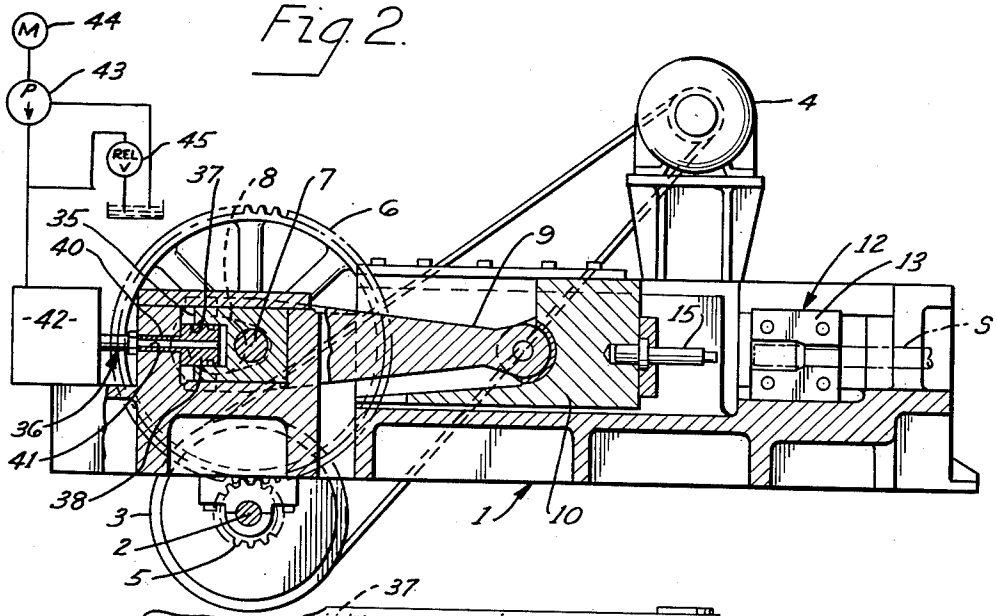
July 3, 1962 W. L. BENNINGHOFF 3,041,899

RELIEF MEANS FOR PREVENTING INTERRUPTION OF THE FORMING CYCLE OF AN UPSET FORGING MACHINE DUE TO OVERLOAD OF GRIPPER DIE

Filed Aug. 22, 1958 3 Sheets-Sheet 1

Fig. 2.



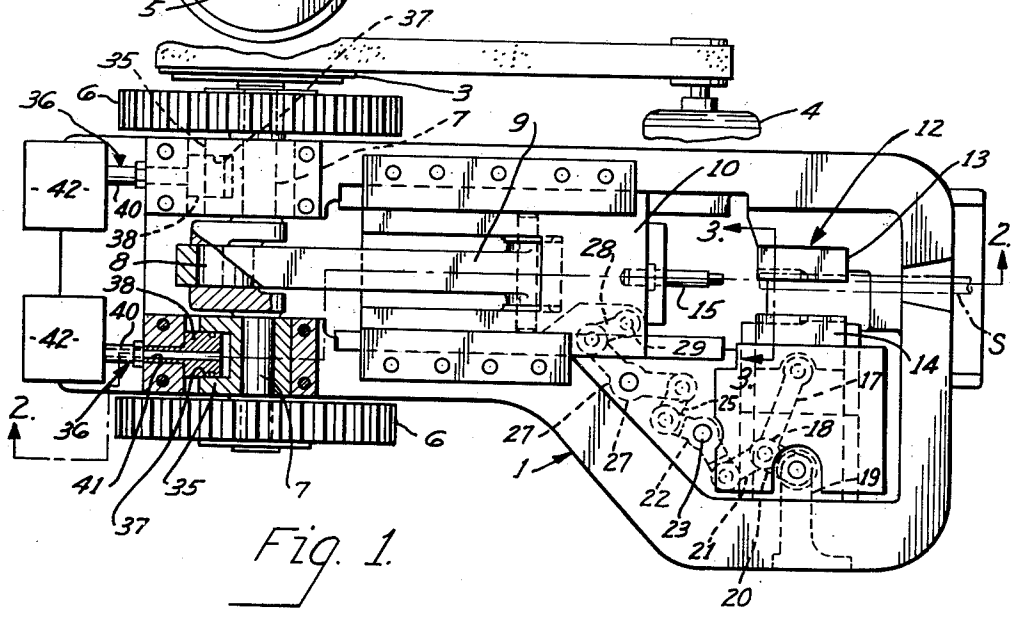


Fig. 1.

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Filed Aug. 22, 1958 3 Sheets-Sheet 2

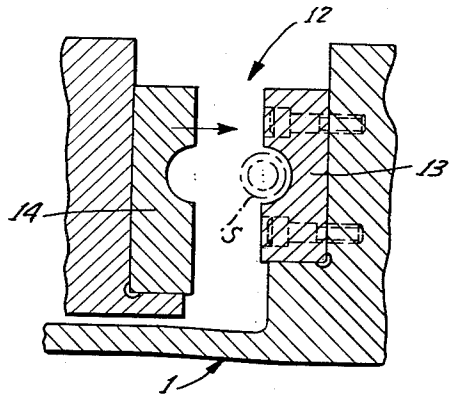


Fig 3.

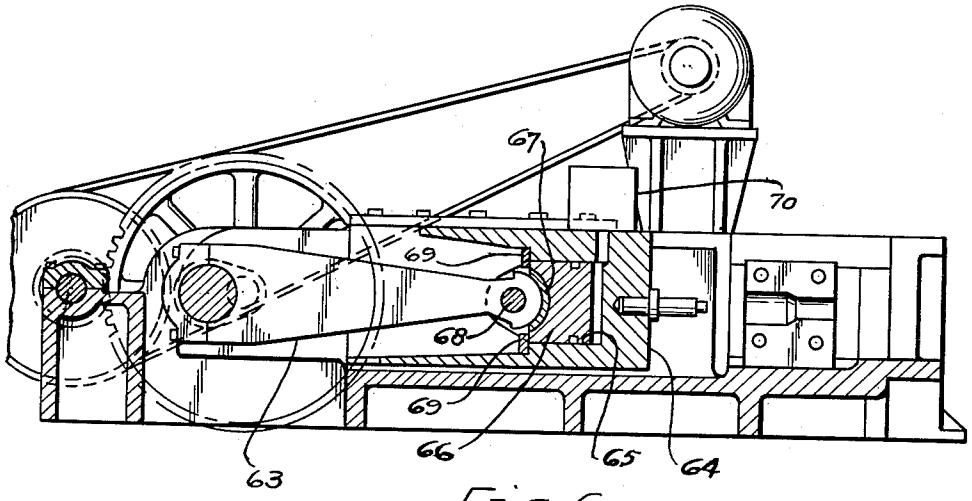


Fig 6.

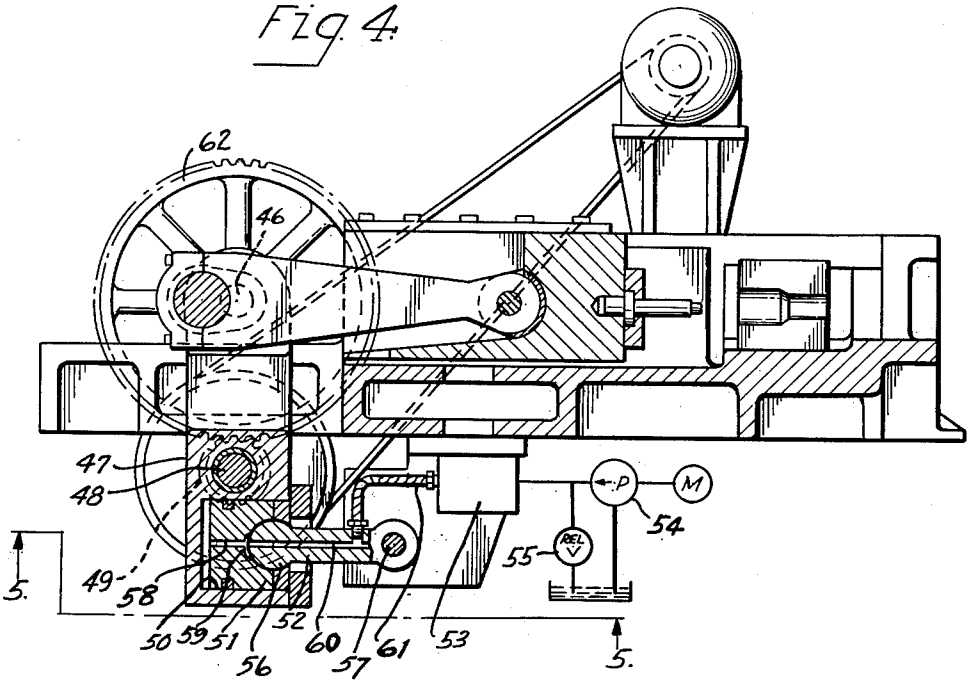
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RELIEF MEANS FOR PREVENTING INTERRUPTION OF THE FORMING CYCLE OF AN UPSET FORGING MACHINE DUE TO OVERLOAD OF GRIPPER DIE

Filed Aug. 22, 1958 3 Sheets-Sheet 3

Fig. 4.



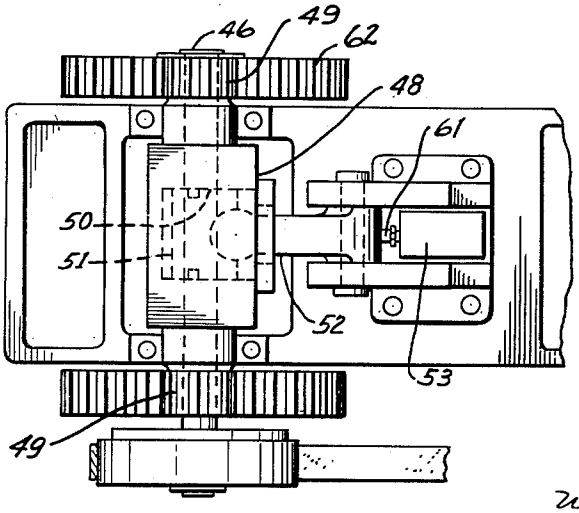


Fig. 5.

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Patented July 3, 1962

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RELIEF MEANS FOR PREVENTING INTERRUPTION OF THE FORMING CYCLE OF AN UPSET FORGING MACHINE DUE TO OVERLOAD OF GRIPPER DIE

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1 Claim. (Cl. 78—13)

This invention relates to upset forging machines and particularly to a mechanically driven upset forging machine in which the upsetting force applied to a tool carrying header slide by a crank and pitman is so controlled in relation to the gripper die holding force that the formation of objectionable fins on the stock, due to the spreading apart of the gripper dies during the terminal portion of the upsetting stroke of the slide, is eliminated, yet each cycle of operation continues to completion and produces an adequate upset piece of stock which completely fills the gripper die cavity.

For the purposes of illustration, the invention is described herein as applied to the upsetting of pipe ends to provide additional thickness for external threading, the application of the invention to other upsetting operations being readily apparent from the illustrative example.

Heretofore, in upsetting a pipe end for this purpose, the pipe customarily is gripped near the end in a suitable gripper die and then is upset by means of the tool carried on the header slide which is driven reciprocably by the crank and pitman, the final forming position of the tool being reached as the crank passes its dead center position at the side of the crankshaft nearest the gripper die.

In such upsetting machines, the driving motor drives a large and heavy flywheel which, when up to speed, is connected by a clutch to a drive shaft. The drive shaft carries, near its ends, small diameter gears which drive complementary large diameter gears on the crankshaft to which the pitman is connected. Accordingly, extremely large inertia forces are developed. Considering the slight amount of movement of the header slide lineally toward the gripper die as the pitman passes dead center position, and the tremendous mechanical advantage of the inertia forces during the terminal portion of the forming stroke, the forces developed in the gripper die when the forward movement of the tool is effectively resisted by the metal become exceedingly high. These forces are so great that an over supply of stock in the gripper die, under the influence of the tool and the inertia forces, customarily spreads the parts of the gripper die apart from each other, causing excess stock to flow out between the partially separated parts and thereby form flash or fins on the stock along the upset portion and the portions adjacent thereto.

Though the holding forces imposed for resisting separation of the gripper die parts are usually at a tremendous mechanical advantage, being provided by toggle or wedge means, and the like, nevertheless, the terrific forces developed in an overloaded gripper die under the impact of the tool cause the parts to separate—even deflecting the buttressing parts and ties of the heavy machine frame itself.

In accordance with the present invention, means are provided by which the forces imposed by the metal in the gripper die and tending to spread the parts of the gripper die apart are relieved when they approach closely to, but before they reach, equality with the holding forces that are opposing the opening of the gripper dies, in such a manner that the moving parts of the machine are enabled to complete the forming cycle, regardless of the overload, and produce an upset piece for each cycle, and also such

a manner that the machine itself is protected from damage by excessive forces.

More specifically, in accordance with the present invention, these forces are relieved in the driving connection between the main driving gear, driven by the power source, and the slide, by a resilient lost motion fluid pressure operated device which may be operatively interposed in this driving connection in a number of different locations, but preferably in accordance with the illustrative examples herein shown and described.

Various objects and advantages of the invention will become apparent from the following description wherein reference is made to the drawings, in which

FIG. 1 is a top plan view, partly in section, of an upsetting machine embodying the principles of my invention;

FIG. 2 is a vertical longitudinal sectional view of the machine illustrated in FIG. 1, and is taken on line 2—2 thereof;

FIG. 3 is an enlarged fragmentary vertical cross sectoinal view of the machine and is taken on lines 3—3 in FIGS. 1 and 2;

FIG. 4 is a view similar to FIG. 2, illustrating a modified arrangement of the lost motion device in the force transmitting means;

FIG. 5 is a fragmentary sectional view taken on line 5—5 of FIG. 4; and

FIG. 6 is a vertical longitudinal sectional view, similar to FIG. 1, illustrating another modified arrangement of the lost motion force transmitting means.

Referring to the drawings, the upset forging machine or press comprises a frame, indicated generally at 1, in which is rotatably mounted a drive shaft 2 which is driven by means of a combined conventional clutch and flywheel 3 which, in turn, is driven by a motor 4.

The shaft 2 extends transversely of the frame and near its opposite ends is provided with small diameter main driving gears 5 which engage complementary large diameter main driven gears 6 on a crankshaft 7. The crankshaft 7 is a provided with a crank portion 8 which is connected by means of a pitman 9 to a header slide 10. The slide 10 is mounted for sliding movement lineally endwise of the frame 1.

Also mounted in the frame 1 is a gripper die, indicated generally at 12, and comprising a stationary part 13 and a laterally movable part 14, these parts being arranged for movement of the part 14 transversely of the frame for opening and closing the gripper die.

An upsetting tool 15 is mounted on the end of the slide 10 for cooperation with the gripper die 12 for upsetting a length of stock S which is gripped by the gripper die.

The gripper die is closed preparatory to the engagement of the tool 15 with the stock. This closure may be effected in various ways. In the form illustrated, it is effected by means of suitable toggle and linkage connections which comprise a link 17 which is pivotally connected at one of its ends to the movable die part 14. The link 17, at its other end, carries a roller 18 which rolls about a laterally fixed abutment 19 on the frame, being held in proper relation thereto by a link 20. Pivotally connected to the link 17 for swinging about the axis of the roller 18 is a link 21. The link 21, in turn, is pivotally connected at one end to one arm of a rocker 22, which is pivoted intermediate its ends for rocking about a fixed pivot 23. The other arm of the rocker 22 is pivotally connected to one end of a link 25. The opposite end of the link 25 is pivotally connected to one arm of a rocker 27, the other arm of which is connected to a link 28. The other end of the link 28 is connected to the slide 10 by a pivot 29.

Forward movement of the slide 10 operates the link and toggle system to close the gripper die in gripping relation

to the stock prior to cooperation of the tool and gripper die, and to hold it closed so long as the tool is operatively engaged with the stock.

For example, as the slide 10 moves to the right in FIGS. 1 and 2, it swings the rocker 27 clockwise, thus rocking the rocker 22 counterclockwise, thrusting the link 21 to the right and causing the roller 18 to roll clockwise about the periphery of the abutment 19. This forces the link 17 toward the die 13, thus moving the part 14 into closed position and holding it in closed position.

The linkage is so arranged that the link 17 is substantially parallel to the direction of closing movement of the die part 14, thus creating a great mechanical advantage for gripping of the stock and holding of the gripper die 12 in closed position.

As mentioned, when the parts are in motion, tremendous inertia forces are developed, particularly in the clutch, flywheel, gears, and rotary shafts. On the other hand, very high forces resist the opening of the gripper die, these including the closing forces or gripping forces occasioned by the link and toggle mechanisms described and the inherent rigidity or resiliency of the machine frame. Even the frame, itself, often yields under those pressures imposed by the tool on the stock which tend to force the gripper die open when the gripper die is overloaded, if the forces occasioned by the tool are not relieved in some manner.

As mentioned, these forces are relieved insofar as concerns cooperation of the tool and the stock in the gripping dies by means of a yieldable lost motion pressure device interposed in the driving connection between the gear 5 and the slide 10. This driving connection generally includes main gears 6, the crankshaft 7, the eccentric or crank 8, and the pitman 9.

In the preferred embodiment of the invention, this device includes a pair of bearing blocks 35 which are slidable in the frame 1 in a direction generally endwise of the path of travel of the slide 10 so that they move in a direction generally toward and away from the gripper die 12. The ends of the crank shaft are rotatably mounted in the blocks 35, respectively. Normally these blocks 35 are in a position such that the axis of the crankshaft 7 and the axis of the drive shaft 2 define a plane at right angles to the direction of travel of the slide 10. Thus, the blocks 35 can move away from the gripper die 12 and allow the driven gears 6 and crankshaft 7 to migrate around the gear 5 with only slight displacement radially of the gears 5 and 6. Consequently, the gears 5 and 6 can maintain a substantially full meshing of their teeth. The blocks 35 may be connected rigidly together if desired, but in the form illustrated are unconnected except by the shaft 7.

Yieldably opposing the movement of the blocks 35 away from the die 12 is a yieldable fluid pressure operated lost motion device, designated generally at 36. The device comprises two units, each of which includes a cylinder member 37 which preferably is formed in its associated block 35, and a piston 38 which is reciprocable in the cylinder. The piston 38 has a rod 40 which is connected fixedly to the frame 1. The rod is provided with an axial bore 41 which communicates through the piston 38 with the cylinder 37 at one end and which, at the other end, communicates with an accumulator 42. The accumulator 42 is continuously supplied with pressure fluid by means of a pump 43 driven by a suitable motor 44. The pump may be a variable delivery pump which can be set to supply a predetermined pressure and which, if the pressure is exceeded, vents the excess fluid to a suitable sump. If desired, instead, a settable relief valve 45 may be provided between the accumulator and pump, this settable relief valve being adjustable so as to maintain the predetermined maximum pressure desired within the accumulator. Generally, one such unit is provided for each block 35, but, if desired, both pistons can be connected to a common accumulator. The accumulators are of adequate capacity to allow almost instantaneous movement of their associated blocks 35 in a direction away from the die 12 upon development of excessive pressure in the die 12 and, consequently, relief of the excessive pressure, and to maintain the resultant reduced pressure until the blocks 35 return to their starting positions.

This large capacity is essential due to the rapidity with which the relief must occur as the eccentric 8 passes the dead center position at the side of the shaft 7 toward the slide 10. The resisting pressure of the accumulators is such that the pressure is relieved and the blocks 35 are permitted to recede from their normal position and allow the continued rotation of the crankshaft even when the forward movement of the slide is completely arrested. This pressure is chosen so that the relief occurs at a pressure approaching but below the pressure which would cause separation of the parts of the gripper die 12 and formation of flash.

Thus the device not only provides protection for the machine but it precludes the formation of the fins or flash on the part due to the overloading and spreading of the gripper die 12 while assuring a complete upsetting operation each cycle.

If, due to overfilling of the die 12 by too thick stock, the pressure increases near to the point where it would cause the metal to separate the parts 13 and 14, the pressure is relieved, and the header 10 and the tool 15 stop, yet the rotating parts continue past the dead center position of the crankshaft, and return the slide to starting position.

The only difference in the resultant upset stock, due to overfilling, as compared to proper filling, is a negligible difference in the thickness of the wall at the upset, and a slight difference in the length of the upset.

Referring next to FIGS. 4 and 5, a shaft 46, corresponding to the shaft 7, is mounted in a rocking frame 47 which is supported on, and rockable about, the shaft 48 of the main driving gears 49 which correspond to the gears 5, heretofore described. The shaft 48 is mounted in the stationary main frame of the press. The frame 47 is provided with a lost motion device which is in the form of a single unit including a cylinder 50 in which is reciprocable a piston 51, the piston 51 having a rod 52. The piston rod is connected to an accumulator 53 to which pressure fluid is supplied from a suitable motor driven pump 54 through an adjustable settable relief valve 55. To withstand the thrust occasioned by rocking of the frame 47, the piston rod is connected at one end to the piston 51 by a ball and socket connection 56 and at the other end is connected to the main frame by a pivot 57. The piston 51 has a duct 58 which leads from the head end of the cyinder 50 to the ball and socket joint at which point the duct opens into a pocket. The piston rod is provided with a duct 60 which opens into the pocket 59 and which is connected to a suitable flexible conduit 61 which, in turn, is connected with the accumulator 53.

This form of the invention has an advantage in that the rotation of the rocking of the frame 47 is about the axis of the shaft 48 and, therefore, the gears 49 remain fully in mesh at all times with their complementary driven gears 62, which correspond to the gears 6 heretofore described.

Referring next to FIG. 6, the yieldable lost motion connection also is a single unit interposed between the pitman 63, which corresponds to the pitman 9, heretofore described in connection with FIG. 1, and the slide 64, which corresponds to the slide 10, heretofore described. In this form, the slide 64 is provided with a cylinder 65 in which is reciprocable a piston 66. The piston 66 is provided at the face adjacent the pitman 63 with a concave cylindrical bearing surface 67. The surface 67 is engaged by a complementary bearing surface on the forward end of the pitman 63 for applying the pressure of the pitman to the piston 66 and through the fluid pressure in the cylinder, to the slide 64.

A suitable pin 68 is mounted in the pitman 63 and is

connected at its ends to the piston **66**. Stops **69** are provided at the entry end of the cylinder **65** for arresting the rearward movement of the piston **66**. Thus, upon return of the pitman **63** toward its starting position, the pin cooperates with the piston **66** to move it in the return direction until it engages the stop **69**, and thereby retracts the slide **64**.

An accummulator **70**, such as heretofore described, is carried on the slide and is connected with the cylinder **65** in front of the piston **66**.

It is apparent that, in all of the examples illustrated, a yieldable lost motion fluid pressure device is interposed in the driving connection between the main driving shaft and the slide in such manner that it can relieve the driving pressure applied to the slide by the driving shaft or power source almost instantaneously while maintaining the full forming pressure, can permit all parts to complete a full cycle, and can prevent the pressure from increasing sufficiently to expand the gripper die **12**.

Having thus described my invention, I claim:

In an upset forging machine including a frame, a gripper die mounted therein and having laterally separable parts, holding means for holding the parts in closed gripping relation to a length of stock and resisting separation of the parts with a predetermined holding force, a header slide, an upsetting tool carried thereby and arranged to enter and cooperate with the gripper die to upset and form metal stock upon movement of the slide on its facing stroke, a power driven drive shaft, force transmitting means, including a pitman and crankshaft, connecting the drive shaft and slide for driving the slide through a complete cycle including a forming stroke and a return stroke, said force transmitting means including a yieldable lost motion fluid pressure device operable to relieve and reduce the driving force applied to the slide by the force transmitting means when the gripper die opening force created by the cooperation of the tool and stock is less than, but has approached, said holding force, and to maintain said driving force at reduced value while affording continued operation of the force transmitting means throughout the remainder of a forming cycle, a movable support for the crank shaft supporting the crank shaft for movement transversely of its axis generally toward and away from the gripper die, said force transmitting means including a main driving gear on the drive shaft drivingly engaging a main driving gear on the crank shaft, the axes of said gears defining a plane at approximately right angles to the direction of the movement of the support, said support being carried by the frame and supported thereon for rocking movement about the axis of the drive shaft, and said device being operatively connected to the support for yieldably opposing said rocking movement of the support in the direction wherein the crank shaft is movable away from the die.

References Cited in the file of this patent

UNITED STATES PATENTS

432,360	Bettendorf	July 15, 1890
733,898	Beker	July 14, 1903
1,610,137	Kratsch	Dec. 7, 1926
1,618,001	Gauthier	Feb. 15, 1927
1,713,974	Massey	May 21, 1929
1,870,527	Pardee	Aug. 9, 1932
2,002,289	Hancock	May 21, 1935
2,128,152	McMillan	Aug. 23, 1938
2,236,154	Patrick	Mar. 25, 1941
2,491,279	Rodgers et al.	Dec. 13, 1949
2,647,421	Criley	Aug. 4, 1953
2,784,665	Georgeff	Mar. 12, 1957

FOREIGN PATENTS

526,298	France	June 29, 1921
657,540	Germany	Aug. 23, 1938