United States Patent

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[73] Assignee Nippon Steel Corporation Tokyo, Japan
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[33] Japan
[31] 42/60835 and 42/60836

[54] METHOD AND APPARATUS FOR HIGH SPEED CUTTING OF SHAPED STEEL
4 Claims, 6 Drawing Figs.

[52] U.S. Cl. 83/311, 83/320
[51] Int. Cl. B26d 1/56, B23d 25/04
[50] Field of Search 83/308, 311, 318, 319, 320, 76, 295

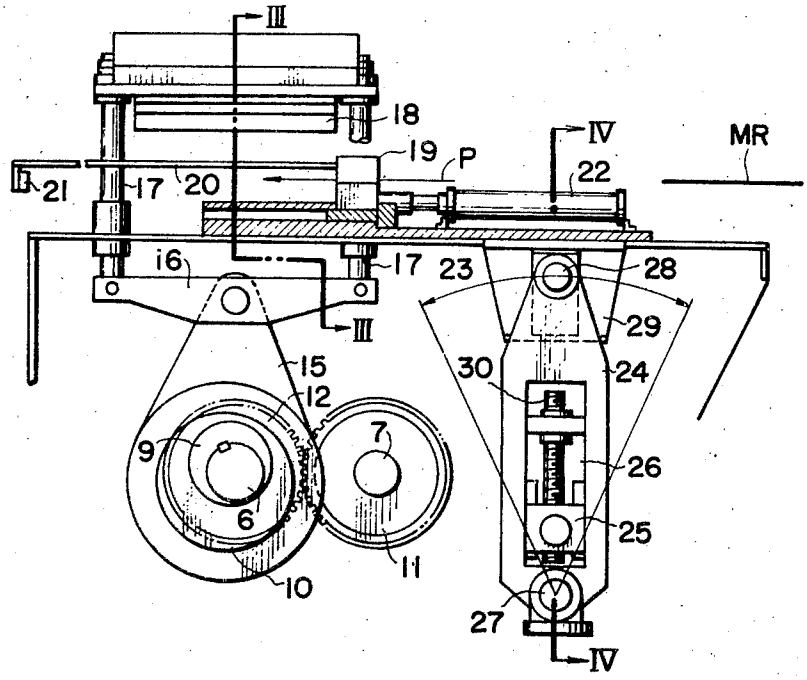
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ABSTRACT: An apparatus for high speed cutting of light gauge steel, comprising a cutter consisting of a mechanism for the vertical movement of a press bed by means of a single or plural sets of eccentric cams or the like and of a mechanism for the reciprocal sliding, in connection with said vertical movement, of a slide base carrying thereon a dieset enclosing a blade for cutting. Means are provided for measuring the speed of the to-be-cut material and the dislocated position of the dieset at the time of cutting. These values are then fed to a means for adjusting the driving speed of the cutter, thereby ensuring that each cutting operation is carried out at the correct position.



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SHEET 1 OF 3

FIG. 1

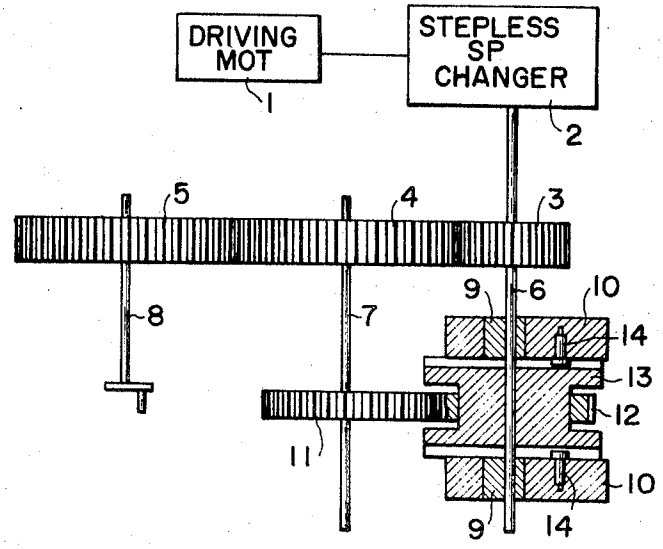
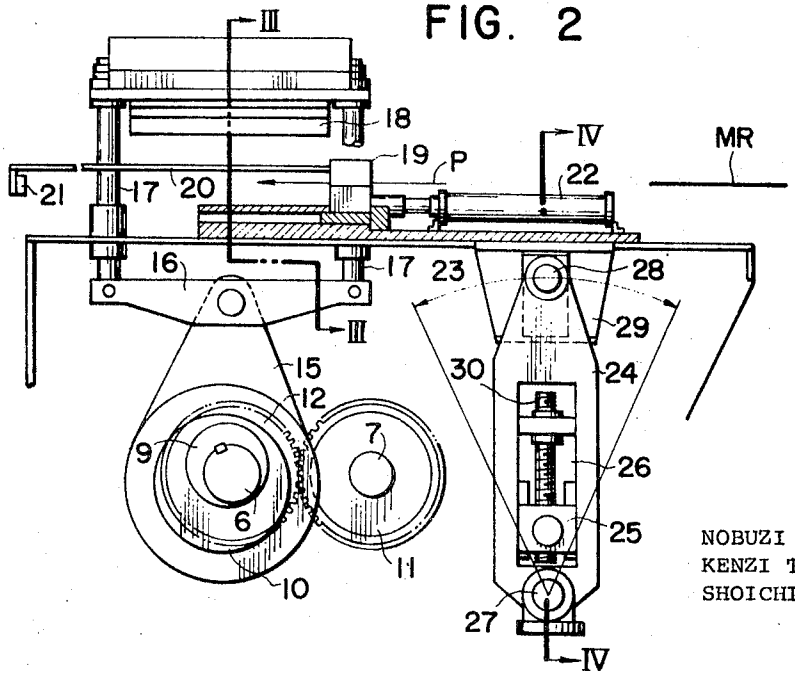


FIG. 2



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FIG. 3

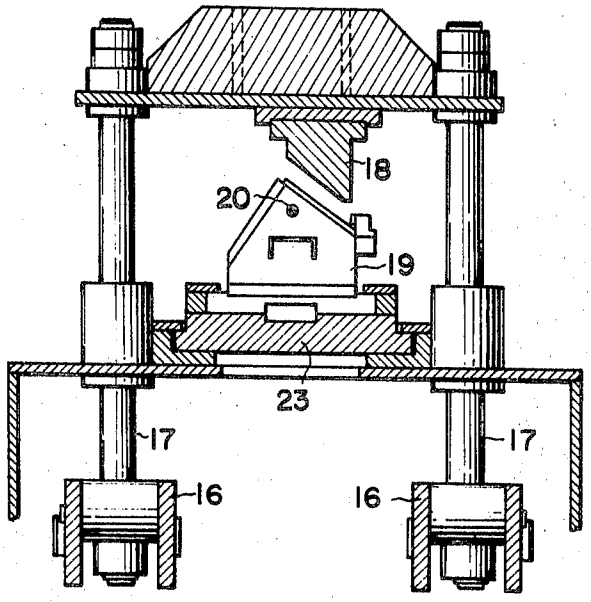
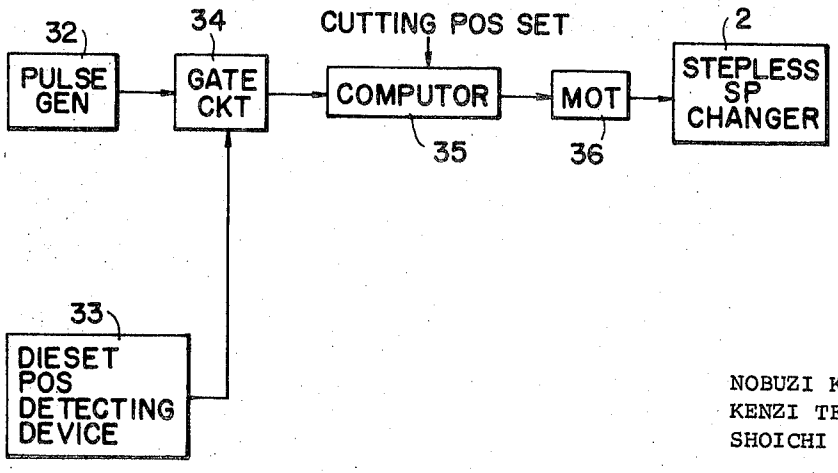


FIG. 6



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FIG. 4

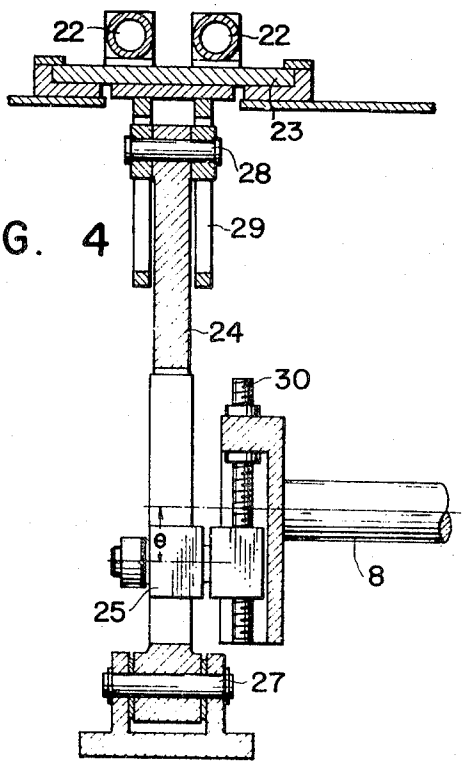
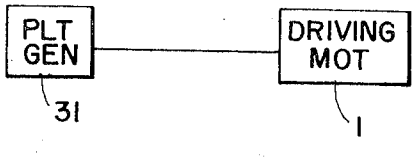


FIG. 5



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METHOD AND APPARATUS FOR HIGH SPEED CUTTING OF SHAPED STEEL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an apparatus for cutting shaped steel, more particularly for cutting steel shapes having comparatively thin thickness, such as light gauge steel, at high speed and accuracy.

2. Description of the Prior Art

Generally according to conventional apparatus, the cutting of steel shapes having comparatively thin thickness, such as light gauge steel, is carried out such that the desired length of steel is detected through the contact of the tip of the steel with a limit switch. A such detection the dieset is moved by a hydraulic cylinder, and cutting is carried out by the intermittent driving of a crankshaft caused by the engaging and disengaging of a clutch.

In the use of such conventional apparatus, however, the speed of the to-be-cut material is limited to about 40 meters per minute. This is due to the fact that the speed of the dieset and associated hydraulic cylinder is limited and also that the mechanism of this conventional apparatus contains such units as a limit switch and a clutch which are relatively inaccurate and slow. This constitutes a bottleneck in the effort to raise operating speeds in the processing of light gauge steel.

In order to solve this difficulty, various cutting devices have been pursued, but none have met the demand for high speed and accuracy.

SUMMARY OF THE INVENTION

An object of the present invention, which has been developed to overcome the difficulties of conventional devices, is to provide an apparatus for cutting steel shapes such as light gauge steel at speeds of more than 150 meters per minute with an error of less than ±2.5 mm.

Another object of the present invention is to provide an apparatus for cutting light gauge steel at such a high speed whereby the operating speed of the processing of such materials is increased. A further object of the present invention is to provide an apparatus for cutting steel shapes at high accuracy while travelling.

In order to achieve these objects, the present invention is characterized by having a high speed cutter consisting of a mechanism comprising a single or plural set of cams for the vertical movement of a press bad to select any desired cutting interval. A mechanism is provided for reciprocally sliding in connection with said vertical movement a slide base carrying thereon the dieset enclosing the cutting blade. The speed of this sliding movement is adjusted to be slightly less than the speed of the to-be-cut steel material. The dieset is arranged to travel with respect to the slide base by the force of the to-be-cut steel material. An air cylinder pulls back the dieset after cutting. Prior to cutting, the slide base is accelerated to a speed slightly slower than that of the to-be-cut material to soften the impact of the material produced at the time of cutting. The travelling speed of the to-be-cut material is measured with a measuring roll. This speed so detected is corrected by the detection of the position of the dieset at the time of cutting, and then adjusting the operation of a stepless speed changer according to the difference between the speed so corrected and the prescribed speed. This ensures that each cutting is carried out at a position within a prescribed limited range.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1 to 4 show an embodiment of the high speed cutter according to the present invention; particularly,

FIG. 1 shows an outline of the driving mechanism of the cutter;

FIG. 2 shows a side view of part of the operation mechanism of the cutter;

FIG. 3 shows a cross section of the apparatus shown in FIG. 2 taken along the line III–III;

FIG. 4 shows a cross section of the apparatus shown in FIG. 2 taken long the line IV–IV;

FIGS. 5 and 6 are drawings illustrating the principle of the control system according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The following is a description of a preferred embodiment of the high speed cutter according to the present invention, with reference to the drawings.

In FIGS. 1 to 4 showing an embodiment of the high speed cutter according to the present invention, 1 indicates a driving motor which drives the below-mentioned elements of the cutter, through the stepless speed changer 2, the pinion 3, the gears 4 and 5 and the driving shafts 6, 7 and 8; 9 indicates an eccentric cam which is fixed on and driven by the shaft 6; 10 indicates an eccentric cam which is set loosely on the eccentric cam 9 and is driven by the shaft 7 through the gears 11 and 12, the drive spider 13 and the pin 14.

Vertical movement is produced by the rotation of the eccentric cams 9 and 10 is transmitted to the press head 18 through the connecting rod 15, which is set loosely on the eccentric cam 10, the connecting beam 16 and the rod 17.

Because of this mechanism, it is possible to freely adjust the cycle of the cutting time of the press head 18 by selecting the rotary speed of the shaft 6.

The dieset 19 enclosing the upper blade and the lower blade, is connected at one end through tie rod 20 with the stopper 21 for determining the cutting length, and, at the other end with the rod of an air cylinder 22 for pulling back the dieset 19. The air cylinder 22 is fixed on the slide base 23, and the slide base 23 is moved reciprocally and horizontally by the swinging arm 24, as mentioned below. The pin 25 which is eccentrically connected with the shaft 8, is set into the opening 26 of the swinging arm 24 to thereby make a pendulous movement centering around the shaft 27 within the range marked with arrows in FIG. 2. The pin 28 set at the tip of the swinging arm 24, is set in the concave part of a part 29 fixed at the bottom of the slide base 23, and transfers the reciprocal movement to the dieset 19 through the air cylinder and the slide base 23, through the pendulous movement of the swinging arm 24. In the figure, 30 indicates the adjusting screw for the adustment of the eccentricity volume e of the pin 25 within opening 26.

In this embodiment, the dieset 19 is slidably positioned on the slide base 23. However, it is not necessary to place the dieset on the slide base 23. The method for imparting reciprocal movement to the slide base 23 is not limited to such pendulous system as mentioned in this embodiment, rather could be replaced by a crank mechanism of the conventional type or a mechanism using piston movement.

The following is a description of the operation of the cutter of the present invention:

While the to-be-cut material is sent along the pass line P in the direction marked by the arrow, the swinging arm 24 through its pendulous movement pushes forward the slide base 23 in the direction of the to-be-cut material until it reaches the position shown in FIG. 2 (the dieset acceleration completion position) when the tip of the to-be-cut material abuts the stopper 21 connected with the dieset 19. The speed of the stopper 21 at this time is made less than that of the to-be-cut material so as not to damage the tip of the material. This can be determined according to the length of the desired cut by adjusting the adjusting screw 30 to control the eccentricity e of the pin 25 against the shaft 8.

When the to-be-cut materials abuts the stopper 21, the dieset 19 which is connected with the stopper through the tie rod 20, is moved by the force of the material with respects to the slide base 23 at the same speed as the material. The dieset 19 pulls the rod of the air cylinder 22 to allow this movement. At a given period of time after this abutment, the press head 18 is moved by cams 9 and 10 down to the position for cutting, and engages the dieset 19, so that the material is cut. Between completion of acceleration and cutting, there must be pro-

vided a certain time lapse, to ensure that the tip of the material contacts the stopper **21**, as mentioned below. When cutting is completed, the cut material is removed by any suitable and conventional arrangement. One such conventional arrangement would be the provision of a cam follower on stopper **21** or tie rod **20** adapted to engage a suitable cam. This engagement would lift or otherwise displace stopper **21** from the end of the cut material. The cut material could then be acted on and removed by any conventional device such as a takeoff chute or arm.

Also, as cutting is stopped, compressed air is conventionally caused to push the rod of air cylinder **22** back to its original position. This of course returns dieset **19** to its original position with respect to slide base **23**. During this process, the speed of the swinging arm **24** is gradually slowed down in returning to the original position, and then starts accelerating for the next cutting cycle. Thus, arm **24** accelerates dieset **19** through cylinder **22** and slide base **23** to return to its original position, and also, the rod of air cylinder accelerates dieset **19** to its original position with respect to slide base **23**, whereby the speed of cutting the material is greatly increased over conventional devices.

An important consideration in the use of this cutter is to synchronize the travelling speed of the to-be-cut material with the start of cutting.

Using FIGS. **5** and **6**, an apparatus to accomplish this synchronization will be described.

In FIG. **5**, **31** indicates a plot generator connected with a measuring roll M.R. Using this pilot generator, the rotary speed of the driving motor **1** is controlled according to changes in the travelling speed of the to-be-cut material. In case of cutting such materials as shaped steel, it is difficult to accurately detect the travelling speed of the materials because of slip between the materials and the measuring roll. This causes errors far exceeding allowable tolerances. Therefore, no complete synchronization can be obtained.

The above-mentioned stopper will insure that the exact length of products are obtained even when operating at incomplete synchronization.

The stopper **21** is fixed at a distance from the dieset **19** so that the exact desired length of cut material can be obtained if the tip of the to-be-cut material abuts the stopper **21** before the start of cutting. Therefore, it is desirable to arrange controls so that the tip of the to-be-cut material abuts the stopper **21** before starting of the cutting and so that the speeds of the stopper **21** and of the to-be-cut material are correlated as to not damage the to-be-cut material.

By providing a certain time period between the time of completion of accelerating the dieset **19** and the stopper **21** (which corresponds to the time when the swinging arm **24** comes to the position shown in FIG. **2** and also to the time when the to-be-cut material abuts the stopper **21** if the speeds of the to-be-cut material and the cutter are completely synchronized) and the time of starting the cutting, and also by making the speeds of the stopper **21** and of the dieset **19** as slow as possible in comparison with the travelling speed of the to-be-cut material, the accuracy in detecting the speed of the measuring roll becomes more difficult to obtain, but may be achieved by controlling the rotary speed of the driving motor **1** with the pilot generator.

Even if complete synchronization between the cutter and the to-be-cut material cannot be obtained by such methods as mentioned above, the exact length of products can be obtained by using the apparatus of the present invention. Errors caused in the length of products due to incomplete synchronization come about as a dislocation of the dieset **19** from the prescribed position at the time of cutting.

As such dislocation tends to be accumulated, it is necessary to return the dieset **19** to the prescribed position whenever dislocation takes place.

In FIG. **6** the principle of the automatic control of the cutting position for the dieset **19** is illustrated. Using this FIG., the method is described, as follows:

32 indicates a pulse generator fixed on the shaft **7**, to give signals for opening and shutting the gate to a gate circuit **34**. **33** indicates a dieset position detecting device using a magnetic scale, etc. This device issues various pulse frequencies determined according to positions of the dieset. Pulses so issued are sent to a computer **35** through the gate circuit **34**. In the computer, the pulses are subjected to computation to obtain the difference from the prescribed value, and according to such difference, a motor **36** is driven to adjust the speed ratio with the stepless speed changer **2** connected with the driving motor **1**.

By changing the rotary speed of the shaft for driving the cutter in this way, complete synchronization between the to-be-cut material and the cutter can be obtained, thereby ensuring that the dieset is properly positioned at the time of cutting.

As mentioned above, by using the cutter according to the present invention, synchronization of the cutter and the to-be-cut material is possible even in the running cutting of shaped materials which heretofore was involved considerable waste due to errors in the detection of speed. For this reason and also because this cutter accelerates the dieset prior to cutting, the speed of cutting the to-be-cut material can be very greatly increased as compared with conventional cutters.

We claim:

1. An apparatus for the high speed cutting of moving shaped steel material comprising a frame; a slide base mounted for reciprocal movement over said frame; a dieset mounted to be reciprocated with said slide base; means for reciprocating said slide base and said dieset along said frame at a speed slightly slower than the seed of said material; means solidly attached to said dieset and adapted to be abutted by the end of said material for stopping the movement of said material with respect to said dieset; means solidly attached to said slide base for allowing said dieset to move with respect to said slide base; a press head mounted above said dieset; and cam means for causing said press head to press against said dieset and thereby cut said material after said end of said material abuts said means for stopping.

2. An apparatus as claimed in claim **1**, wherein said means for reciprocating comprises an arm pivoted at one end to said slide base and pivoted at the other end to a stationary pivot, and an eccentric shaft attached to said arm to impart pendulous motion to said arm.

3. An apparatus as claimed in claim **1**, wherein said means for allowing said dieset to move comprises an air cylinder solidly mounted on said slide base and having a rod solidly attached to said dieset, said rod being slidable within said cylinder.

4. An apparatus as claimed in claim **1**, further comprising a motor mounted for driving said reciprocating means and said cam means; a dieset position detecting means for issuing pulses representative of the position of said dieset; a computer adapted to receive said pulses and compare them with pulses representing prescribed values; and speed change means operable in response to said computer to alter the speed of said motor.