JAPAN FORMING MACHINERY ASSOCIATION

2012

Technology Guide of Forming Machine

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INDEX

Introduction

1. Current Situation of Japanese Press Industry

Recently, the environment of manufacturing that surrounds the metal press processing industry and the press machine manufacturers has changed greatly.

The press work of the metalworking method that exists for a long time has also changed.

The new object material of the press work appears every day, and the machines and the dies etc. corresponding to it have changed in terrible speed.

Though the quality improvement of processed products is always requested, a lot of companies began to deal with an excessive quality by distinction between part where high quality is demanded and part not demanded. The attempt to consolidate all processing to the final product around the press work for the pursuit of reduction in costs that is an eternal problem is increasing drastically, and the users of the press machine are aiming at the pursuit of their original processing system.

Moreover, it is a situation in which China cannot be disregarded when thinking about a global manufacturing environment, regarding the cost of processing cost as important. Now, China is undergoing a transfiguration from the production base in the world to the large consumption country.

The recent key words of the press work are as follows;

1) Key word throughout the processing
   - High accuracy, complex, and difficult processing technology
   - Precise forging technology
   - Super fine press processing technology
   - Dry and Semi-dry processing
   - Forming simulation

2) Key word of processing technology
   - Net-shape
   - Progressive cold forging
   - Fine-blanking
   - Tailored blanking
   - Tube hydro-forming
   - Super high tensile steel board processing technology

Figure 1-1 Servo press system

The above-mentioned are a part of the key words, and the theme of the press work is increasing greatly.

As a result, there is a change in production conditions, as follows;

1) Diversification in material processed
2) Diversification in product quality
3) Diversification in structure of die
4) Diversification in processing process
5) Increasing of user's original processing system

Those progressing processing technology and the diversification of production conditions became a starting point to request a big revolution for the press machine.

As it is said, "Rush into to a serious mega-competing age", such a big revolution element is making a new trend in the press industry.

The press work (plastic forming), the processing method of the metal existed from the ancient times. Tools necessary for life was made through the process of beating it with the hammer to a required shape after the chunk of metal had been made.

And, it developed rapidly in recent years as the main processing means for mass-production, for example, the car.

The basis of the press work is to transcribe the shape of the die in the material by putting the material between divided dies, and to give a certain power to the dies.

The machine designed to give the die reasonable movement with the addition of high power, that is, a press machine. The simple reciprocation of a slide was required to keep accuracy and safety for a long time as a function of the press machine.

However, a big change in the manufacturing environment brought the diversification of all the production conditions, and a revolution of productivity, a revolution of the production system, and the correspondence to a new production environment has been requested of press machine.

Thus, the golden days of the crank type machine press and the hydraulic press for about 100 years see the ending symptom by these revolution requests, and the "servo press", such as a mechanical servo press of servo motor direct drive structure, a mechanical servo press of servo motor drive with the combination structure of the ball screw and the link mechanism, a hydraulic servo press using servo valve, a hydraulic servo press of system to drive hydraulic pump directly by servo motor, were appeared. The appearance of the machine built in a servo motor as a "servo press" is very recent though the servo technology has been applied to various machine and devices so far.

Great expectations are focused on such a new press machine, which completely changes the concept of the press machine and becomes a big technical improvement in the press machine industry where a long history exists. The element of many kinds of production technical improvements, such as the one concerning the above-mentioned processing key word,

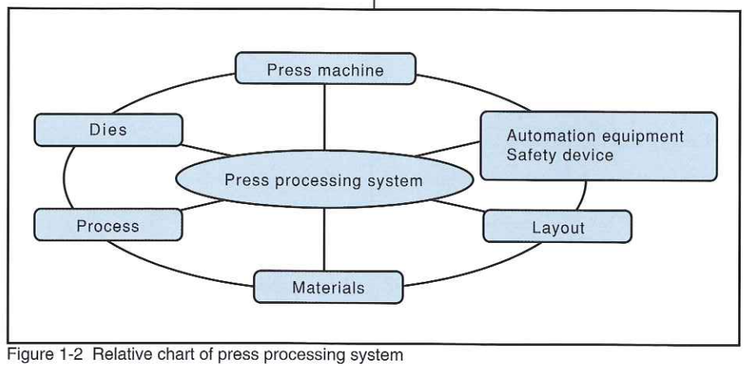


Figure 1-2 Relative chart of press processing system

improvement of productivity, the achievement of the processing environment of low noise and low vibrations, and a structural reform for the energy reformation etc. are built into this "servo press".

Figure 1-2 shows a basic form of the press processing element. The requested revolution is based on this element.
The servo press that tries to obtain a technical lead in the world starts appearing from this processing element form, and is growing up exceeding this frame.
The servo press will be able to offer the new processing technology and the environment for the new business development that makes the best use of the new technology for the metalworking company.

It is said that the "rapid-prototyping" is paid to attention in various revolutions requested of the press work in the 21st century. This is a technique to finish up the product in the stage of the drawing very early. The production technique offered with the function of the servo press is the one which realizes this "rapid-prototyping" at the same time.

Moreover, the extension and expansion of "Energy supply and demand structural reform investment promotion tax system" for which we appealed to the METI (Ministry of Economy, Trade and Industry) is decided, and has been constructed since 2004 fiscal year. This means that the application time limit of the object equipment is extended for two years, and "Servo drive type press machine" and others were added newly. It is because there is a conviction that various advantages of the servo press activate various activities of the press industry on the background where such an administrative measure is admitted.

There is no standard to promote standardization now because the servo press is a new technology, and we will promote the standard making. For the future of the servo press machine which has a big influence on the manufacturing environment in the world, aiming at safe base machine making of the acceptance in the manufacturing premise became our big proposition in the future.

The servo press is a machine in new age that can surely do the requested revolution, and a hero of the 21st century that promotes the development of the press industry.

2. What is the Servo Drive Press Machine ?

About 300,000 press machines are now operating in Japan. The kind of the press machine such as the mechanical press, the hydraulic press, bending machine, and shearing machine is numerous and a lot of crank presses are used among those presses overwhelmingly. It is because it's capacity, operation easiness, and the price, etc. were suitable on both sides of manufacturing and the introduction.

The crank press still keeps prosperous in present market, and the processing is approved by satisfying " Three basic capacities " (① Pressure capacity ② Torque capacity ③Energy capacity) that this machine originally has.
In these three basic capacities, the energy capacity is very much related with the speed of the slide and is especially important for the recent highly difficult forming processing and the blanking.
Figure 1-3 shows the crank press. The source of all the capacities is a flywheel, and the energy capacity is called " Flywheel capacity ".
The capacity of the press is invented by the flywheel, mere the mass of iron, rotating at a certain velocity. And, the moment of inertia by it's rotation, that is, the flywheel energy becomes the source of the press working. Therefore, when the weight of flywheel is large and it's rotation speed is high (in a word, the speed of the slide is fast), higher energy is generated, and the crank press can do bigger work.
However, it is understood that the lower processing speed (slide speed) improves the accuracy of the product in various processing. And also confirmed that it has a good influence on the durability of the tool and the press machine, a remarkable effect is confirmed on the production environment such as the processing noises and the vibrations.
Therefore, the contradicted demand of " wanting a big energy and a slow speed in processing " arose. It was a big dilemma for the past crank press, and it could not satisfy both things at the same time.

Moreover, to obtain a big energy, the press machine of a high rank (big capacity) was necessary, though it's big processing load (pressure capacity) was not necessary occasionally.
These were a big problem for the crank press, and the problems existed for a long time. Recently, several companies started the research and development so that they might cancel this contradiction without losing productivity. The link press was developed in the United States about 40 years ago, and various types of the link press were appeared in the market also in Japan afterwards. That was a press machine which tried to cancel big contradiction of the crank press. Though the slide curve of the each manufacturer's machine was various, it was similar that the slide speed was slow in the vicinity of the bottom dead centre and high in the vicinity of the upper dead center. The slowness of the slide speed at the bottom dead center is not produced by lowering the rotation of the flywheel. Because each manufacturer developed an original link mechanism, and slowness was produced mechanically, it was able to satisfy the user's demand " the processing energy is large and the speed is slow ".
However, the user's demand swelled further. They requested

> " A machine with more slow speed that could be stopped at the bottom dead center, had good productivity, high energy and the processing flexibility "

There is such a historical background, and, recently, the press machine manufacturers in Japan are pouring big energy into the development of the servo drive type press machine. This is the reason that the crank press was most popular in the market and the user's demand was also high to it.

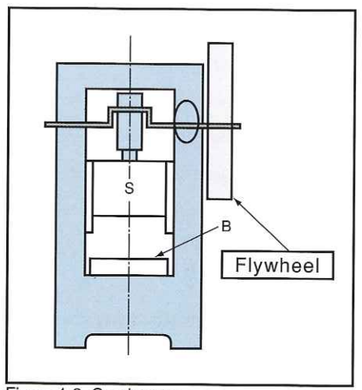


Figure 1-3 Crank press

Last year JFMA questioned the member concerning the servo press machine. (25 companies answered, including plural selections) In the content of the question, we introduce the excerpts of the part concerning the development concept of the servo press.

Q-1

What model(kind of the press machine) is the servo being installed now ?

Mechanical press	16
Hydraulic press	7
Screw press	4
Turret punching press	1
Press brake	4
Others	2

Q-2

For what market was the servo press which your company manufacturing now developed ?

Automobile industry	17
Consumer electronics industry	14
Metallic goods industry for architectural material etc.	7
Semiconductor industry	5
IT equipment industry(semiconductor is excluded)	9
Others	4

(vending machine, vehicle, lighting, telecommunication equipment, plastic card, carbide tool and ceramics)

Q-3

What kind of productivity improvement do you think that the servo press contributes to ?

A company :

①Decrease of defective product

②Decrease in abrasion of die(extension of die maintenance period)

③Decrease in number of processes (decrease in number of die and scale down of press machine)

④Decrease in total pressurizing power (scale down of capacity of press machine)

B company :

①Processing of hard processing materials

②Coexistence of high quality and high productivity owing to a low-speed processing and a high-speed rise and descent

③Task improvement by synchronization with peripherals

C company :

①The layout is free because the equipment composition is simple, and the line is compactly installed.

D company :

①Shortening of arrangements time

②Improvement of processing speed

E company :

①Productivity improves in total because it can reduce a defective rate, inspection, the die preparation, and the maintenance for a highly accurate processing and the high-value-added processing of the high-strength steel board (carbon steel, spring steel, stainless steel and non-iron, etc.) including the high tensile strength steel.

F company :

①Improvement of SPM in transfer processing

②Improvement of SPM in progressive processing

③Improvement of productivity for hard-to-process area

G company :

①Improvement of yield ratio owing to the stability of accuracy

②Reduction of accuracy confirmation work

Q-4

In what processing does the servo press demonstrate the effect ?

1) Shearing · Punching : 20 companies

Improvement of processing accuracy	16
Improvement of processing speed	4
New material processing	11
New processing method	9

2) Bending : 18 companies

Improvement of processing accuracy (reduction of spring back etc.)	17
Improvement of processing speed	3
Expansion of processing range	9
New material processing	10
New processing method	2

3) Drawing · Forming : 21 companies

Improvement of processing accuracy	17
Improvement of processing speed	2
Reduction in number of processing (improvement of drawing ratio etc.)	12
Expansion of processing range	12
New material processing	13
New processing method	3

4) Compression forming : 16 companies

Improvement of processing accuracy	14
Improvement of processing speed	2
Reduction in number of processing	5
Expansion of processing range	8
New material processing	5
New processing method	4

5) Complex processing : 7 companies

- Accumulating (Accumulating of different kind and different thickness materials)
- Double action compression forming using differential pressure, Punching
- Punching & Forming
- Tapping
- Simultaneous processing of double parts
- Laser & Press processing(speed adjustment in laser processing)
- Compound processing in assembly line (preliminary caulking of parts A by synchronization with the robot → slightly raise the press slide → put parts B on A and caulking, etc.)

6) Other processing : 5 companies

- Powder forming (stability of quality : crackles)
- Conversion from cutting to press work (change of processing)
- Guarantee of press fitting position and input pressure
- Press fitting under pressure control
- Caulking & Coining
- Forging
- Stability of quality
- Reduction in number of processing
- Highly accurate operation and the shock-less control contributes to the die life
- Various kind of Examination machine

Q-5

Do you think that the servo press is effective in the improvement of the processing environment ?

Low noise : 20 companies

Low vibration : 15 companies

Energy saving (power consumption decrease) : 16 companies

Cleanness : 12 companies

Others : 5 companies (decrease in amount of wasted oil and processing oil, and decrease of maintenance frequency)

Q-6

Do you think that the servo press has a good influence for the dies ?

Prolongation of the life : 20 companies

Reduction in number of processing : 12 companies

Simplification of structure : 12 companies

Reduction in costs of material and heat-treatment : 5 companies

New structural dies : 9 companies

Reduction in amount of anointment : 5 companies

Simplification of cooling structure or no need for it : 2 companies

Others : 4 companies (prevention of galling and burning, control of heat generation) (setting of the motion matched to the characteristics and the maintenance period of die material) (decrease in the entire pressurizing power and local stress in powder forming. It depends on the stress leveling of the combination die.)

A main purpose of the development of the servo press is user's easiness to use as showing in this investigation result. The feature of each developed machine appears well in the effect of processing and the influence on the die etc., because the idea of each company is reflected in the structure of the machine and the target of the processing.

Each servo press manufacturer keeps making an effort to answer a full demand of the user

" The machine with more slow speed that could be stopped at the bottom dead center, had good productivity, high energy and the processing flexibility "

In addition, the manufacturers should accomplish another big responsibility to he user. It is a safety securing of the servo press machine.

To examine the basis of " the servo press made in Japan " that tries to fly away to the world now in order to supply a safe machine to the processing industry in the world which is greatly progressing, now, we report this research investigation concerning standard and standardization of servo drive press machine.

Feature of Servo Press

1. Superiority of processing with Servo Press

The press work is the one to make the material a product with the die installed between the slide and the bolster by the simple vertical (or horizontal) movement of a slide, regardless of the kind or the structure of the press machine, and the processing method that transcribes the shape of the die in the material. In other words, the machine thought to give reasonable movement to the die as a forming tool is a press machine. It was a past mission of the press machine to give the die the reciprocation that had power with high accuracy though it was simple.

Diverse-types-and-small-quantity production was demanded with the change in the age, and correspondence to various diversifications became indispensable recently though the press work was used for mass production and developed greatly.

That is to say the correspondences to ① Diversification of the processing materials, ② Diversification of the processing process, ③ Prolongation of the life and diversification of the structure of the die, ④ Diversification of product quality, ⑤ User's original processing system etc., and demands of the market for the press machine at the same time.

Thus, the demand for the press machine is " A press machine that can make the slide speed slow at processing and fast at not processing, with high energy ability, can make the program of operation pattern according to the processing application, and also corresponds to systematization (computer-link) ", and this exactly becomes the feature of " Servo Press ".

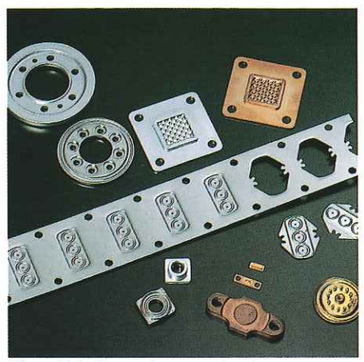


Figure 2-1 Processing sample of servo press

Though the press work is a kind of the metalworking method, there are a lot of applications, and each processing content is complex unlike other processing methods.

The classifications based on the mechanism of the processing are as follows when a similar processing is brought together. And each one contains a lot of kinds.

① Blanking
② Bending
③ Drawing · Forming
④ Pressing
⑤ Others

For instance, shearing, blanking, half-blanking, trimming, notching, slitting, parting, and piercing, etc. are included in the blanking, and there are infinite kinds when a detailed name is counted. Including such a number of processing, we describe the feature of the processing by " Servo press " as follows.

1) Basic function of Servo Press

There are lots kinds of the press machine structure. The basic function does not change even if they are controlled by NC and changes into the servo press.

For example, the crank press has " Bottom dead center " the stroke end in the slide operation, and "Bottoming processing" pursuit of the processing accuracy in the bending or drawing with that point is possible. As for the servo press of the crank system, the element of low speed joins to the bottom dead center and the pursuit of the processing accuracy becomes more advanced.

In addition, making and selecting the best operation for various processing became possible because it was able to set the work motion of the slide freely.

① Swing motion for blanking
② Silent motion for fine blanking
③ Link motion for deep drawing
④ Knuckle motion for coining

This function remarkably changes processing conditions of a past hard-to-process material, and also contributes to the improvement of productivity greatly.

For the press machine before, operation started only by pushing the the run button when the operator turned on the power and set the condition of operation with the switch etc. Software did not exist there, and it was "Operated by whoever, it was the same" machine. The servo press is a machine of "Program" according to the condition of the processing material, the content of the processing, the die structure, and the automation etc., and the quality of product becomes good or defective depending on operator's idea.

Medium and large-scale press machine before were equipped with the optional feature of " Micro-inching " that was able to drive the slide at the speed of about 1~5SPM used for arrangements of the dies etc. While the servo press is equipped with the " Micro-inching " function as standard which is done by the manual pulse-handle etc. for a kind of the slightly moving mode.

2) Effect of processing and influence to the die

In fine-blanking, precise bending, drawing, projection forming, etc. when the servo press is used, the range of the processing such as the kind of processing materials and the processing limit etc. is expanded more than the past press machine.

" Drawing ratio " improves in drawing, and the range of drawing in one shot expands greatly. Moreover, the number of processes reduces exstremely especially in multi process drawing.

In bending, "spring back" decreases extremely by using the function to stop the slide operation at the bottom dead center as mentioned above.

Though, in the field of precise blanking, a special press machine and a special die for " Fine blanking " have been used, it is confirmed to be able to process considerable level also by using usual die adopting usual die-cushion as a back pressure with the servo press.

It is reported to be able to set the best speed for the material in the processing of the back and forth extrusion, and to be able to simplify the structure of the knock out from the top and bottom part (processing product putting out structure).

The processing example of effectively using the function of the servo press has

Figure 2-2 Processing sample of servo press

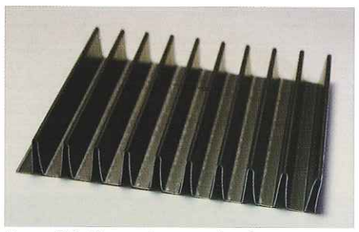


Figure 2-3 Processing sample of servo press

Figure 2-4 Processing sample of servo press


Figure 2-5 Processing sample of servo press

been reported a lot besides the above-mentioned, and it is said that some effects are shown in all the press work now.

The effect that the servo press gives the die is large. It is also reported that comparing the servo press with the past press machine, the die life becomes 10 to 20 times longer when using the same die.

In blanking, the point of the blade of the die might sometimes momentarily reach 500 to 800 degrees, and the die is damaged remarkably because of the high temperature and wear-out. The rise in heat and wear-out decrease when the speed is lower, and the damage degree of the die becomes greatly smaller than the same processing done at a high speed.

Being able to set various operation parameters such as slow at processing and fast at non-processing etc. for the die in complex structure (ex. Multi-step cam type die, progressive type combination die, and die with built-in tapping, etc.) leads to the improvement of productivity, and becomes the result of extending the die life.

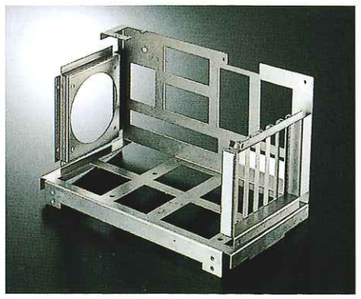


Figure 2-6 Processing sample of servo press


Figure 2-7 Processing sample of servo press

The new one joins the object material for the press work every day. It is thought that processing conditions of the press and the structure of the die will become more complex in the future by the change of the material such as the super-high-tensile strength steel for the auto sector and the magnesium alloys from which the application in various fields is expected and the changes in the processing method for that new materials and the change of structure of the die.

Therefore, the setting of the operation parameter meeting with the processing method and the condition of the die is indispensable to think about the overall productivity, and the expectation and the necessity to the servo press are high.

Moreover, there is a forecast that the press machine which is the mother machine of the plastic forming will be made to possess many multipurpose element in the future, too.

Providing with the free setting of slide operation and the big output energy, the possibility of the servo press of expanding the range of the processing to not only the genre of forming but also the genre of cutting and the combination processing is high.

When an eternal theme such as global production and reduction in costs is essentially considered, the press work will face a new phase mainly composed of a precise processing.

2. CNC control and expansion of the system

Among the processing machine group that is called a mother machine, the one that operates only by pushing the run button without the software is a press machine only which remained at the end. For the machine controlled with NC, it is necessary to set the operation program, and some software exists there.

If software doesn't exist, there was a fault that the machine can not be set easily as a unit to a series of processing system, although the machine of simple operation which doesn't need time at operation was very desirable.

In the meaning of the above-mentioned point, the servo press controlled with CNC was able to become one unit that composed a flexible production system.

For instance, the production line where one part is made with the unit of A, B, and C is composed. The operation schedule of the processing unit and the material transportation unit exists there and the processing will be advanced while confirming the operation each other, when B unit operates by two cycles after A unit operates by one cycle and C unit operates in addition by three cycles to complete the parts.

Naturally, data is exchanged between each unit. Because this data communication cannot be done by the machine without software, it is not possible to build it in such a line as a unit.

The element of the automation is indispensable to recent press work.

The equipment of software and NC control is indispensable when the press machine is the unit that composes a part of the line system like a docking system with various machine tools or robots and when you form the system inside or around the press machine like an automatic switching system of the die.

One feature requested from the servo press is an expansion of such a system(computer link).

" Flywheel " to generate big energy was a critical factor on the mechanism composition so far for a mechanical press. However,the flywheel is not used for a present servo press excluding some exceptions. It is because there are circumstances that aservo motor with big output that invents high power to install it in the press machine was developed because all sources of the energy of the servo press are in the servo motor.

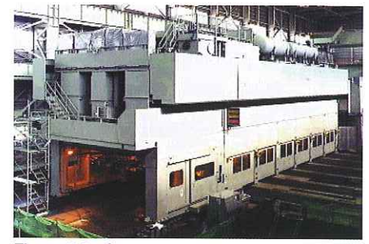


Figure 2-8 Servo press system

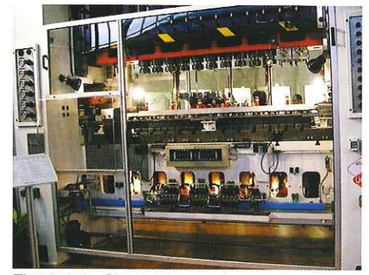


Figure 2-9 Servo press system

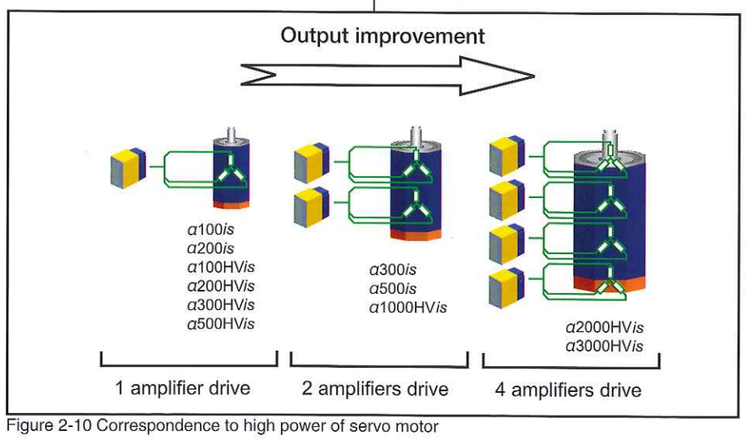


Figure 2-10 Correspondence to high power of servo motor

Moreover, the technology that drove the motor in parallel with two or more servo amplifiers was developed, and the servo motor became possible having a big output, and obtained high reliability. (Figure 2-10、Figure 2-11)

However, the motor of big output needs big electric power for the drive. Therefore, if the servo press needs electric power several times larger compared with a past press machine when equal work is done, the commercial value of the servo press will extremely fall. "Energy saving" of the servo system was researched to cancel this anxiety, and the mechanism was commercialized.

" Resurrection mechanism of energy " described later is a condition of the servo press machine recognition in "Energy supply and demand structural reform investment promotion tax system" explained in Chapter 1.

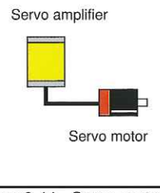
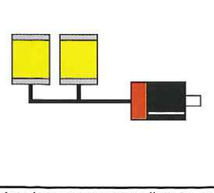
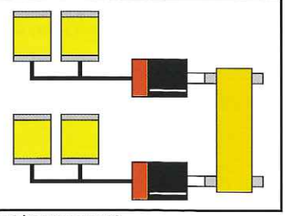
Output energy rising with one motor and one amplifier (under 60kw)	One motor driven by more than one amplifier (60kW～250kW)	Feeding spindle driven by more than one servo motor (over 250kW)
		

Figure 2-11 Servo system technology corresponding to output improvement

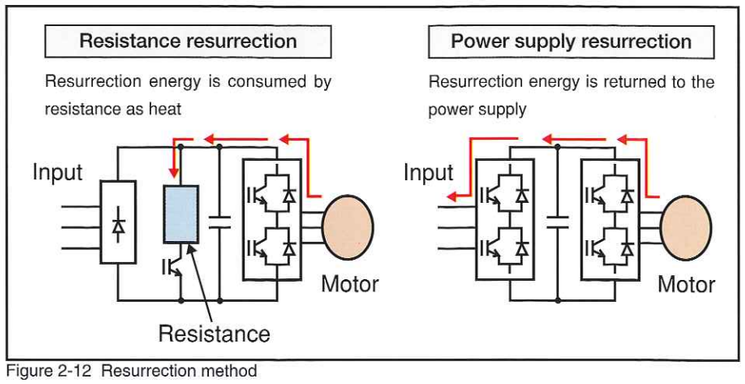


Figure 2-12 Resurrection method

Resurrection mechanism of energy

When deceleration, it is necessary to collect the consumption energy as a " Resurrection energy " except the consumed amount by forming or friction, which is used for acceleration of servo motor and was converted into the kinetic energy by driving system (movement of the press machine). As for the resurrection energy, the method (resistance resurrection) with which the energy is consumed by resistance and discharged as heat is common now. And the power supply resurrection method to return the power supply the resurrection energy aiming at energy conservation was developed, and it was adopted for the high power servo amplifier. (Figure 2-12)

The point of the feature of CNC used for the servo press can be summarized in the following items.

①High power output at moment

The energy ability of the servo press is decided by the max torque of the servo motor. Though the continuous average output of servo press is smaller than a past mechanical press, a high power at the moment is necessary according to the content of the processing, and the composition and the software of the CNC equipment considered enough about the power-supply voltage descent at the maximum current and maximum output are necessary. Servo motor, servo amplifier, transformer, detector, power cable, etc.

②Continuous high power output with small servo motor

It is easy to treat a motor as small as possible. Moreover, because an important performance that competes for the speed of production is demanded from the press machine, the ability of the continuous output torque of the servo motorshould be high. The structure of the servo motor should be improved, because a continuous torque is decided by the ability to overheating besides the max torque at the moment.

③Correspondence to high power output (Mentioned above)

④High reliability

Because the press machine is a machine that competes for the speed of production, it always operates without the rest and the utilization rates is extremely high. It's frequency of the acceleration and deceleration is very high compared with other machines. Moreover, the press machine should give mechanical strength to the impact power to the servo motor installed directly by the machine because it might become " Vibration generator " according to the content of the processing. Moreover, the press machine might become "Vibration generator" according to the content of the processing. Therefore, it is necessary to give mechanical strength to the servo motor directly installed in the machine, which endures the impact power.

Enough consideration is necessary for the design because it is used under very rigid conditions as a big current always flows repeatedly, and a big impact is given from the outside (main body of the press machine) to the motor.

⑤High efficiency

High efficiency is requested in every area from the low SPM (low speed rotation of servo motor)to the high SPM (high speed rotation of servo motor).

⑥Decrease of power consumption (Mentioned above)

⑦Technology corresponding to high power(Mentioned above)

⑧ High precision

The servo motor always does accurate operation by the instruction based on the feedback data from the detector (encoder and others) installed in the motor shaft and the machine. It should correct the change by the vibration and heat etc.occurred in press work, regardless of the control forms such as " Full-closed feedback " and " Semi-closed feedback ", and always should do steady operation.

Especially, " Control by leaning function " is effective to improve accuracy when the same operation is repeated in the press work. It is a function that makes possible to follow to a periodic target input in high accuracy by adding the deflection data before one cycle in addition to the feedback control by usual deflection, and it is effective to the process that has repeated operational conditions such as the operation tracks and the load etc.

⑨Safety

It is necessary to stop the motor immediately when an alarm signal is received from the machine and when the alarm of CNC including the servo motor is recognized.

It should be a CNC in which high safety is established by a "dual-check" etc.

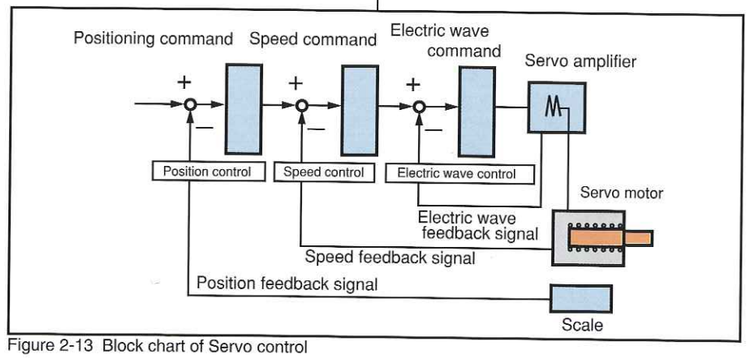


Figure 2-13 Block chart of Servo control

3. Superior point of Servo Press concerning environment, safety and energy

1) Reduction of noise and vibration

The site of the press work was considered to be a typical bad environment by noise and vibration.

The influence from the noise and the vibration that happens one after another on the human body is very large. The operators who have worked for long term on the site received the disaster of hard hearing, headache, and stomachache, etc., while they did not notice the cause.

Especially, the noise and the vibration of the blanking is violent, sometimes the roll-feed (coil material feeding device) which is adhered directly to the bolster has fallen on the floor due to the damage of welded part.

As for the influence given to the human body, danger of receiving a secondary disaster such as falls of the equipment besides an direct disaster like right figure is in a high level.

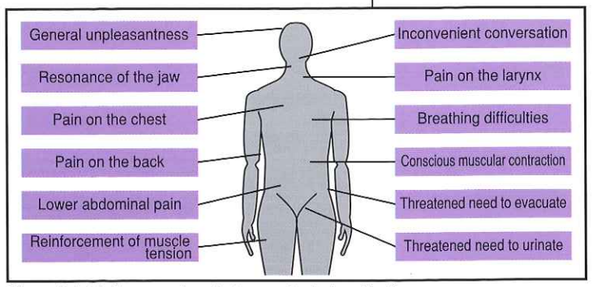


Figure 2-14 Influence given to human body by vibration

No.	Target	Measures
1	Noise・Vibration	Structure and model selection that can down the speed in processing area (ex. Link press, Hydraulic press) ※Before the model selection, having to examine overall production etc. is necessary.
2	Noise・Vibration	Machine selection that gives ability margin for the content of processing
3	Noise	Soundproof chamber (attenuated about -20～-30dB) ※Necessary having of the examination concerning the work like arrangements etc.
4	Vibration	Vibration absorption device (attenuated about -10～-20dB) ※Necessary having of the examination for the press shake during automatic processing
5	Noise・Vibration	Die : To give shear angle on the cutting edge ※Necessary to examine the status of the product and the scrap
6	Noise	Die : Size down of the board suppression plate, and the stripper plate ※Necessary to examine defective product avoiding

Figure 2-15 Measures sample for noise and vibration

The noise and the vibration of the blanking happen because the frame and the die of the press machine vibrate in impact breakthrough (load removal) by blanking the material. The vibration is generated because the elastic energy which has been saved by the press machine while processing is suddenly released at the time of blanking the material. Therefore, a thick material and a hard material generate a bigger vibration and a noise.

The measures to reduce the noise and the vibration had been sought so far, and there were both merits and demerits in any, and the effective one for any processing site was not found.

Because the dropping of the slide speed in the processing region of No.1 on the above table (breaking process of the blanking) reduces the breakthrough, it is very effective method.

However, this technique was kept at a distance in a past mechanical press, because the processing sometimes became impossible due to energy falling when the slide speed was dropped and the productivity fell too. (refer to Chapter 1, Clause 2, What is the servo drive press machine ?)

As for the servo press, the speed and the movement pattern of the slide can be programmed according to the quality and thickness of the material, the structure of the die, the ability of the press machine, and the finish extent on the processing side, etc.

Moreover, the best operation condition can be given to "two steps punching" die structure to punch the material twice.

It is the " Maximum processing environment improvement " for the people who works on the press processing site.

2) Measures for safety

For the past mechanical press, "Punching twice" is the No.1 among the accident factor on machine side. Therefore, the air-solenoid valve for the clutch and brake that does the start and stop of a mechanical press, has been developed and manufactured placing importance on the certainty of operation and the fail-safe for breakdown, as a special one for press machines.

Because for the servo press except a special machine, this clutch and brake did not exist, one of the past accident factor was naturally deleted.

In the meaning to pursue further safety of the servo press machine, we study the details concerning measures for safety further in another clause.

3) Energy saving

A motor of big capacity needs a high electric power for the drive as described in the preceding clause.

The adoption of servo press won't increase even if there are a lot of merits in the processing characteristic, if the servo press compared with a past press machine needs the electric power in multiple times. Therefore, " Energy saving " is an important point for the servo press.

The servo press needs energy supply only when the power is necessary, that is only when the processing time, unlike the mechanical press that keeps always turning the flywheel against the loss of energy nor the hydraulic press that should always drive the motor for the pump to keep the oil pressure.

Though the output value of the servo motor shows the ability of the motor, it is often misunderstood that this shows the energy consumed. Actual energy consumption is a sumtotal of the energy necessary for the processing, the internal loss of the motor and the amplifier, and friction energy in the machine.

When the consumption energy is measured, it might be only a fraction to 1/10 of output rating value of servo motor, though it is influenced by the drive system or the movement patterns.

Simulation of electric power consumption

As an actual movement of press, it was assumed that the servo motor was driven clockwise and counterclockwise, and shuttled between the upper dead center and the bottom dead center. Figure 2-17 shows the relation between the speed of the motor and the torque, showing a time in a horizontal axis.

For instance, when the speed of the press is assumed to be 60spm, deceleration of 120 times per minute is repeated and the resurrection corresponding to that amount is generated. Resurrection energy grows high by the frequency of start and stop, due to the high capacity motor and heavy weight of the moving part such as slide. So, it is an indispensable element to adopt the servo amplifier with the resurrection function for the servo press.

The contribution to energy saving and environmental preservation, in addition to the pursuit of safety, is highly expected of the servo press that will be introduced more and more in the future.

Press Machine Model "NS-1-1500(D)"	Material thickness	t = 4.5	t = 6.0	t = 4.5	t = 6.0
	Clearance of Die	2.0%	1.5%	10.0%	7.5%
Crank motion	Empty blanking	83.6	83.6	84.3	84.3
	Blanking noise	89.9	88.2	88.2	88.2
Silent motion	Empty blanking	72.1	72.1	71.1	71.1
	Blanking noise	76.8	76.0	76.7	77.4

Figure 2-16 Test result of blanking noise ※from AIDA ENGINEERING, LTD. (Unit : dB)

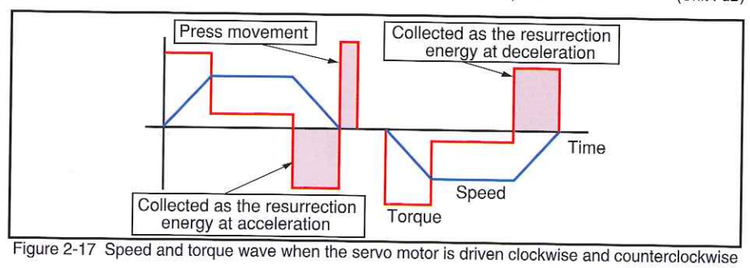


Figure 2-17 Speed and torque wave when the servo motor is driven clockwise and counterclockwise

Basic structure of Servo Press

1. Structure of Mechanical Servo Press

Kind of servo press in structure

①Crank shaft direct drive system (gear connection system)
②Crank shaft indirect drive system (link system)
③Crank shaft indirect drive system (belt system)
④Knuckle (toggle crank) system
⑤Ball screw system
⑥Linear servo system
⑦Hydraulic pump direct drive with servo motor system
⑧Servo valve (proportional control valve) system
⑨Hybrid system (combination of various mechanisms)

The kind of structure will increase if a new mechanism element will be developed in the future.
The object machine detail examined in the future was set in JFMA, as the Servo Press with servo motor for the driving source excluding the above ⑥ and ⑧.
The basic structure of those servo presses is introduced below.

Though the above ①～⑤ are all mechanical servo press machine, their structures are various.
The press machine of Figure 3-1, Figure 3-2 and Figure 3-3 is a mechanical servo press of a direct driving system to replace the flywheel and the clutch & brake part of the past crank press with a servo motor. This is a very easy-to-use machine for the user which takes over the merit of the crank press, and the structure is very simple, and not different from a past machine in the outside view.

The machine of Figure 3-4 and Figure 3-5 is a mechanical servo press with the structure to drive the slide by servo motor through link mechanism.
This was designed to use the servo motor of small capacity as much as possible, and the feature of this machine was to have achieved the power amplification by the link mechanism. The outside view is almost the same as a past machine.

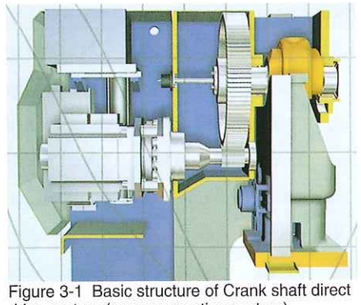


Figure 3-1 Basic structure of Crank shaft direct drive system (gear connection system)

Figure 3-2

Figure 3-3

Figure 3-5

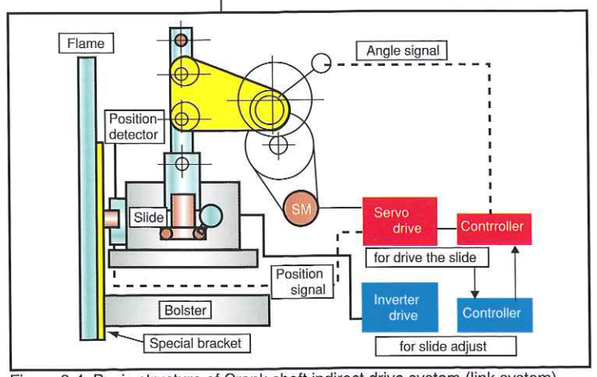


Figure 3-4 Basic structure of Crank shaft indirect drive system (link system)

The Figure 3-6 and the Figure 3-7 is a so-called Dieing machine with under-drive mechanism rotates crank shaft with a servo motor, and operates slide by toggle crank.

Figure 3-8, Figure 3-9, Figure 3-10, Figure 3-11 and Figure 3-12 is ball screw system servo press.
The slide is driven by ball screw and there are various mechanisms for the drive of the ball screw.

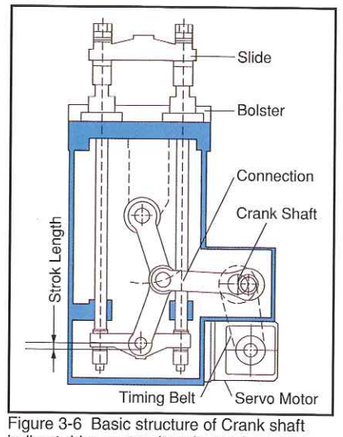


Figure 3-6 Basic structure of Crank shaft indirect drive system(toggle crank system)

Figure 3-7

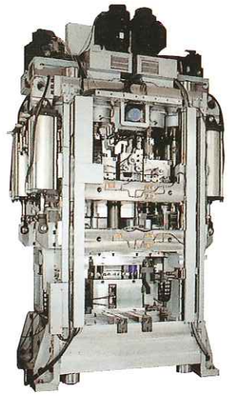


Figure 3-8

Figure 3-9

Figure 3-10

Figure 3-11

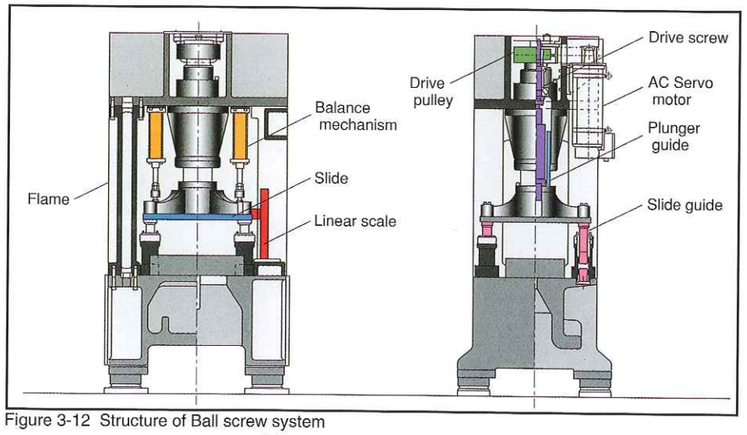


Figure 3-12 Structure of Ball screw system

Figure 3-13 and Figure 3-14 is also a ball screw system servo press. The ball screw is driven directly by the servo motor with the belt.

Figure 3-15, Figure 3-16, Figure 3-17 and Figure 3-18 are Hybrid type servo press of a system to transmits drive to slide from ball screw through toggle crank, which is suitable for the enlargement of the machine.

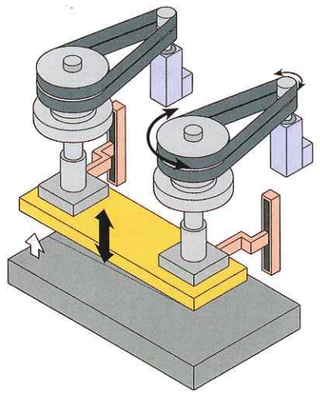


Figure 3-13 Structure of Ball screw system

Figure 3-14

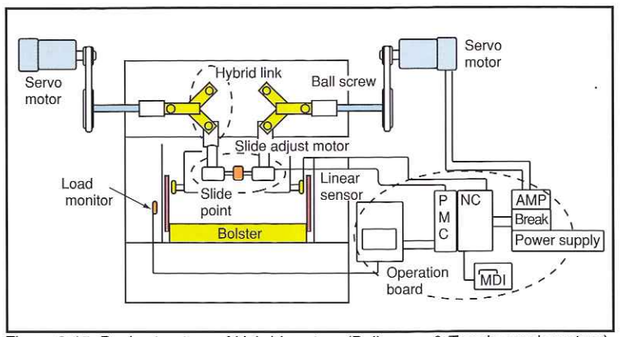


Figure 3-15 Basic structure of Hybrid system (Ball screw & Toggle crank system)

Figure 3-16

Figure 3-17

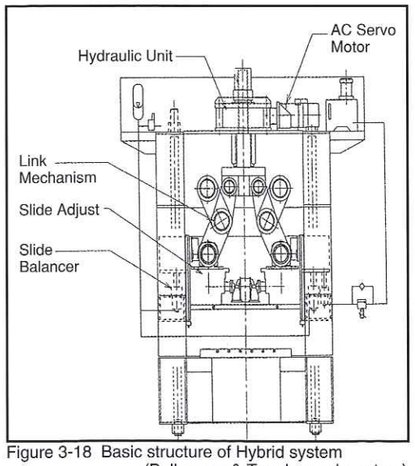


Figure 3-18 Basic structure of Hybrid system (Ball screw & Toggle crank system)

2. Structure of Hydraulic Servo Press

Figure 3-19 and Figure 3-20 are Oil hydraulic servo press of system to drive oil pressure pump as a driving source of oil hydraulic press directly with servo motor.

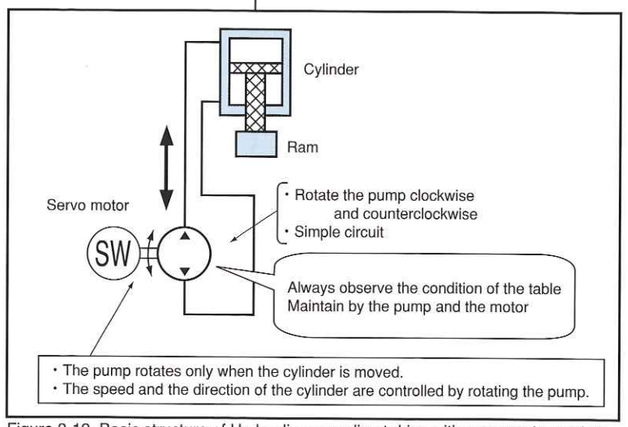


Figure 3-19 Basic structure of Hydraulic pump direct drive with servo motor system

There are various kinds of oil hydraulic servo press besides the type to control the flowing quantity of oil with the servo valve. There is a lot of oil hydraulic press that adopts the mechanism of Figure 3-19 recently.

Figure 3-20

3. Structure of Servo Punching Press

The servo punching press equipped with the servo in the punching mechanism appears recently though the most of the punching press were " NC turret punching press". The punching press of Figure 3-21 and Figure 3-22 is a servo punching press that drives the crank shaft directly by synchronous driving of two servo motors.

It aims at the reduction in the running cost by energy saving by doing a complete synchronous driving with two small motors.

Figure 3-21

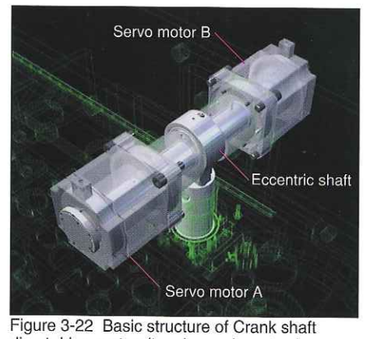


Figure 3-22 Basic structure of Crank shaft direct drive system(toggle crank system)

4. Structure of Servo Press Break

Figure 3-23, Figure 3-24 and Figure 3-25 indicate a servo press break. This is an oil hydraulic servo press brake of the system to drive the oil pressure pump as a driving source directly with a servo motor as well as the above-mentioned oil hydraulic press.

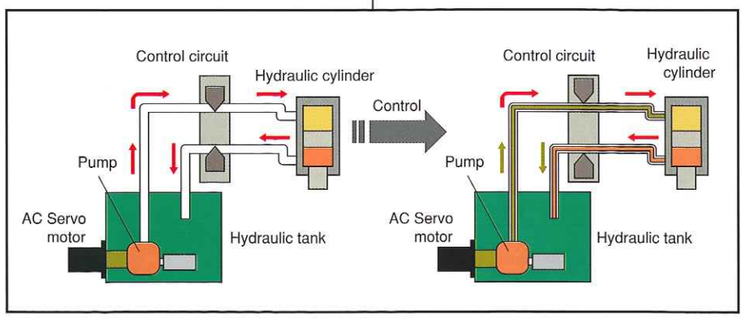


Figure 3-23 Basic structure of Hydraulic pump direct drive with servo motor system

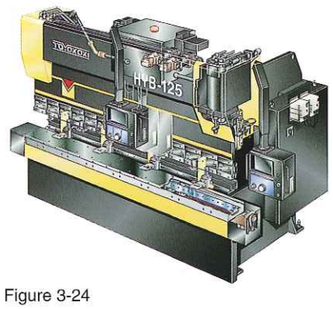


Figure 3-24

Figure 3-25

Examination concerning safety of Servo Press

1. Safety feature of Servo Press

In " Machine safety risk assessment guide ", The Japan Machinery Federation interprets that a machine under the condition where " The risk has been appropriately decreased " as a " Safe machine ". That can be read as " There is not any risk not accepted in general, or, it is a level in which all risks can be allowed under a certain condition ".

Recently, the safety of the machine is considered as a natural social responsibility of the manufacturing company requested by not only the machine user but also the society public. And, the social responsibility becomes an important index to evaluate the enterprise.

Under such circumstances, in order to promote the decrease of the risk of the machine, and the effort to make it safe by manufacturers and users, the Ministry of Health, Labor and Welfare made public " Index concerning inclusive safety standard of machine " , the standard concerning an inclusive safety strategy applicable to all machines in June, 2001.

In this index, it is assumed that the size of danger is caught by the concept of " Risk ", and the risk is decreased , saying that " Make the machine safe ".

Therefore, " Risk assessment " related to the estimate and the evaluation of the risk is to have to execute it in making the machine safe and it is to become the standard of the safety strategy.

The basic idea of the risk assessment are ①how to use which standard ②how to evaluate and decrease the risk ③how to secure the safety ④how to inform the user of remaining risk, at which stage of the machine design .

How should we think about the safety of " Servo press " which appeared in the market as a hero of the times and is spreading in the industry ? How we execute appropriate strategies to the risk, and how is the verification standard of them ? What should we do to keep higher safety compared with a past press machine ? And, how should we disclose information to the user ? The process and the result of the examination concerning these are shown below.

1)Starting point of essential safety for Servo Press

In the study of essential safety of the servo press, we set the starting point of the examination based on the " HAND-IN DIE " work (put the hand in dangerous zone) of the operator, in the same way as " Power press machine structural standard "

①In the both hands operation method, when setting for the press machine to stop if both hands are taken off the press start button while the slide is descending by inching of the servo press, safety when the hand is inserted is unwarrantable only with the stop by " Servo lock ".

②Under the same conditions above, the safety strategy " Both hands operation method " does not become an allowed

basic technique which secures essential safety of the servo press.

③How is the certainty of the operation of the mechanical brake that functions to the emergency stop and the urgency stop guaranteed ? And, how is their safety feature secured ? How can the system that stops urgently by the over-running detection when worn out by usual operation be given to the servo press, like a past press machine with clutch brake ?

④When the mechanical brake is used the emergency stop and to urgency stop, the brake performance and the inspection requirement need the monitor function of "Using two or more springs. Maintain the functions when the spring breaks down by 50% or more, and the brake performance is checked at appropriate intervals of time" as a machine structural requirement for the servo press.

⑤Regarding the reliability of mute system, the category of the control safety strategy needs the "4" or higher level because it causes the danger when the system configuration and the setting are mistaken.

As for the past press machine with a flywheel as a power source, the reversal movement at the moment was not assumed due the inertia of the flywheel. So, it is not possible to change into the descent process instantaneously while the slide is rising. Meanwhile, for the servo press, the malfunction by the noise etc. is assumed because the CW and CCW motion are controlled by the signal. Therefore, the defense strategy to the descent of the slide during the mute operation is necessary.

2)Various examinations concerning safety of Servo Press

In conformity with the above-mentioned starting point of essential safety, we examined the safety concerning the structure and the control of the servo press, and established basic measures to secure safety.

We examined the details of the control means and protecting in the control in order to execute the measures after the examination about the way of guarantee for the means and the conditions to insure safety. " Risk assessment concerning the control system : Measures for breakdown of the control circuit of the servo press " was executed as a final confirmation based on the result of these examinations. Moreover, the investigation of the current state of the safety feature concerning servo press systems of manufacturers that developed and manufactured the servo press was done on the way of the examination, and the result was edited as a comparison material.

Machine specification of Servo Press manufacturing

1. Crank shaft direct drive system

Model			NC1-800(D)	NC1-1100(D)	NC1-1500(D)	NC1-2000(D)
Pressure capacity		kN	800	1100	1500	2000
Torque capacity		mm	5	5	6	6
Energy capacity		J	4000	4600	7900	13100
Stroke length	mm	The upper :	60/100/130	70/110/150	80/120/160	110/160/200
		at the swing motion	160	180	200	250
Number of continuous strokes on no load	spm	It corresponds to the stroke length	108/85/73	99/78/64	83/67/55	70/57/48
			65	55	45	40
Die height		mm	320	350	400	450
Slide adjustment		mm	80	90	100	110
Size of slide (LR × FB)		mm	540×460	630×520	700×580	800×650
Size of bolster (LR × FB)		mm	1030×600	1140×680	1250×760	1470×840
Frame gap size		mm	310	350	390	430
Intraframe side size		mm	587	615	685	865
Bolster thickness		mm	140	155	165	180
Bolster upper height from floor		mm	900	900	900	1000
Machine total height from floor		mm	2955	3075	3240	3695
Capacity of servo motor		kW	25	35	40	40
Capacity of main breaker		A	60	60	75	100
Use air pressure		Mpa	0.5	0.5	0.5	0.5

Model			NC1-2000(D)
Pressure capacity		kN	2500
Torque capacity		mm	6.5
Energy capacity		J	24000
Stroke length	mm	The upper :	120/180/240
		at the swing motion	300
Number of continuous strokes on no load	spm	It corresponds to the stroke length	60/48/39
			30
Die height		mm	540
Slide adjustment		mm	120
Size of slide (LR × FB)		mm	1100×730
Size of bolster (LR × FB)		mm	1750×900
Frame gap size		mm	470
Intraframe side size		mm	1099
Bolster thickness		mm	180
Bolster upper height from floor		mm	1100
Machine total height from floor		mm	4375
Capacity of servo motor		kW	45
Capacity of main breaker		A	125
Use air pressure		Mpa	0.5

NC1 type

Model			NS2-1100(D)	NS2-1600(D)	NS2-2000(D)	NS2-2500(D)
Pressure capacity		kN	1100	1600	2000	2500
Torque capacity		mm	5	6	7	7
Energy capacity		J	6000	9600	16500	28000
Stroke length	mm	The upper :	70/110/150	80/120/160	110/160/200	120/170/230
		at the swing motion	180	200	250	280
Number of continuous		It corresponds to	88/72/59	78/65/53	68/56/48	59/48/38
strokes on no load	spm	the stroke length	55	45	40	30
Die height		mm	400	450	500	550
Slide adjustment		mm	90	100	110	120
Size of slide (LR × FB)		mm	1360×520	1500×580	1850×650	2100×700
Size of bolster (LR × FB)		mm	1660×680	1800×760	2150×840	2400×920
Bolster thickness		mm	155	165	170	180
Side opening size		mm	700×335(325)	780×385(375)	860×425(415)	940×465(455)
Bolster upper height from floor		mm	900	900	1000	1100
Possible range that upper die installe		mm	1410	1550	1900	2150
Machine total height from floor		mm	3080	3300	3710	4135
Capacity of servo motor		kW	35	40	40	45
Capacity of main breaker		A	75	100	125	175
Use air pressure		Mpa	0.5	0.5	0.5	0.5

Model			NS2-3000(D)
Pressure capacity		kN	3000
Torque capacity		mm	6
Energy capacity		J	39000
Stroke length	mm	The upper :	120/180/240
		at the swing motion	300
Number of continuous		It corresponds to	55/43/35
strokes on no load	spm	the stroke length	27
Die height		mm	650
Slide adjustment		mm	130
Size of slide (LR × FB)		mm	2400×900
Size of bolster (LR × FB)		mm	2600×1200
Bolster thickness		mm	200
Side opening size		mm	1220×590(580)
Bolster upper height from floor		mm	1150
Possible range that upper die installe		mm	2450
Machine total height from floor		mm	4520
Capacity of servo motor		kW	50
Capacity of main breaker		kVA	200
Use air pressure		Mpa	0.5

NS2 type

Model		SDE4514	SDE6016	SDE8018
Pressure capacity	kN	450	600	800
Torque capacity	mm	3.0	3.5	4.8
Energy capacity	J			4000
Stroke length	mm	140	160	180
Number of continuous strokes on no load	spm	~70	~70	~75
Die height	mm	290	335	350
Slide adjustment	mm	60	70	80
Size of slide (LR × FB)	mm	400×350	500×400	550×450
Size of bolster (LR × FB)	mm	800×450×115	920×550×125	1030×600×135
Capacity of servo motor	kW	11	15	25
Machine weight	ton	4.3	6.3	7.5

SDE type

2. Crank shaft indirect drive system

Model		H1F35		H1F45		H1F60		H1F80	
		S	H	S	H	S	H	S	H
Frame shape		C - frame							
Pressure capacity	kN	350		450		600		800	
Torque capacity	mm	4.5	3.0	5.5	3.0	6.0	3.5	5.0	5.0
Stroke length	mm	~80	~40	~100	~50	~120	~60	~130	~100
Max number of strokes	spm	~80	~230	~70	~180	~60	~150	~75	~110
Die height	mm	210		250		300		320	
Slide adjustment	mm	55		60		65		80	
Size of slide (LR × FB)	mm	350×300		400×350		500×400		550×450	
Shank hole diameter	mm	ϕ38.5		ϕ50.5		ϕ50.5		ϕ50.5	
Size of bolster (LR × FB)	mm	700×400		800×450		900×550		1000×600	
Bolster thickness	mm	86		110		130		140	
Capacity of servo motor	kW	5	7	7	7	7	11	15	22
Balancer capacity	kg	50		80		130		190	

Model		H1F110		H1F150		H1F200	
		S	H	S	H	S	H
Frame shape		C - frame					
Pressure capacity	kN	1100		1500		2000	
Torque capacity	mm	5.0	5.0	6.0	6.0	6.0	6.0
Stroke length	mm	~150	~110	~200	~130	~250	~160
Max number of strokes	spm	~65	~100	~55	~85	~50	~70
Die height	mm	350		420		450	
Slide adjustment	mm	100		100		120	
Size of slide (LR × FB)	mm	620×530		700×550		850×650	
Shank hole diameter	mm	ϕ50.5		ϕ50.5		ϕ50.5	
Size of bolster (LR × FB)	mm	1100×680		1250×760		1450×840	
Bolster thickness	mm	150		165		190	
Capacity of servo motor	kW	22	30	30	37	37	45
Balancer capacity	kg	350		500		650	

Model		H1F45	H1F60
		H	H
Frame shape		C - frame	
Pressure capacity	kN	450	600
Torque capacity	mm	3.0	3.5
Stroke length	mm	~50	~60
Max number of strokes	spm	~180	~150
Die height	mm	250	300
Slide adjustment	mm	60	65
Size of slide (LR × FB)	mm	400×350	500×400
Shank hole diameter	mm	ϕ50.5	ϕ50.5
Size of bolster (LR × FB)	mm	600×450	750×550
Bolster thickness	mm	110	130
Capacity of servo motor	kW	7	11
Balancer capacity	kg	80	130

H1F type

Model		H2F200	H2F300	H2F400B	
				WL	T
Pressure capacity	kN	2000	3000	4000	
Torque capacity	mm	6.0	6.0	6.5	13.0
Stroke length	mm	30-200	30-250	300	400
Max number of strokes	spm	~88	~80	~60	~36
Die height	mm	475	550	700	800
Slide adjustment	mm	100	100	150	150
Size of slide (LR × FB)	mm	1850×850	2150×900	2450×1150	3000×1200
Size of bolster (LR × FB)	mm	1850×950	2150×1000	2450×1250	3000×1200
Bolster thickness	mm	230	250	280	200
Front opening	mm	1900	2200	2500	3700
Side opening	mm	890	940	1190	1700
Balancer capacity	ton	1.5	1.5	3.0	5.0

Model		H2F500B		H2F600B	
		WL	T	WL	T
Pressure capacity	kN	5000		6000	
Torque capacity	mm	6.5	13.0	6.5	13.0
Stroke length	mm	300	450	300	450
Max number of strokes	spm	~60	~36	~50	~25
Die height	mm	700	900	750	900
Slide adjustment	mm	150	150	150	150
Size of slide (LR × FB)	mm	2450×1150	3600×1400	2750×1200	3600×1400
Size of bolster (LR × FB)	mm	2450×1250	3600×1400	2750×1300	3600×1400
Bolster thickness	mm	280	220	290	230
Front opening	mm	2500	4300	2800	4400
Side opening	mm	1190	1900	1490	1900
Balancer capacity	ton	3.0	8.0	5.0	8.0

Model		H2F800B	
		WL	T
Pressure capacity	kN	8000	
Torque capacity	mm	6.5	13.0
Stroke length	mm	300	500
Max number of strokes	spm	~50	~25
Die height	mm	750	900
Slide adjustment	mm	150	150
Size of slide (LR × FB)	mm	2750×1200	4200×1400
Size of bolster (LR × FB)	mm	2750×1300	4200×1400
Bolster thickness	mm	300	230
Front opening	mm	2900	5000
Side opening	mm	1800	2400
Balancer capacity	ton	5.0	10.0

H2F type

Model		AC-LP200	AC-LP300	AC-LP500	AC-LP800
Pressure capacity	kN	2000	3000	5000	8000
Torque capacity	mm	2	2	2	2
Max workload	kN·m	4	6	10	16
Stroke length	mm	400	500	600	800
Die height	mm	600~400	700~400	800~500	1000~600
Slide adjustment	mm	200	300	300	400
Size of bolster (LR × FB)	mm	2000×1200	2200×1400	2800~1600	3500×2000
Number of strokes	spm	15~25	15~25	15~20	15~20
Die cushion capacity	kN	400	600	1000	1500
Die cushion stroke	mm	150	200	250	300
Size of die cushion pad	mm	1500×700	1600×800	2100×1000	2500×1200
Capacity of servo motor	kW	50	60	100	100×2

Model		AC-LP1000	AC-LP1500
Pressure capacity	kN	10000	15000
Torque capacity	mm	2	2
Max workload	kN·m	20	30
Stroke length	mm	800	1000
Die height	mm	1200~800	1300~800
Slide adjustment	mm	400	500
Size of bolster (LR × FB)	mm	4000~2200	4500×2500
Number of strokes	spm	15~20	15~20
Die cushion capacity	kN	2000	2500
Die cushion stroke	mm	300	300
Size of die cushion pad	mm	3200×1600	3500×1800
Capacity of servo motor	kW	100×2	200×2

AC-LP type

Model		SVO-5	SVO-10	SVO-20
Pressure capacity	kN	50	100	200
Stroke length	mm	20/30/40	20/30/50	20/30/60
Number of strokes	spm	50~180/150/120	50~230/200/150	80~300/250/170
Die height	mm	184	184	200
Slide adjustment	mm	1~10	1~20	2
Size of bolster (LR × FB)	mm	400×425	500×350	550×450
Bolster thickness	mm	60	50	80
Size of slide (LR × FB)	mm	400×320	500×300	550×320
Bed opening	mm	310×66	350×66	450×80
Side opening	mm	160	210	200
Power consumption	A	10	30	28
Balancer capacity	kg	30	40	50
Capacity of servo motor	kW	1.5	3.5	5.0
Machine weight	ton	1.0	1.5	2.5

SVO type

3. Ball screw system

Model		MPS4150	MPS4200	MPS4300	MPZ5120
Pressure capacity	kN	1470	1960	2940	1176
Max stroke length	mm	150	150	150	150
Open height	mm	600	650	750	650
Setting unit of stroke position	mm	0.001	0.001	0.001	
B・D・C repeatedly accuracy	mm	±0.01	±0.01	±0.01	
Max slide speed	mm/sec	150	120	83	333
Size of bolster (LR × FB)	mm	1500×800	1500×1200	2200×900	1200×600

Model		MPS8300DS
Pressure capacity (inner)	kN	1960
Pressure capacity (outer)	kN	980
Max stroke length (inner)	mm	150
Max stroke length (outer)	mm	150
Open height	mm	850
Setting unit of stroke position	mm	
B・D・C repeatedly accuracy	mm	
Max slide speed (inner)	mm/sec	120
Max slide speed (outer)	mm/sec	95
Size of bolster (LR × FB)	mm	1200×600

MPS type

MPZ type

Model		CFP3-100	CFP3-150	CFP3-200
Pressure capacity	kN	1000	1500	2000
Max stroke length	mm	200	300	400
Die height	mm	400	500	600
Size of bolster (LR × FB)	mm	700×800	800×900	800×1000

CFP type

Model		HCP3000
Pressure capacity	kN	800
Max stroke length	mm	160
Die height	mm	430
Max slide speed	mm/sec	150
Processing speed	mm/sec	~150
Size of slide (LR × FB)	mm	900×450
Size of bolster (LR × FB)	mm	1050×500
Bolster thickness	mm	140
Side opening	mm	550
Capacity of servo motor	kW	12×2

HCP型

Model		A-SF-600S	A-SF-700S	A-SF-950D	A-SF-1100D
Number of point		Single	Single	Double	Double
Pressure capacity	kN	300	400	600	800
Stroke length	mm	0-100	0-100	0-100	0-100
Max slide speed	mm/sec	255	235	255	235
Max workload	J	1500	2000	3000	4000
Number of strokes	spm	78/50mm	75/50mm	78/50mm	75/50mm
Shut height	mm	180	180	230	230
Open height	mm	280	280	330	330
Size of slide (LR × FB)	mm	600×360	700×430	950×480	1100×550
Size of bolster (LR × FB)	mm	600×500	700×500	950×650	1100×650
Bolster thickness	mm	120	120	130	130
Bolster upper height from floor	mm	950	950	1050	1050
Balancer capacity	kg	100	100	200	200
Capacity of servo motor	kW	30×1	30×1	30×2	30×2

A-SF type

4. Hydraulic pump direct drive with servo motor system

Model		SDH40	SDH110
Pressure capacity	kN	400	1100
Stroke length	mm	20	300
Open height	mm	500	600
Max slide speed	mm/sec	200	60
Processing speed	mm/sec	0.01~20	0.01~20
Size of slide (LR × FB)	mm	700×600	1000×900
Size of bolster (LR × FB)	mm	800×630	1100×1050
Capacity of servo motor	kW	2.9	7.5

SDH type

5. Direct drive servo punching press system

Model		EM255NT	EM2510NT
Pressure capacity	kN	200	
Stroke length	mm	37	
Max processing material thickness	mm	3.2	
Axis movement / 1 clamping	mm	1270×1270	1270×2500
Max speed of axis : X,Y	m/min	X 100, Y 80	
Max material weight	kg	50 (F1) / 150 (F4)	
Hit rate ①	hpm	500 (5mm stroke, 25.4mm pitch)	
Hit rate ②	hpm	780 (5mm stroke, 1.0mm pitch)	
Hit rate ③	hpm	1800 (1.4mm stroke, 0.5mm pitch)	
Processing accuracy	mm	±0.1	
Rotational speed of turret	rpm	30	
Max punch diameter	mm	114.3	
Machine weight	ton	17.5	18.0

EM type

6. Hybrid servo press break

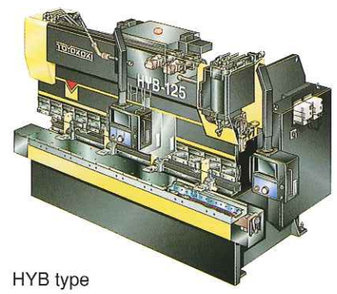
Model			HYB-60		HYB-80	
			13	20	20	25
Pressure capacity		kN	588	588	834	834
Table length		mm	1300	2000	2000	2500
Frame distance		mm	980	1685	1570	2070
Table width		mm	100	100	190	190
Open height		mm	290	290	340	340
Table height		mm	910	910	910	910
Frame depth		mm	1295	1295	1390	1390
Frame gap		mm	410	410	410	410
Machine total height from floor		mm	2521	2521	2680	2680
Burial depth from floor		mm	0	0	0	0
Stroke length		mm	150	150	200	200
Ram inclination		mm	5.0	5.0	5.0	5.0
Ram speed	Descent	mm/sec	2~150	2~150	1~110	1~110
	Processing	mm/sec	0.1~13	0.1~13	0.1~14	0.1~14
	Rise	mm/sec	2~150	2~150	2~200	2~200
Capacity of servo motor		kW	1.3X2	1.3X2	1.8X2	1.8X2
Machine weight		ton	3.3	4.9	5.6	5.8

Model			HYB-125			HYB-175
			20	30	40	25
Pressure capacity		kN	1225	1225	1225	1716
Table length		mm	2500	3000	4000	2500
Frame distance		mm	2050	2550	3550	2050
Table width		mm	190	190	190	190
Open height		mm	340	340	340	340
Table height		mm	910	910	910	910
Frame depth		mm	1450	1460	1495	1560
Frame gap		mm	410	410	410	400
Machine total height from floor		mm	2750	2750	3040	3005
Burial depth from floor		mm	0	0	0	0
Stroke length		mm	200	200	200	200
Ram inclination		mm	5.0	5.0	5.0	5.0
Ram speed	Descent	mm/sec	1~108	1~108	1~108	1~100
	Processing	mm/sec	0.1~13	0.1~13	0.1~14	0.1~15
	Rise	mm/sec	2~196	2~196	2~196	2~194
Capacity of servo motor		kW	2.9X2	2.9X2	2.9X2	4.4X2
Machine weight		ton	6.3	8.0	10.5	10.0

Model			HYB-175		HYB-250	
			30	40	25	30
Pressure capacity		kN	1716	1716	2450	2450
Table length		mm	3000	4000	2500	3000
Frame distance		mm	2550	3550	2050	2550
Table width		mm	190	210	190	190
Open height		mm	340	340	390	390
Table height		mm	910	910	910	910
Frame depth		mm	1585	1620	1705	1745
Frame gap		mm	400	400	400	400
Machine total height from floor		mm	3005	3130	3245	3245
Burial depth from floor		mm	0	0	0	0
Stroke length		mm	200	200	250	250
Ram inclination		mm	5.0	5.0	5.0	5.0
Ram speed	Descent	mm/sec	1~100	1~100	1~95	1~95
	Processing	mm/sec	0.1~15	0.1~15	0.1~13	0.1~13
	Rise	mm/sec	2~194	2~194	2~174	2~174
Capacity of servo motor		kW	4.4X2	4.4X2	5.5X2	5.5X2
Machine weight		ton	17.0	20.0	12.0	18.0

Model			HYB-250	HYB-300		HYB-400
			40	30	40	30
Pressure capacity		kN	2450	2940	2940	3920
Table length		mm	4000	3000	4000	3000
Frame distance		mm	3550	2550	3550	2400
Table width		mm	210	210	190	210
Open height		mm	390	390	390	440
Table height		mm	910	910	910	910
Frame depth		mm	1760	1835	1780	1900
Frame gap		mm	400	400	400	400
Machine total height from floor		mm	3260	3350	3400	3340
Burial depth from floor		mm	0	0	770	0
Stroke length		mm	250	250	250	300
Ram inclination		mm	5.0	5.0	5.0	5.0
Ram speed	Descent	mm/sec	1~95	1~110	1~110	1~75
	Processing	mm/sec	0.1~13	0.1~12	0.1~12	0.1~10
	Rise	mm/sec	2~174	2~150	2~150	1~100
Capacity of servo motor		kW	5.5X2	7.5X2	7.5X2	11.0X2
Machine weight		ton	21.0	22.0	25.0	30.0

Model			HYB-400	HYB-500	
			40	30	40
Pressure capacity		kN	3920	4900	4900
Table length		mm	4000	3000	4000
Frame distance		mm	3400	2350	3350
Table width		mm	190	210	190
Open height		mm	440	440	440
Table height		mm	910	910	910
Frame depth		mm	1900	1900	1900
Frame gap		mm	400	400	400
Machine total height from floor		mm	3455	3340	3500
Burial depth from floor		mm	1080	0	1100
Stroke length		mm	300	300	300
Ram inclination		mm	5.0	5.0	5.0
Ram speed	Descent	mm/sec	1~75	1~75	1~75
	Processing	mm/sec	0.1~10	0.1~8	0.1~8
	Rise	mm/sec	1~100	1~100	1~100
Capacity of servo motor		kW	11.0X2	11.0X2	11.0X2
Machine weight		ton	35.0	35.0	38.0



HYB type

Model			HDS5020	HDS8025	HDS1303	HDS1703
Pressure capacity		kN	490	784	1274	1666
Bending length		mm	2070	2600	3220	3220
Stroke length		mm	200	200	200	250
Number of cylinders (Assistance)			2 (2)	2 (2)	2 (2)	2 (3)
Ram speed	Descent	mm/sec	200	200	200	200
	Processing	mm/sec	20	20	20	20
	Rise	mm/sec	200	200	200	200
Machine weight		ton	5.3	6.7	12.0	20.0
Capacity of servo motor		kW	1.8×2	2.9×2	4.4×2	7.5×2

Model			HDS2203	HDS2204
Pressure capacity		kN	2156	2156
Bending length		mm	3220	4280
Stroke length		mm	250	250
Number of cylinders (Assistance)			2 (3)	2 (3)
Ram speed	Descent	mm/sec	200	200
	Processing	mm/sec	20	20
	Rise	mm/sec	200	200
Machine weight		ton	23.0	23.0
Capacity of servo motor		kW	7.5×2	7.5×2

HDS type

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