July 6, 1937. J. R. COE 2,085,729

METALWORKING

Filed Dec. 30, 1933 3 Sheets-Sheet 1

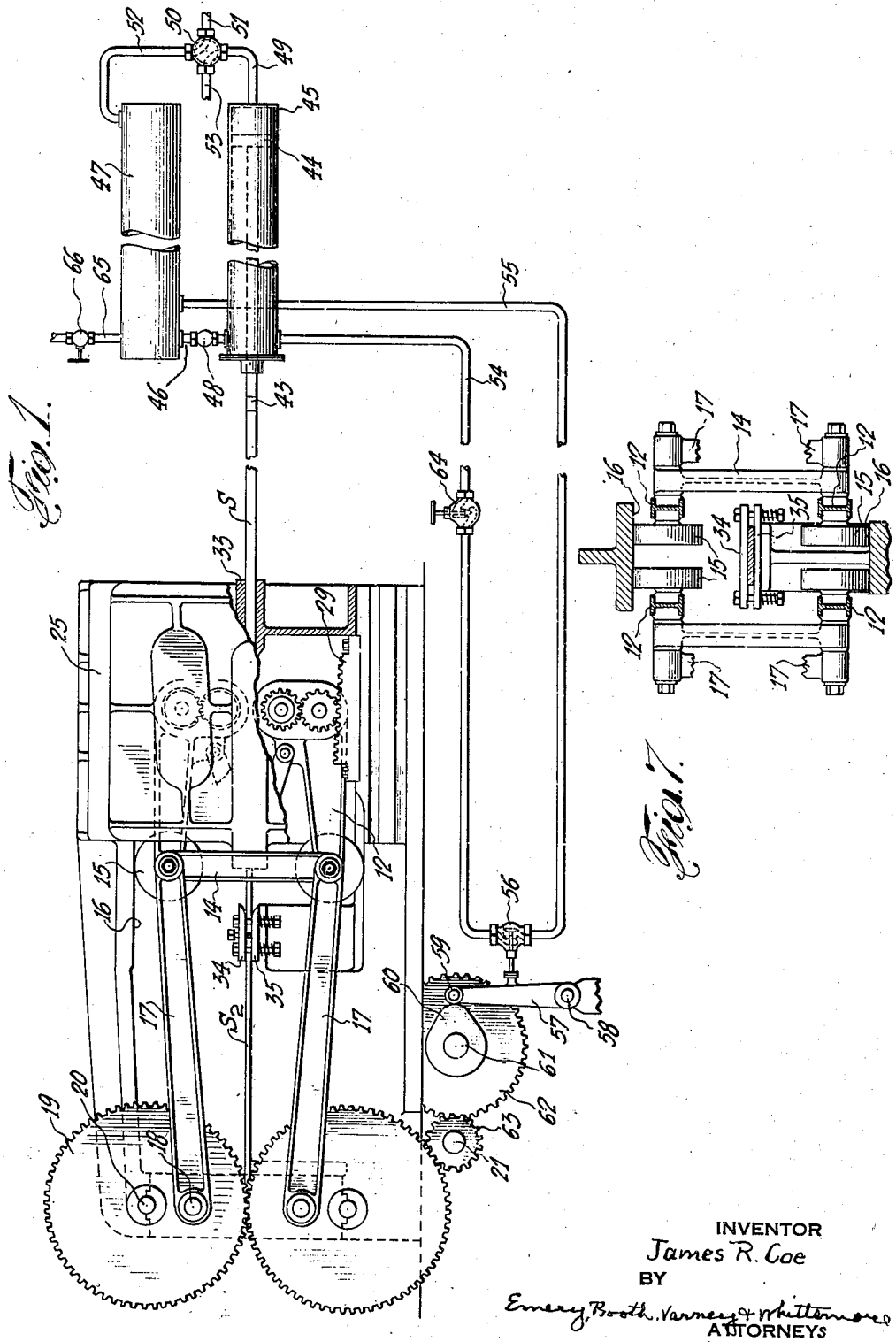

Fig. 1.

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Fig. 2.

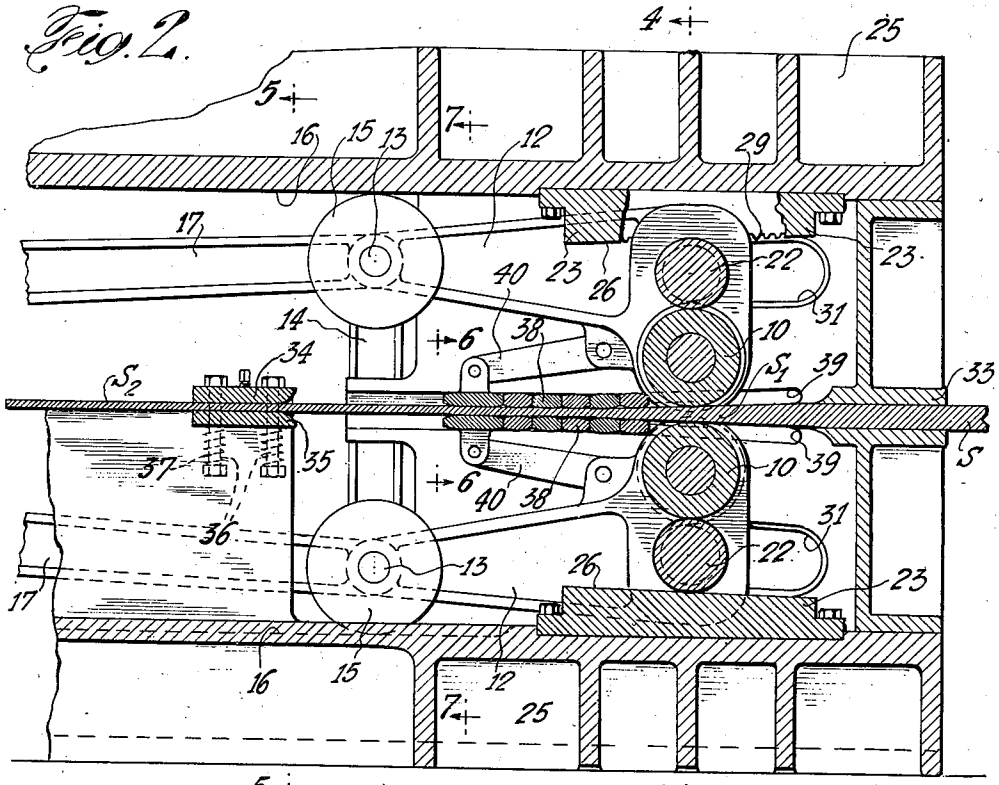

Fig. 3.

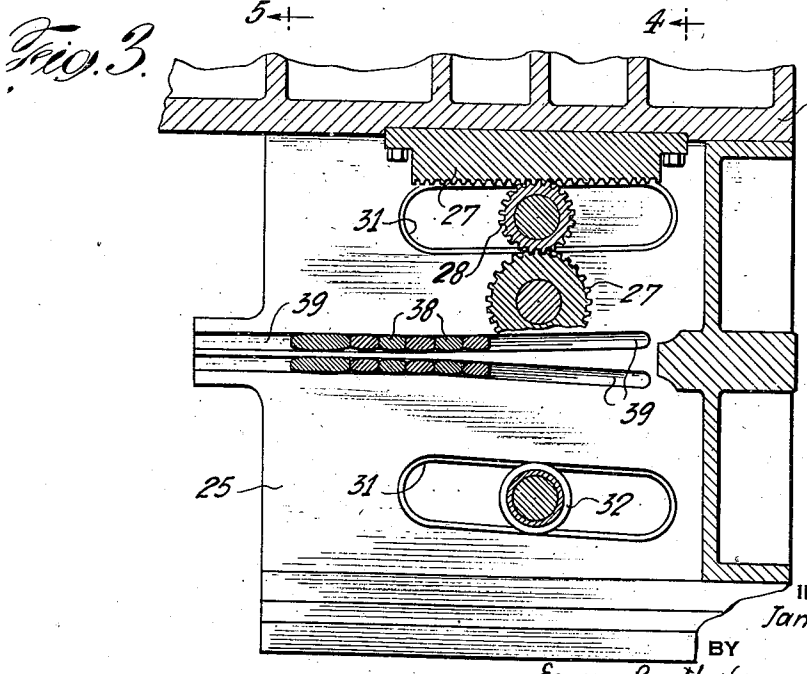

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Fig. 4.

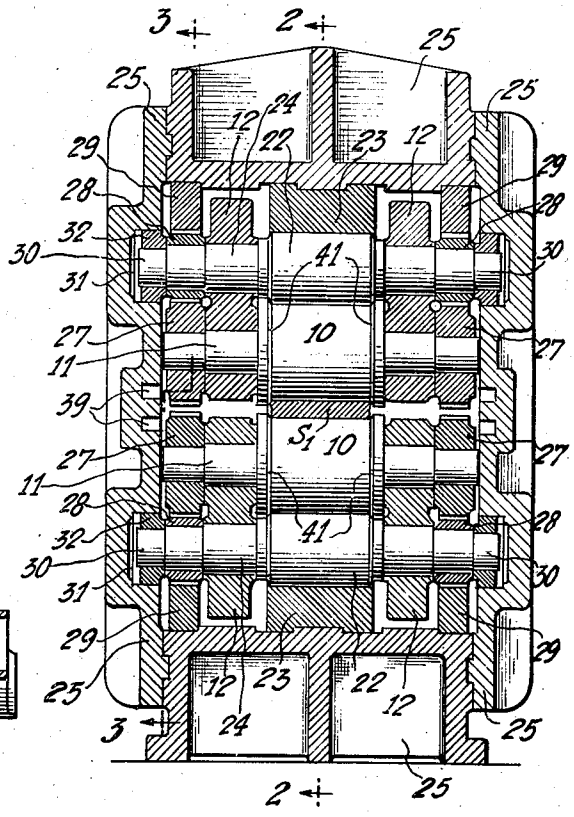


Fig. 5.

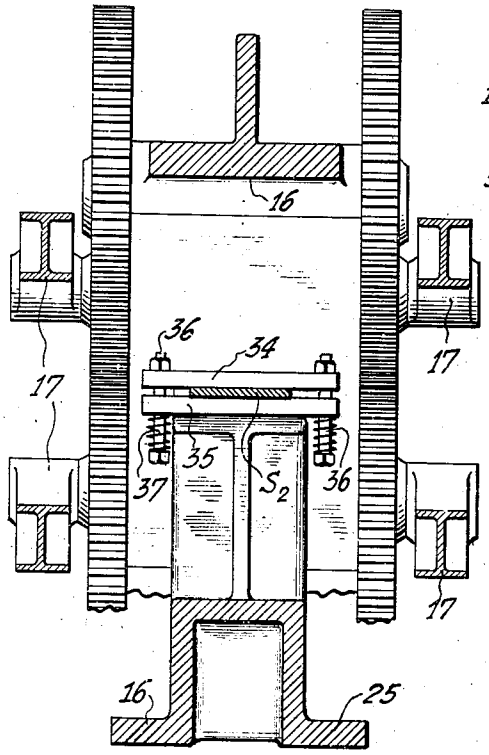
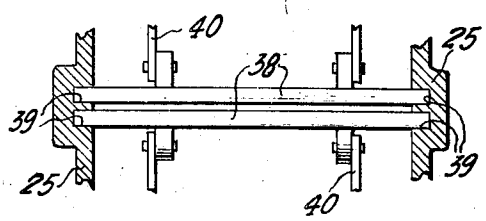


Fig. 6.



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Patented July 6, 1937 2,085,729

UNITED STATES PATENT OFFICE

2,085,729

METALWORKING

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Application December 30, 1933, Serial No. 704,609

16 Claims. (Cl. 80—31.1)

This invention relates to a method of and apparatus for working metal, particularly to apparatus for reducing the cross-sectional area of metal stock by a step-by-step process whereby the metal may be worked cold with the least possible injury to its internal structure. The apparatus is especially adapted for the cold working of metal and will reduce stock of almost any known commercially workable metals to any extent desired without the necessity of annealing for further working and without undue strain upon the metal. The object of the invention is the provision of improved apparatus of the class described. In particular it is an aim to provide for reducing by concentric rather than eccentric reducing rolls whereby machining of the rolls is simplified; to provide a fixed rather than a travelling backing structure for the rolls whereby greater strength may be obtained and lighter reciprocating parts employed; to provide improved stock guiding means; to provide improved stock feeding means; to provide improved roll shapes whereby when flat stock is reduced the edges will be preserved; to provide improved mechanism for operating and coordinating the movements of the rolls; and to provide a simple and efficient machine as a whole.

In order to illustrate the principles of the invention an exemplary embodiment thereof will be described with reference to the accompanying drawings thereof, in which:

Fig. 1 is a schematic side elevation of apparatus embodying the invention;

Fig. 2 is an enlarged vertical longitudinal section through the reducing devices taken on the line 2—2 of Fig. 4;

Fig. 3 is a vertical longitudinal section taken approximately on the line 3—3 of Fig. 4;

Fig. 4 is a transverse vertical section taken on the line 4—4 of Fig. 2;

Fig. 5 is a transverse vertical section taken on the line 5—5 of Fig. 2;

Fig. 6 is a fragmentary transverse vertical section taken on the line 6—6 of Fig. 2; and

Fig. 7 is a transverse section on the line 7—7 of Fig. 2.

In the illustrated embodiment of the invention flat sheet stock S is being reduced to a thinner sheet S2 but other types of stock may be reduced by changing the working rolls and other elements of the machine as may be appropriate. The stock is reduced by a set of spaced reducing rolls 10 which are mounted by their journals 11 in the ends of reciprocating drive rods 12. There may be a pair of rods 12 for each roll to engage the journals at the opposite ends of the roll. The rods are driven by crosshead pins 13 carried by a crosshead 14 provided with guide rollers 15 operating along guides 16. The crosshead 14 is actuated by crank rods 17 which are driven by cranks 18. The cranks are carried by crank discs 19 mounted upon crank shaft 20. The shafts 20 are geared together and are driven by a power shaft 21 which is geared to one of them.

The working or reducing rolls 10 are circular in cross section but may have any desired shape in axial section. They are in contact with backing rolls 22, also carried by the rods 12, which roll upon and bear against the backing plates 23. The rolls 22 are provided with journals 24 which operate in bearings formed in the ends of rods 12. The backing plates 23 are secured to a heavy frame 25. The frame 25 being stationary, may be made as heavy and strong as desired, whereas if it were reciprocated the inertia of excess weight would have to be taken into consideration.

The backing plates 23 may have any longitudinal contour desired and this contour determines the path of movement of the working rolls. Herein the plates are formed with converging or tapered portions 26 and if desired may have parallel portions, not shown. The stock S in Fig. 2 is seen to have a corresponding tapered section S1 where it is being reduced and a straight portion S2 where it has been finished.

At each end the rolls 10 are provided with gears 27 which mesh with the gears 28 of the backing rolls 22, which latter gears are in mesh with the fixed racks 29. These racks have a longitudinal contour paralleling that of the backing plates 23 so that the gears will remain in contact with the racks while the backing rolls remain in contact with the backing plates. The two working rolls although adjacent to each other are not geared together since they advance toward and recede from each other, making the use of such gearing impractical. They are kept synchronized, however, by the rods 12 and the fixed racks 29.

The backing rolls 22 are provided with journal extensions 30 which operate in grooves 31 of the fixed frame 25. The grooves 31 are parallel to the working surfaces of the backing plates 23 and assist in guiding and backing the rolls 22. The journal extensions 30 may be provided with rollers 32 operating in the grooves.

The stock is guided in between the working rolls 10 by entrance guides 33 which are formed on the fixed frame 25.

Exit guides including a pair of plates 34, 35

and guide pins 36 are pressed down upon the stock by coil springs 37. One of the plates (the lower) is anchored to the frame as shown in Fig. 2. Intermediately in the vicinity of the rolls the stock is guided by a plurality of sliding bars 38 mounted at their ends in slots 39 formed in the fixed frame 25. The slots have approximately the same longitudinal contour as the backing plates 23 insofar as they are coextensive therewith and are parallel therebeyond. In short, the slots have approximately the same contour as the stock but are open sufficiently to allow increments of stock to be fed. The bars 38 are operated by parts on the front ends of the rods 12 and by an end bar which is connected to the rods 12 by links 40. The plates 34, 35, being resiliently pressed against the stock at all times, assist in controlling its feed by preventing it from moving too far by inertia and also prevent its displacement when the rolls have moved clear of it near the end of the stroke but while the friction guide bars 38 are in engagement with it and are still moving.

When flat sheet stock is reduced it tends to spread out on the sides along the parallel faces of the sheet. With heavy reductions the concavity at the sides may become pronounced and the sharp longitudinal edges thus produced are objectionable. To remedy this, the rolls are beveled outwardly at each end, as shown at 41 in Fig. 4, where they work on the edges of the stock to keep the sharp edges from forming and to some extent to prevent the formation of concavities along the sides of the strip.

Means are provided for feeding the stock in successive relatively short increments between reductions and after the rolls have been returned to the rear end of their stroke. This means, as shown in Fig. 1, comprises a ram 43 operated by a piston 44 within a feed cylinder 45.

The piston is actuated in the feeding direction under a constant resilient force as by a gas under pressure and this is opposed by a non-resilient force as by a liquid in confinement. Herein the front end of the cylinder is filled with water which is admitted by a pipe 46 from a supply tank 47, the pipe being provided with a check valve 48 to trap the water in the cylinder. Air under pressure is admitted to the rear end of the cylinder by way of a pipe 49 and a four-way valve 50 from a supply pipe 51. When air is admitted to the cylinder 45 the top of the tank 47 is connected to the atmosphere by way of a pipe 52, valve 50 and an exhaust pipe 53.

The periodic release of liquid from the cylinder 45 is effected by any suitable escapement. Herein an exhaust pipe system 54, 55 connects the front end of the cylinder 45 with a discharge receptacle, for example, the tank 47 from which the water was derived. The time of release, i. e., the time of stock feeding, is controlled by an intermittently operated valve 56 which is synchronized with the reducing mechanism of the machine. As illustrated, the valve 56 is formed as a poppet valve which is operated by a cam lever 57. The lever 57 is pivoted at 58 at one end and at the other end is provided with a cam roller 59 operating upon a cam 60. The cam 60 is secured to a cam shaft 61 driven from the main drive shaft 21 through gears 62 and 63. The amount of water released, i. e. the amount of feeding, is controlled by a needle valve 64 located in the pipe system 54, 55.

If additional water is required it is supplied to the tank 47 by an inlet pipe 65 provided with a hand valve 66.

After the piston 44 has moved the stock forward to the point where a new length of stock is required, it is returned toward the rear end of the cylinder by reversing the valve 50 to open the rear end of the cylinder 45 to the exhaust pipe 53 and to connect the pipe 52 leading to the tank to the air supply pipe 51. The air under pressure in the tank forces the water therefrom into the front end of the cylinder 45 and forces the piston 44 rearward. At this time air from the rear end of the cylinder is forced out the exhaust pipe 53. Preferably, the machine is stopped while a new length of stock is being introduced.

In operation, a length of stock is fed into the guide 33 and its front end engaged behind the end of the previous length of stock when the feed ram 43 is retracted. At each stroke of the crank shafts the reducing rolls act upon the stock to reduce it under compression as they move forward and then they return without doing any appreciable work on the stock. At the rear end of the return stroke the rolls are held substantially clear of the stock. While the rolls are in this position the ram is moved forward by the release of an increment of fluid from the feed cylinder 45 by the exhaust valve 56. This intermittent action continues until the feed ram reaches the end of its stroke when it is withdrawn and a new length of stock is placed in the machine.

By known reducing processes it is impossible to work strip or sheet metal stock cold beyond about 35% or 40% reduction without annealing; but by the present process one is enabled to reduce strip and sheet metal of any known type above 40% and even up to 400% and above to almost any extent desired without annealing.

While one embodiment of the invention has been described in detail for the purpose of furnishing a ready understanding of the invention, it is to be understood that various changes and modifications may be made within the scope of the invention as expressed in the subjoined claims.

I claim:

1. Apparatus for reducing metal stock by a series of intermittent reducing actions which work the metal stock in successive increments of length under rolling compression from a larger section toward a smaller section, comprising in combination, a set of opposed reducing rolls, backing rolls for said reducing rolls, fixed inclined backing plates for said rolls, said rolls being reciprocable relative to said stock and backing plates and also being movable from and toward the axis of the stock as they move along said backing plates, said backing plates providing sufficient opening at their more widely spaced ends to cause said rolls to release the stock, means for gearing said rolls for positive rotation, and means timed in action with the operation of said rolls for feeding increments of length of stock to said rolls for successive action thereon by said rolls.

2. Apparatus for reducing metal stock by a series of intermittent reducing actions which work the metal stock in successive increments of length under rolling compression down a taper from a larger section toward a smaller section, comprising in combination, a set of opposed reducing rolls, backing rolls for said reducing rolls, mounting means for said rolls providing advancing and receding movement of the rolls from and

toward the longitudinal axis of the stock coincident with relative longitudinal movement between the rolls and stock, inclined backing plates for said backing rolls, said backing plates and rolls having relative longitudinal movement but said backing plates and stock not having relative longitudinal movement during each reducing stroke, said backing plates providing sufficient opening at their more widely spaced ends to cause said rolls to release the stock, said stock being fed forward by an increment of length after said rolls have released it and means for causing positive rotation of said reducing rolls during their relative longitudinal movement with respect to the stock.

3. Apparatus as set forth in claim 2 in which said roll rotating means comprises gears on said rolls, and racks which have relative longitudinal movement with respect to said gears.

4. Apparatus as set forth in claim 2 which further comprises means timed in action with the operation of said rolls for feeding increments of length of stock to said rolls for successive action thereon by the rolls.

5. Apparatus for reducing metal stock, comprising in combination, a set of reducing rolls for operating upon the stock to reduce it under compression down a taper in successive relatively short increments of length, backing rolls for said reducing rolls, backing plates for said backing rolls, a rigid frame for maintaining said backing plates at a predetermined distance apart; a relatively light mounting device on each side of the stock for holding a reducing roll and backing roll in position between the stock and the backing plate, means to reciprocate said mounting means and the rolls carried thereby, and means constraining the operative portions of said reducing rolls to move in a given general path whether the stock is positioned between them or not, said constraining means comprising elements carried by said mounting means and cooperating elements on said frame for holding said backing rolls outwardly against the backing plates.

6. Apparatus for reducing metal stock, comprising in combination, a set of reducing rolls for operating upon the stock to reduce it under compression down a taper in successive relatively short increments of length, backing rolls for said reducing rolls, backing plates for said backing rolls, a rigid frame for maintaining said backing plates at a predetermined distance apart, a relatively light mounting device on each side of the stock for holding a reducing roll and backing roll in position between the stock and the backing plate, means to reciprocate said mounting means and the rolls carried thereby, and means constraining the operative portions of said reducing rolls to move in a given general path whether the stock is positioned between them or not, said constraining means comprising extensions from certain of said rolls on each side of the stock axis and guide means for said extensions parallel to the backing plates for holding said backing rolls outwardly against the backing plates.

7. Apparatus for reducing metal stock, comprising in combination, a set of reducing rolls for operating upon the stock to reduce it under compression down a taper in successive relatively short increments of length, backing rolls for said reducing rolls, backing plates for said backing rolls, means functioning in cooperation with said backing plates for causing said reducing rolls to be moved clear of the stock at times, and means for feeding increments of stock to said rolls at such times.

8. Apparatus for reducing stock, comprising in combination, a pair of reducing rolls mounted for reciprocation along the stock axis and for transaxial movement from and toward each other, and means for guiding stock between the rolls, said means comprising members mounted to reciprocate with the rolls and trans-axially movable independently of the rolls.

9. Apparatus for reducing stock, comprising in combination, stock reducing rolls, reciprocating mounting means therefor permitting independent trans-axial movement of the rolls on opposite sides of the stock, and stock guides connected to and movable with the mounting means so as to travel with the rolls, said guides having transaxial movement independently of the rolls.

10. Apparatus as set forth in claim 9 in which said guides comprise a plurality of transverse bars attached to move with said mounting means.

11. Apparatus as set forth in claim 9 in which said guides comprise a plurality of bars in the group guided at their ends in slots in a fixed frame, and pivoted links connecting the remote bar of a group to move with the mounting means, the nearest bar of the group being moved by contact with a part of the mounting means.

12. Apparatus for reducing metal stock, comprising in combination, reciprocating means acting intermittently upon the stock to reduce it in successive relatively short increments of length, said means moving clear of the stock at one end of its stroke to permit the stock to be fed forward, guide means moving with the reducing means and frictionally engaging the stock, and devices located at a fixed position resiliently and frictionally engaging the stock to assist in controlling its feed and to hold it fixed longitudinally while said guide means are moving and said reducing means are disengaged from the stock.

13. Apparatus for reducing stock, comprising in combination, a set of reducing rolls mounted for reciprocation along the axis of the stock which reduce the stock down a taper, means located near the rolls for guiding stock therebetween, said guide means being reciprocable with the rolls, and means for causing said guide means to follow the taper of the stock.

14. Apparatus for reducing stock, comprising in combination, reducing means for reducing the stock in successive relatively short increments of length, said reducing means releasing the stock at times, and means for feeding the stock when released, said means comprising a ram, a piston and cylinder therefor, there being entrapped fluid at one end of the cylinder and resilient pressure means at the other end, means for exhausting an increment of fluid from said cylinder for each action of the rolls to permit the ram to be moved forward by the resilient pressure means, and means for introducing fluid into the cylinder to move the ram in the reverse direction and resupply fluid to the cylinder at the end of the feeding movements.

15. Apparatus as set forth in claim 14 in which said exhausting means comprises a cam actuated exhaust valve.

16. Apparatus as set forth in claim 14 in which said exhausting means comprises a cam actuated valve for timing the exhaust and means for regulating the amount of the exhaust.

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