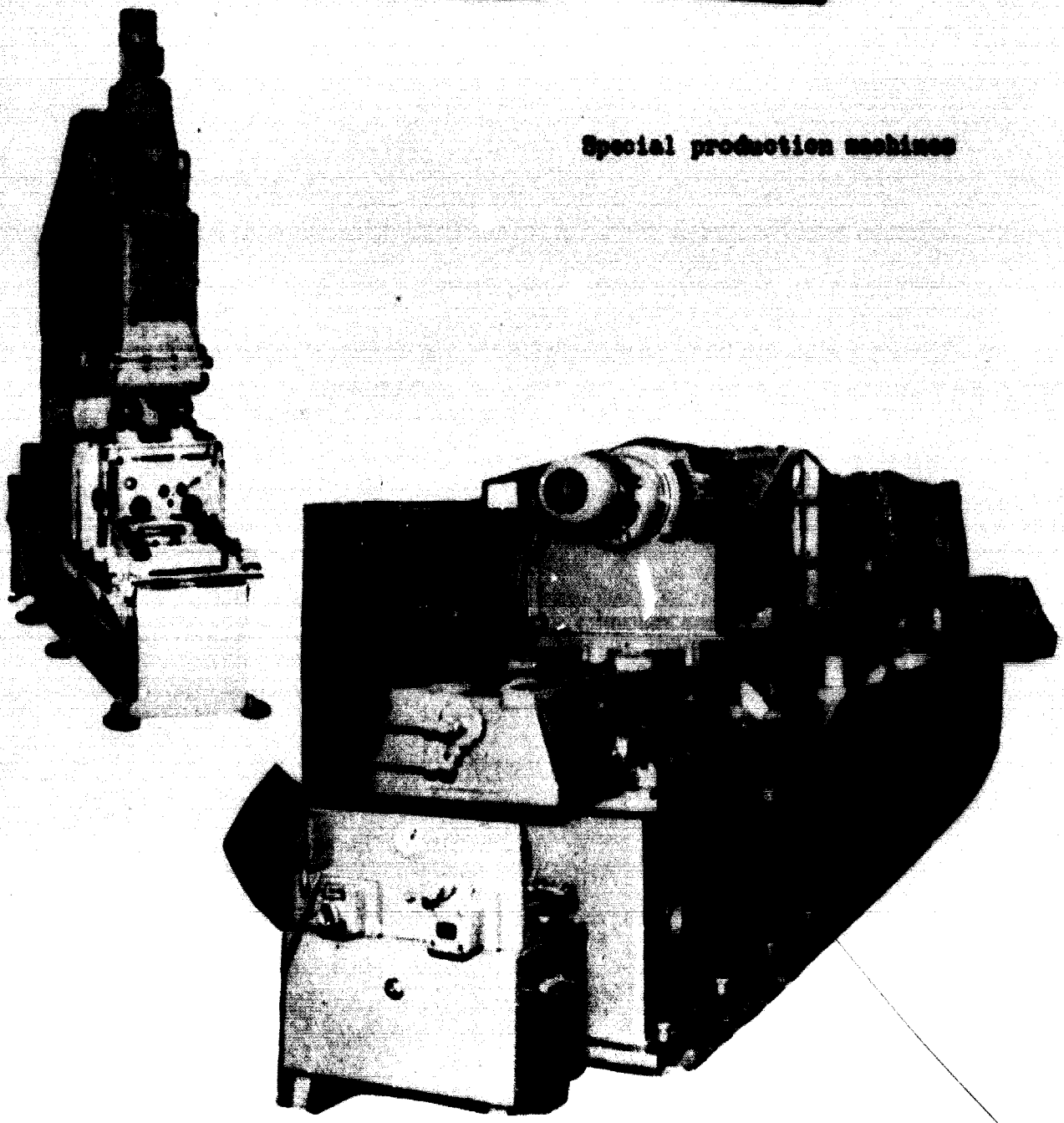




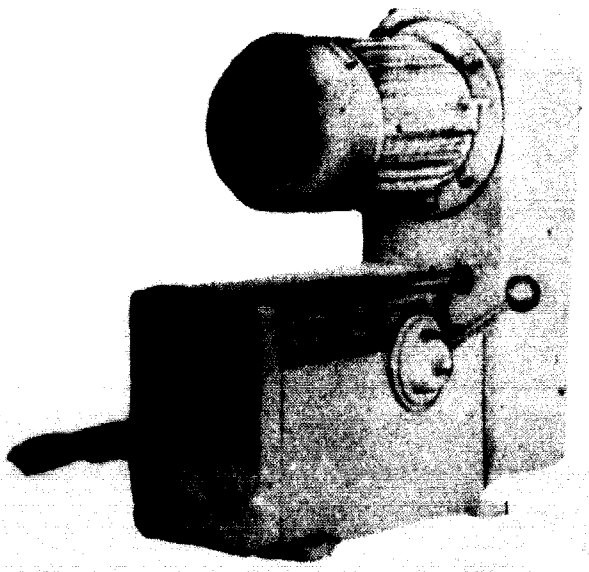
Special
boring
machine

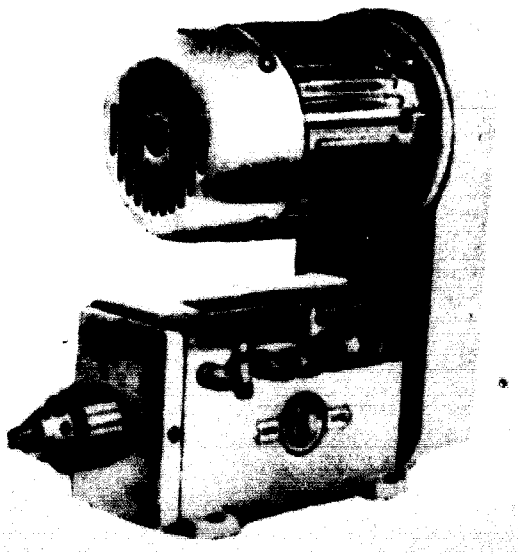






Special production machines





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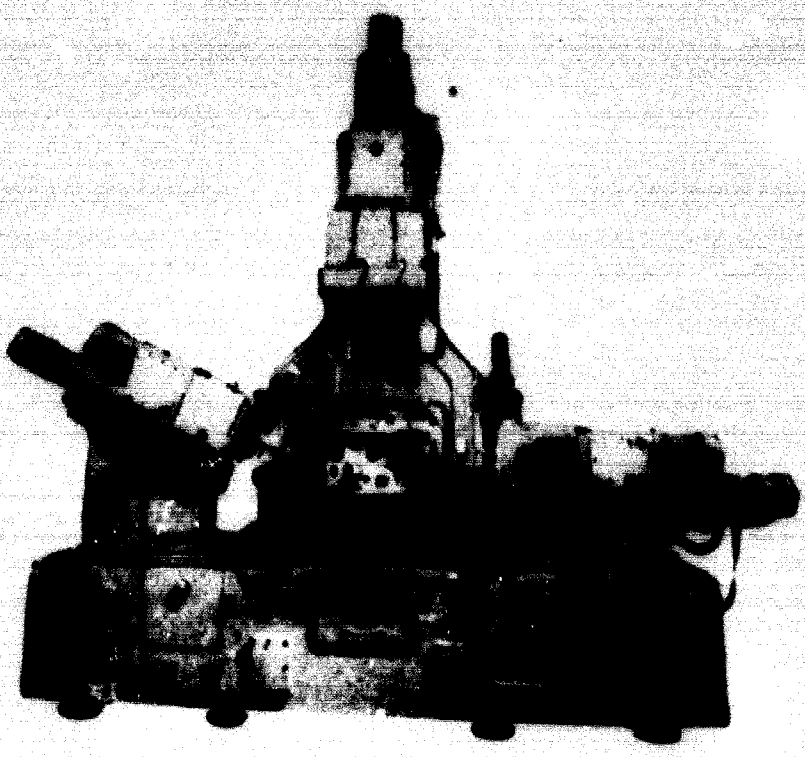
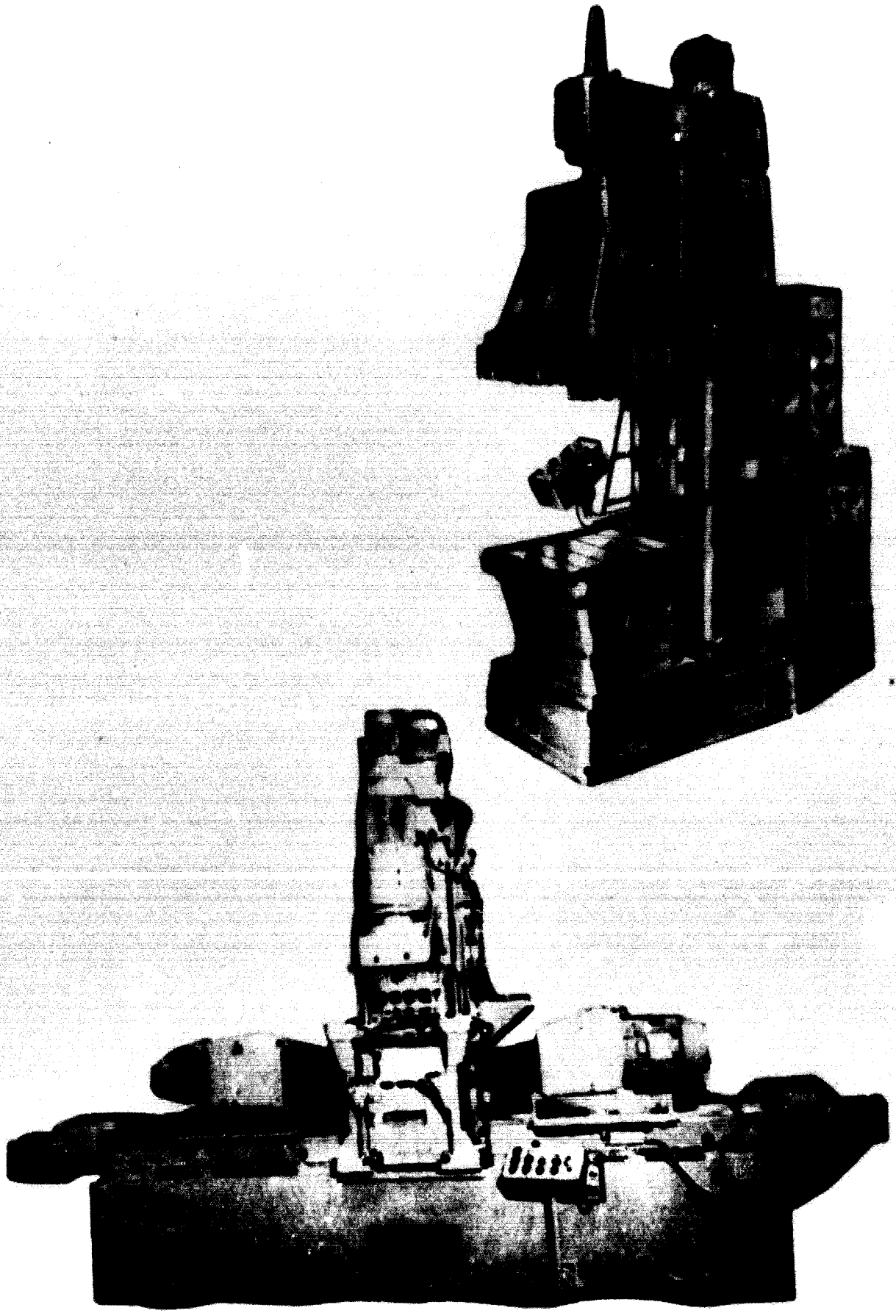
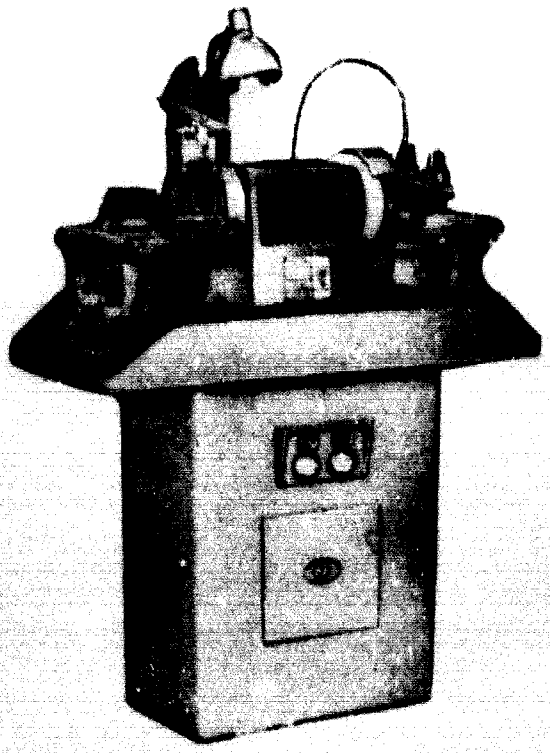
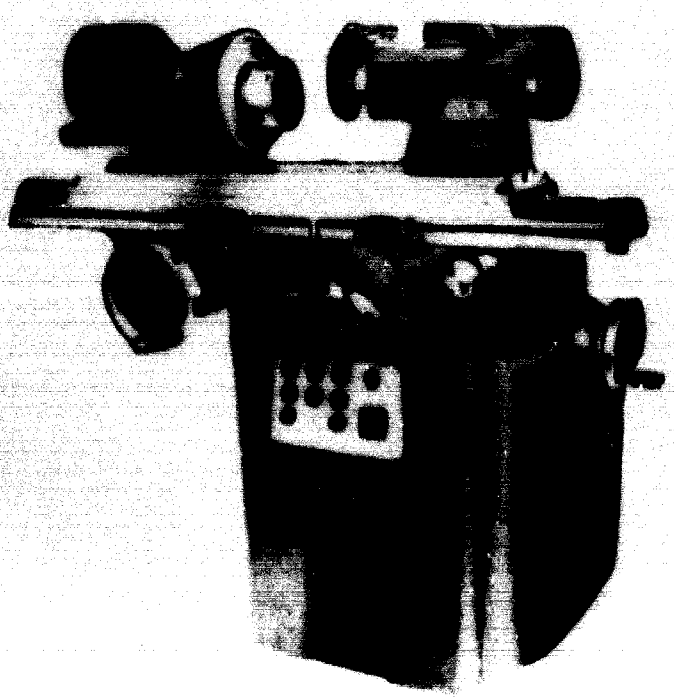
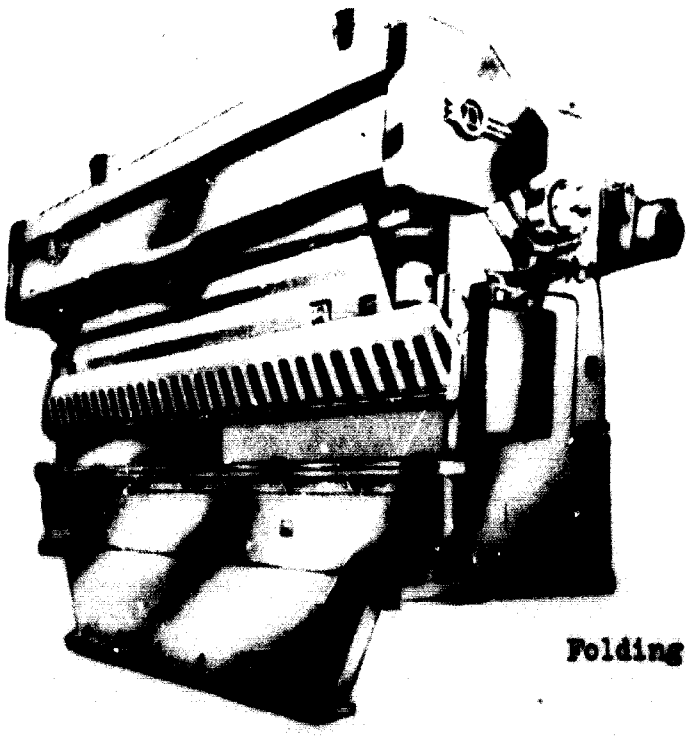






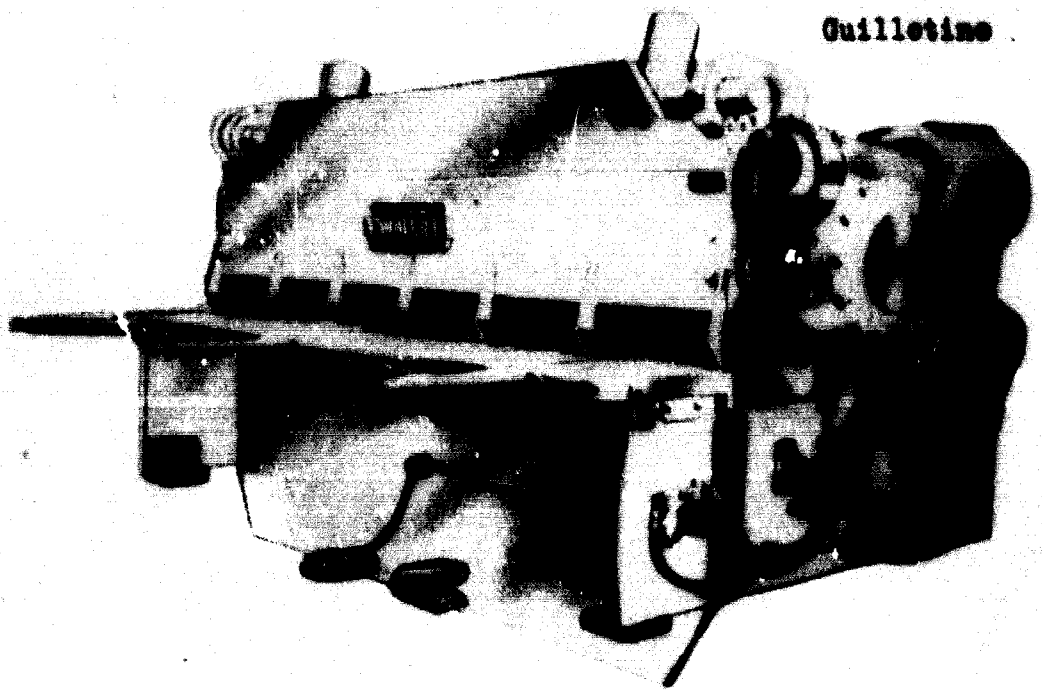
Tool and cutter grinders

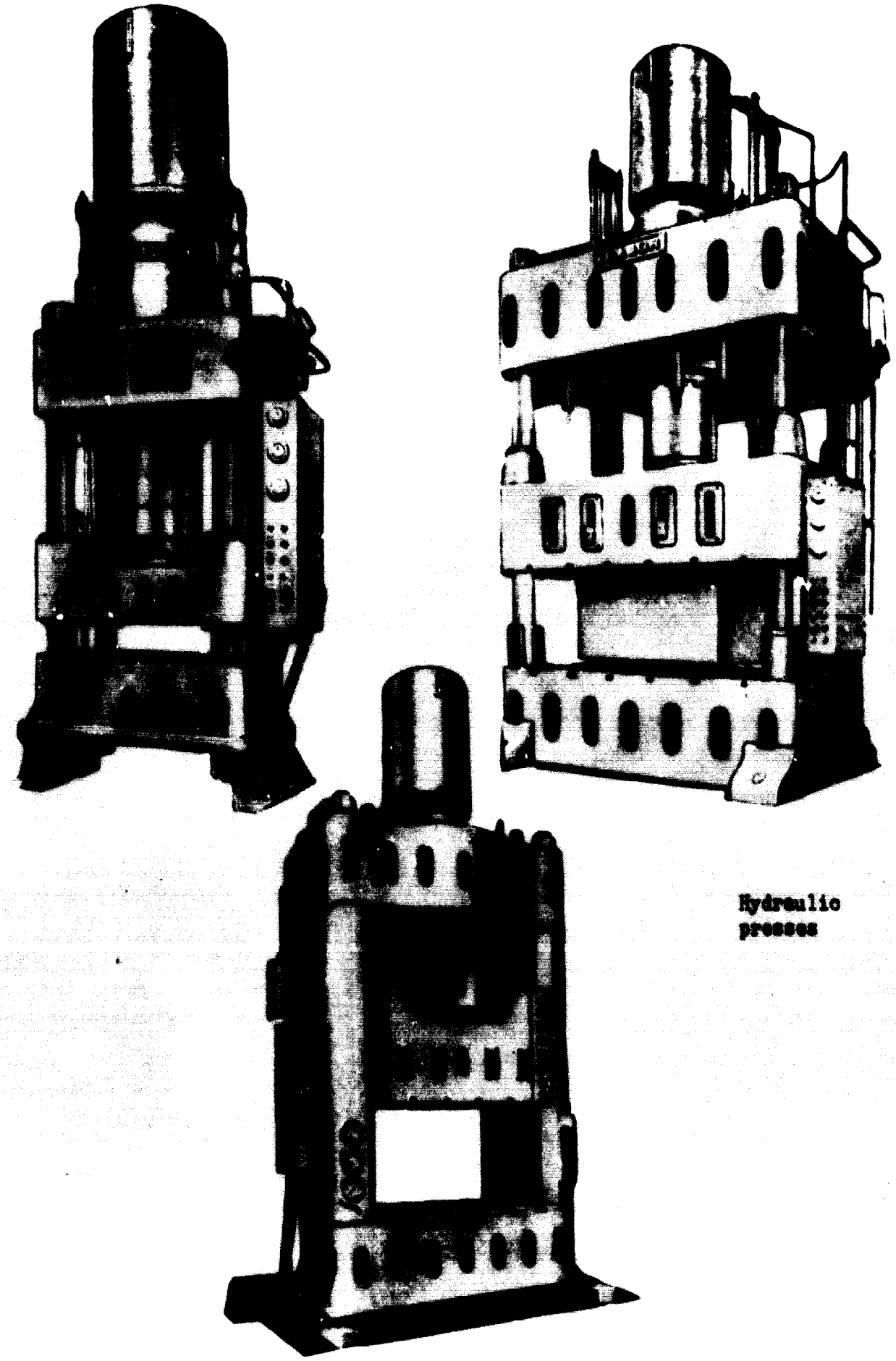




Folding machine

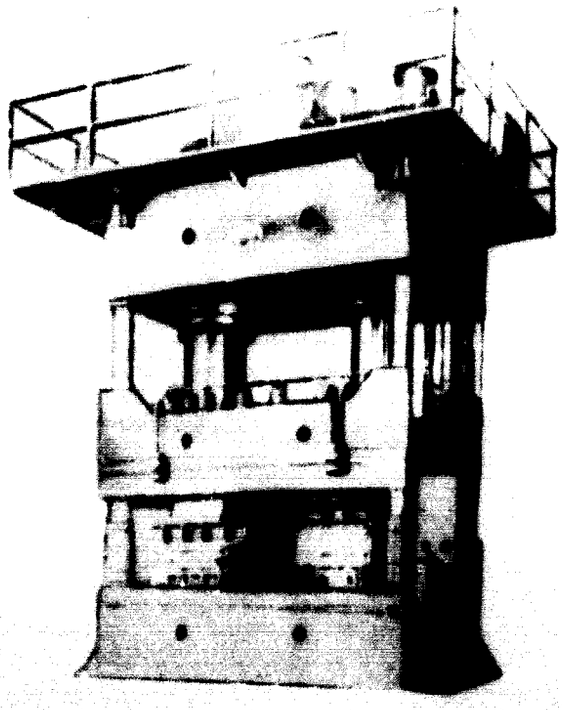
Guillotine



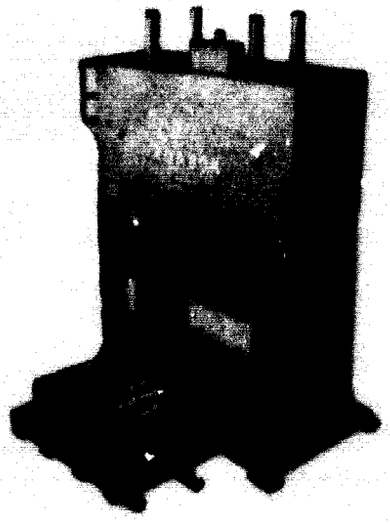


Hydraulic presses

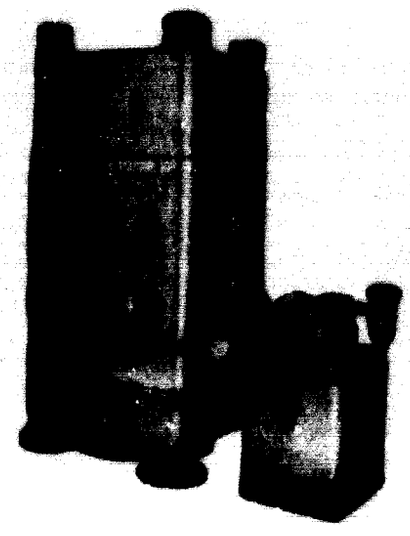
Presses



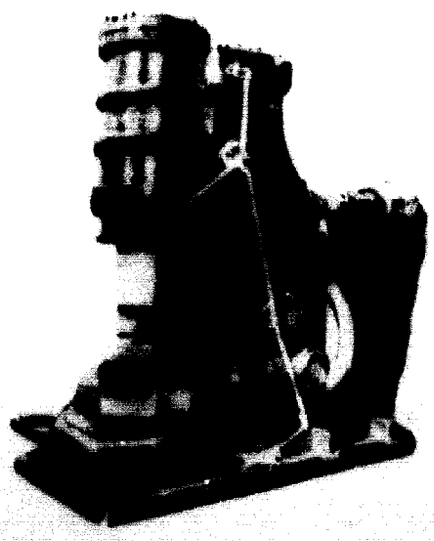
1,000 tonnes. For drop forging and stamping of metals, with a table 3,500 x 2,000 mm.



Hydro-mechanical 50-tonne press



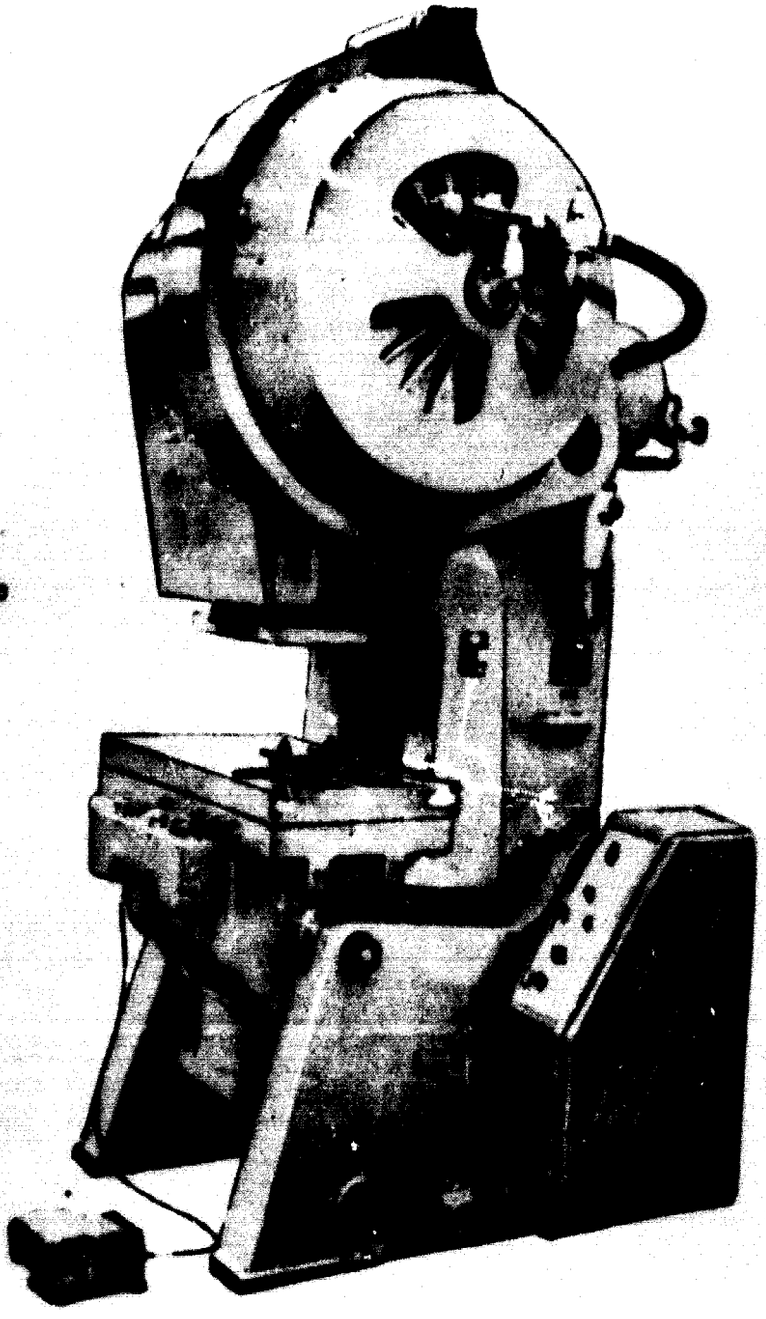
Die-sinking press



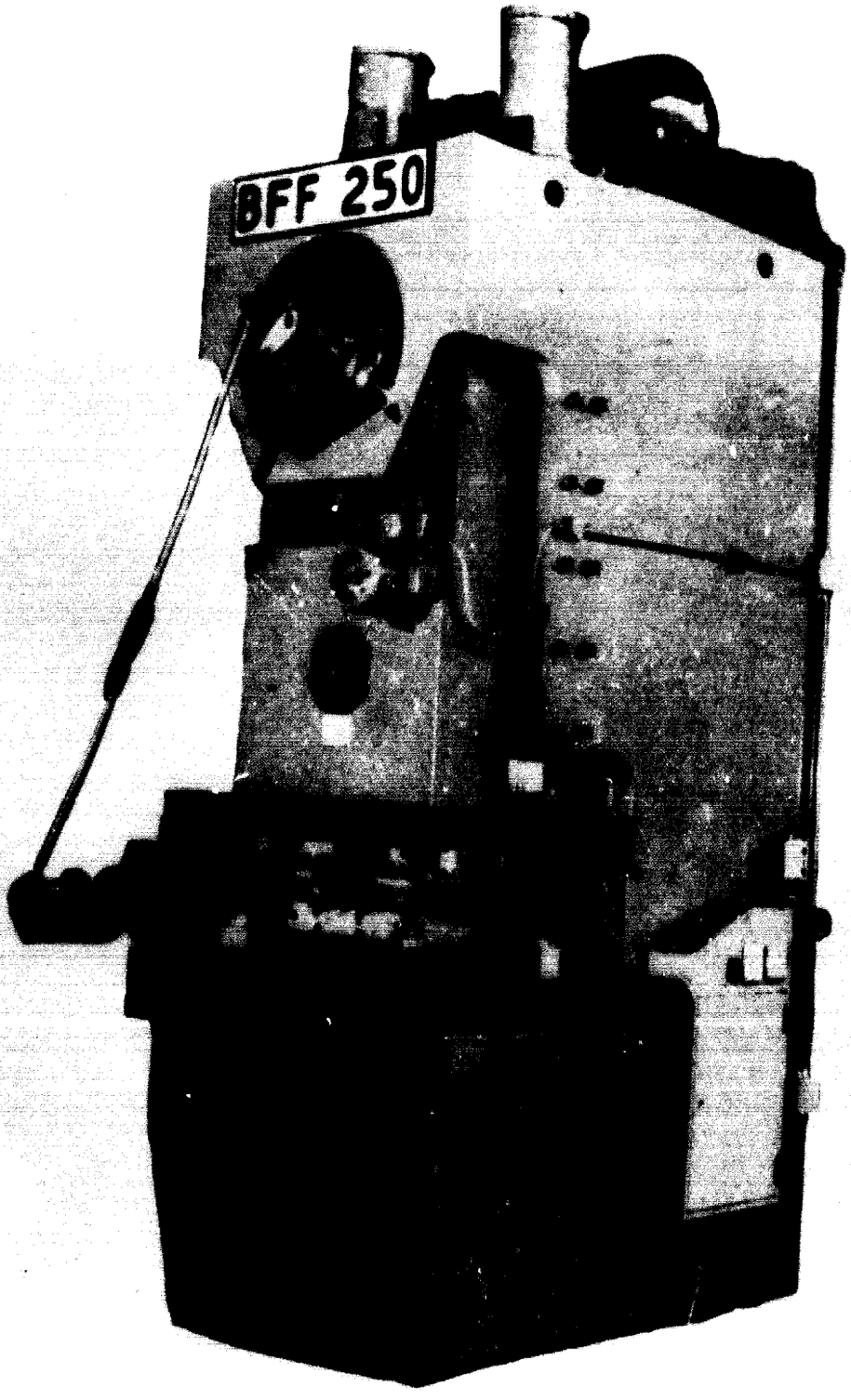
Drop hammer

Forge hammer

Friction press



Excentric press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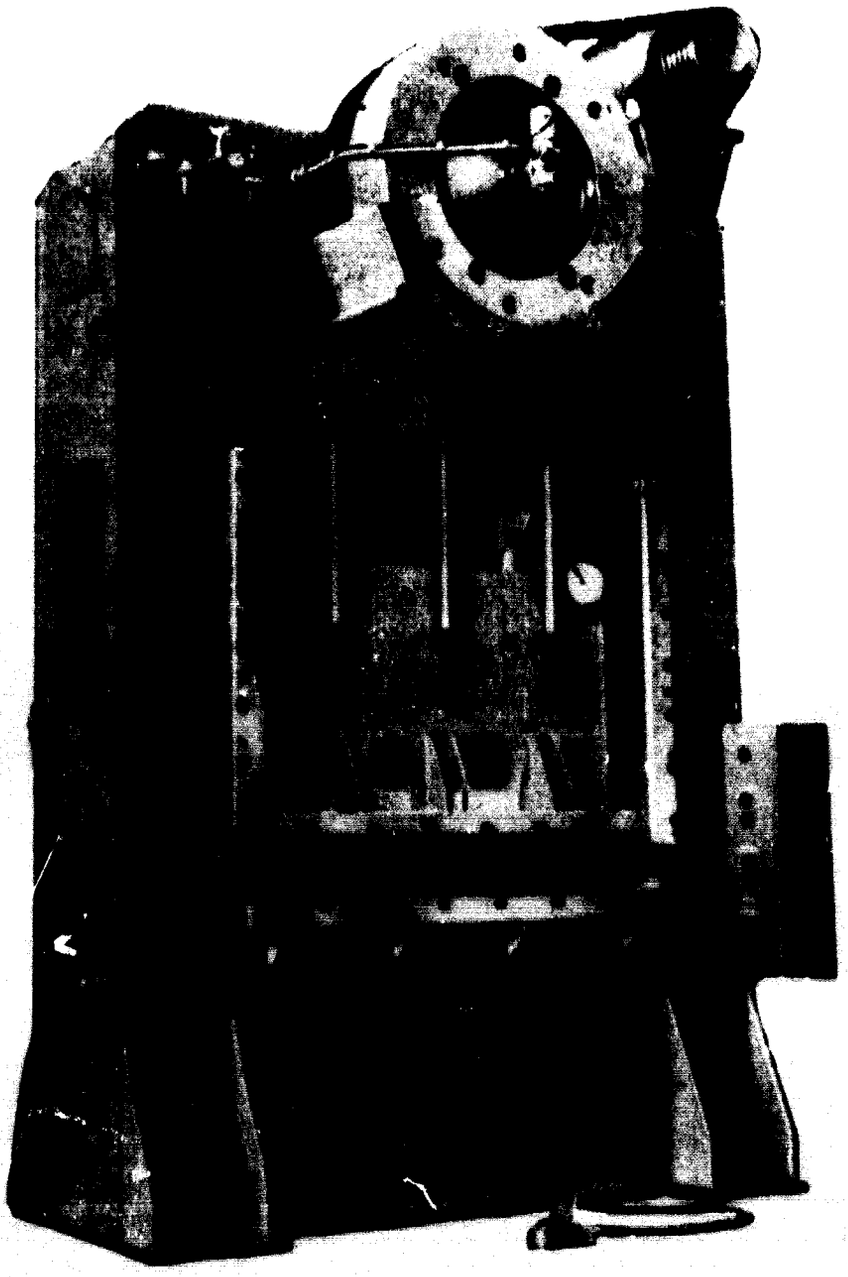
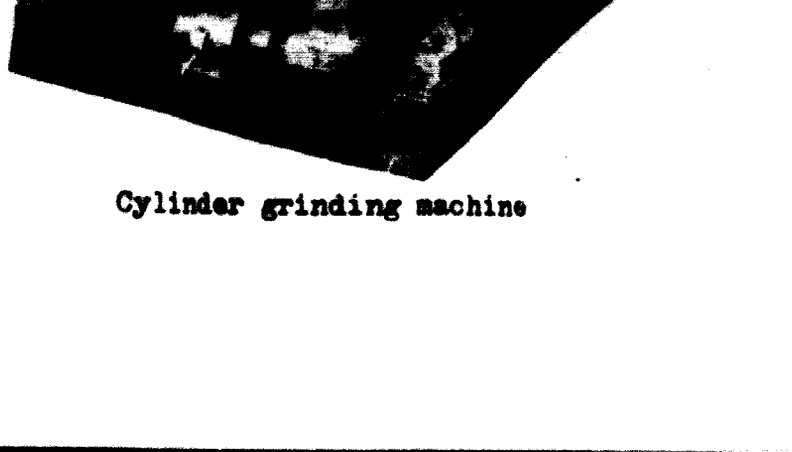
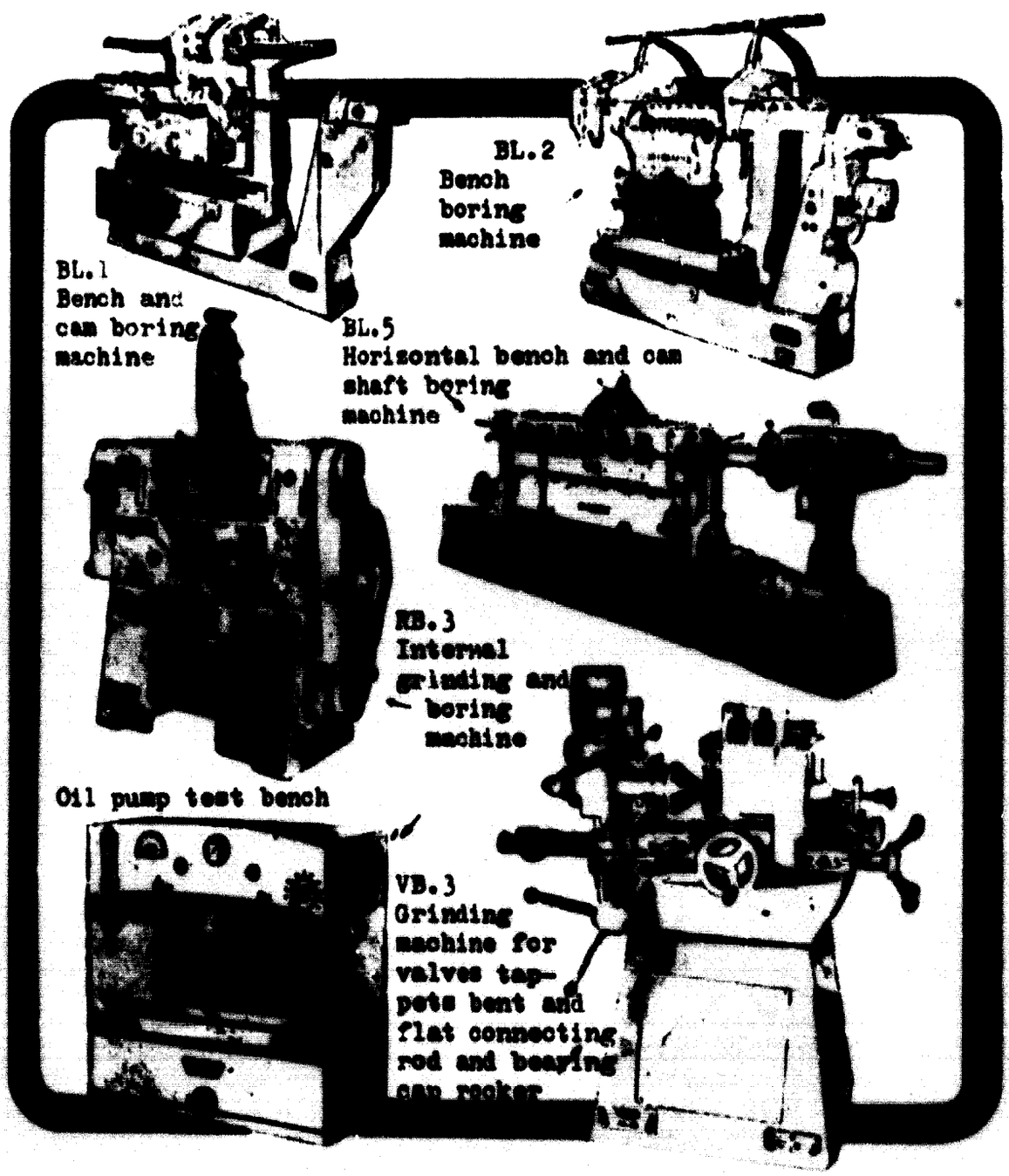


Balancing machine

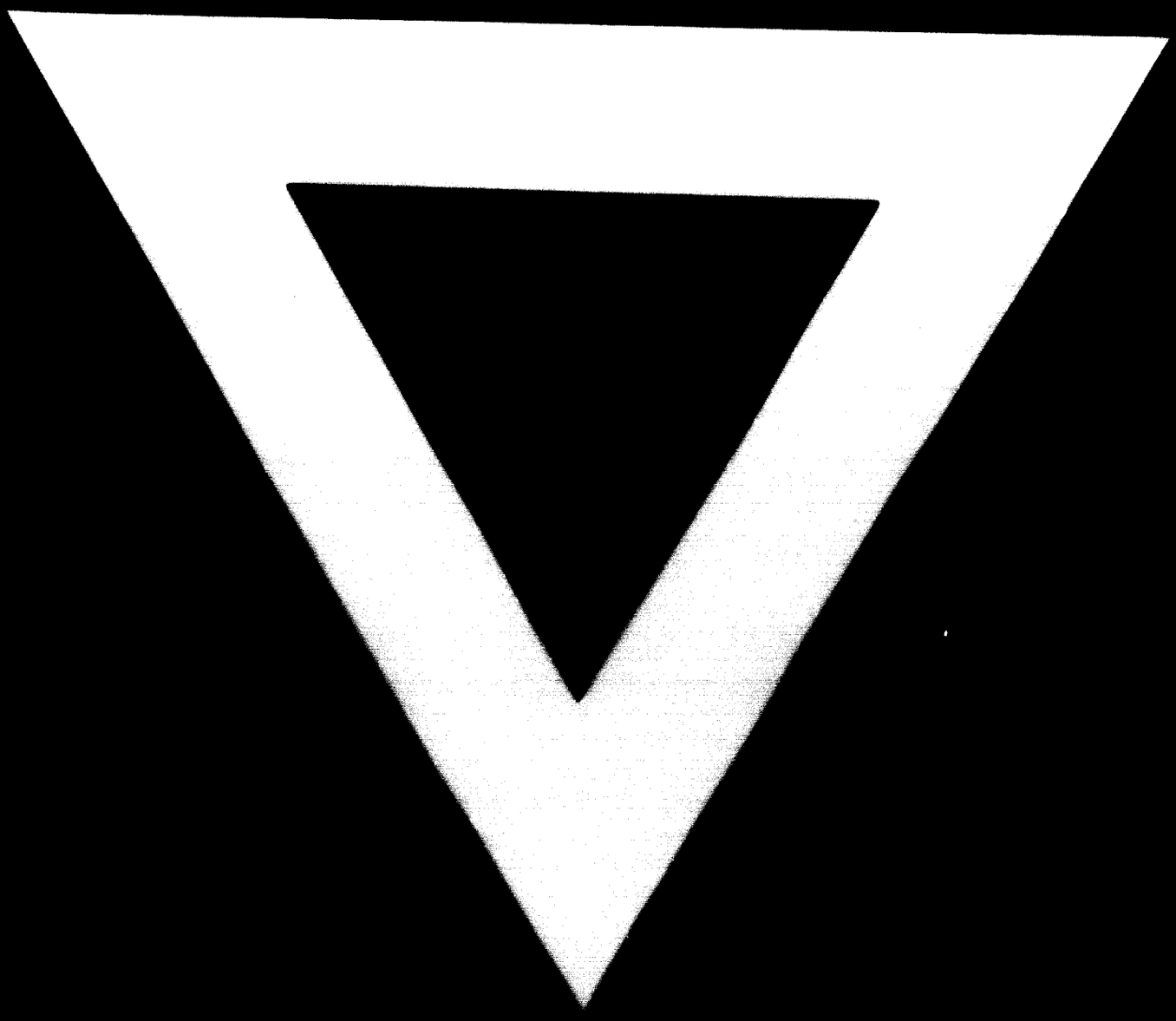
Combination universal machine



Cylinder grinding machine



Machines for motor vehicle workshops



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