

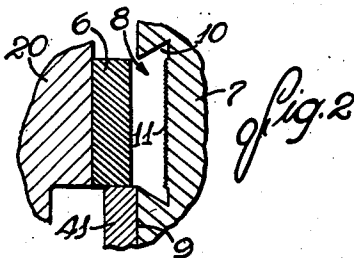
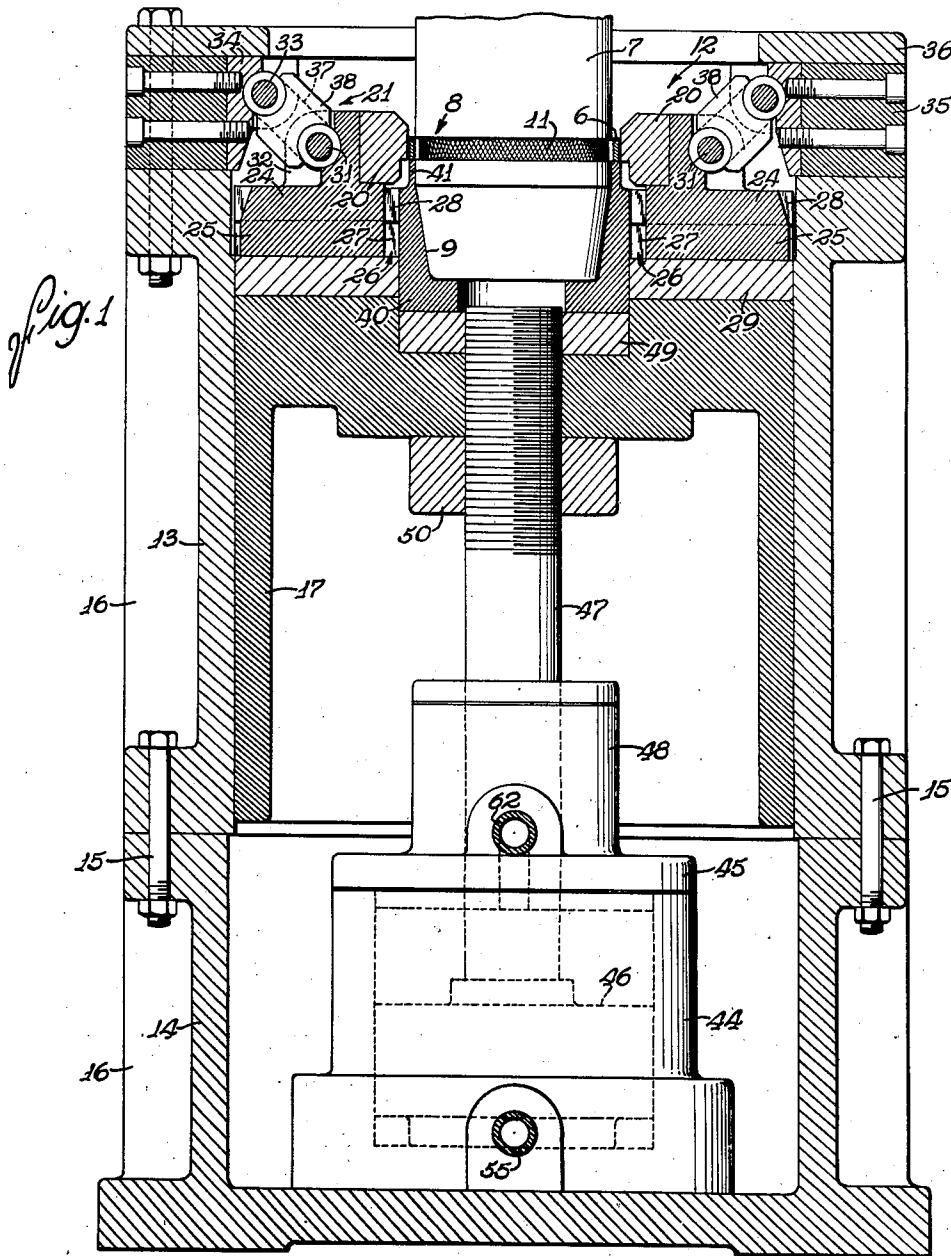
Aug. 4, 1942.

C. C. GROTNES  
SHELL BANDING MACHINE

2,291,803

Filed Dec. 9, 1940

2 Sheets-Sheet 1



INVENTOR  
Carl C. Grotnes  
B. Parker, Gordon, P. J. Hubbard.  
ATTORNEYS

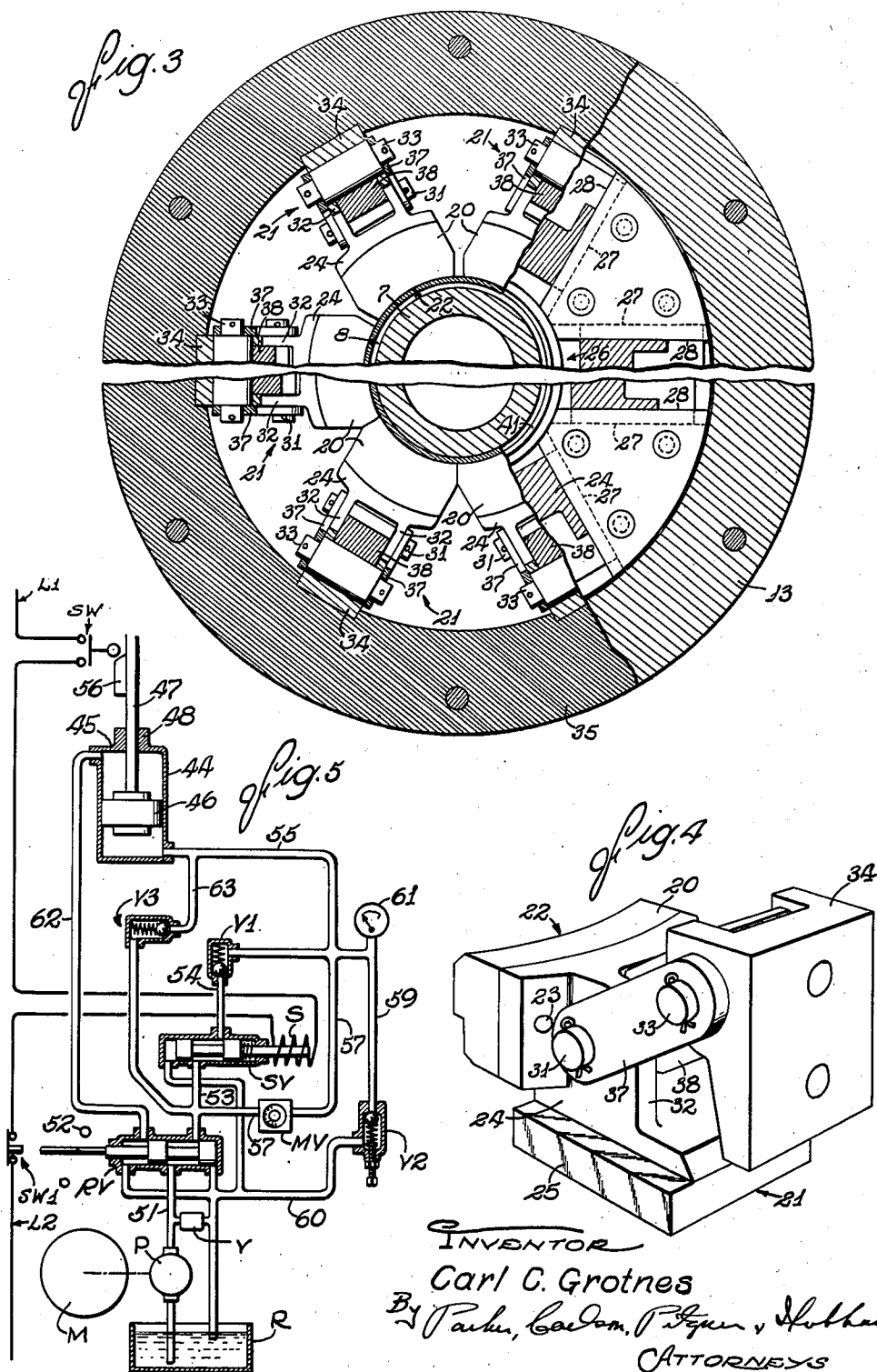
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## UNITED STATES PATENT OFFICE

2,291,803

## SHELL BANDING MACHINE

Carl C. Grotnes, Park Ridge, Ill.

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4 Claims. (Cl. 78—15)

The invention relates to an improved machine for applying driving bands to projectiles or shells.

Shells intended for use in rifled guns are provided with one or more driving bands which, in conjunction with the rifling of the gun, impart 5 rotational movement to the shell in its passage through the gun bore. The band is customarily made of copper or a copper alloy known as gilding metal, and it is ordinarily pressed into an undercut peripheral groove near the base of the shell. To insure proper functioning when the shell is fired, the band must be pressed in place with sufficient force to effect a firm binding or gripping engagement between the band and the walls of the groove, and for satisfactory results a high degree of uniformity is essential. 10

The application of driving bands with the shell banding machines heretofore available has been a slow and difficult process. Such machines ordinarily include a series of radially movable dies, each with an individual power driven actuator for moving it inwardly into engagement with the band, and the band is subjected to three or more pressing operations between each of which the shell is rotated about its longitudinal axis to present a different band area to the dies. With such machines a substantial amount of time is unnecessarily consumed, considerable skill on the part of the attendant is required, and the operation is apt not to be uniform and is generally unsatisfactory. 15

A factor of primary importance in the application of driving bands to shells is the time required to insure the flow of the metal of the band as the same is being compressed into its groove. Thus, a predetermined minimum time is required for the compressing operation, varying with the size of the band i. e., the circumference and cross sectional area thereof, more time being required as the band increases in size. Moreover, it is important that the compressing operation take place at a gradually decreasing rate but with a gradually increasing force in order to insure that a firm gripping engagement between the band and the shell will be produced. Finally, a high degree of uniformity in the operation is desirable, not only to insure proper seating of the band in its groove, but to avoid variations in hardness of the band which may occur as an incident to variations in the rate and degree of pressure exerted thereon. 20

The primary object of the present invention is to provide a shell banding machine having means for compressing the band into its receiving groove operative with a gradually increasing 25

force but at a decreasing rate of compression, together with means for controlling the operation so as to obtain uniformity while permitting variations in accordance with the size of the band.

Another object is to provide in a machine of the foregoing character, an actuating means automatically operative to prevent compression of the band beyond a predetermined desired maximum degree. 30

Another object is to provide a shell banding machine in which a set of compressing dies are actuated in the performance of the compressing operation by means of a reciprocatory actuator movable at a predetermined constant speed, through the medium of a mechanical motion transmitting connection acting to increase the effective pressure gradually up to a predetermined maximum, while simultaneously decreasing the rate of movement of the dies. 35

Another object is the provision of an improved shell banding machine which is faster and more accurate in operation and which requires a minimum of skill on the part of the attendant. 40

Another object is to provide a shell banding machine embodying novel die actuating mechanism and controls whereby the dies may be rapidly closed upon the driving band to avoid waste of time and then advanced at an accurately controllable rate so as to effect a gradual flow of metal of the band into all portions of the shell groove. 45

Other objects and advantages of the invention will become apparent from the following detailed description of the preferred embodiment illustrated in the accompanying drawings in which: 50

Figure 1 is a vertical sectional view of a shell banding machine embodying the features of the invention.

Fig. 2 is a fragmentary sectional view of a shell and a driving band as assembled in the machine before the band is pressed into the shell groove.

Fig. 3 is a top view of the machine with a portion broken away to show the arrangement of the die mechanism and the actuating means therefor. 55

Fig. 4 is a perspective view of one of the units forming the die mechanism.

Fig. 5 is a diagrammatic view of the hydraulic and electrical control and operating circuits of the machine.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment, but

it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

For purposes of illustration, the improved shell banding machine has been shown as arranged for applying a copper band 6 (Figs. 1 and 2) to a shell 7 having a single band receiving groove 8. This groove extends around the periphery of the shell closely adjacent the base portion thereof which is slightly tapered as indicated at 9. In accordance with the usual practice, the sides of the groove are under-cut as at 10 (Fig. 2) and the base 11 of the groove is knurled or otherwise roughened to effectually maintain a driving engagement between the band and the shell under all conditions. The band 6 of course, is initially formed with an internal diameter sufficient to enable it to be slipped over the shell. It is then contracted and pressed into the groove 8 by a suitable die mechanism 12.

In carrying out the invention, a die mechanism is employed including a set of radially movable dies, together with an actuating mechanism comprising a reciprocatory actuator disposed axially of the dies, and a motion transmitting connection including toggle links operative in the movement of the actuator to exert a gradually increasing force upon the dies. Although the actuator be moved at a predetermined constant rate, the toggle links, due to their power multiplying action, automatically introduce the gradually increasing time interval necessary to the flow of the metal in the compressing operation. For variations in the rate of compression rendered necessary because of differences in the sizes of the bands, it is only necessary to change the rate of movement of the actuator, an adjustment which is obtainable to advantage through the use of actuating mechanism hydraulic in character.

In its preferred form the machine comprises a generally cylindrical base herein shown as consisting of upper and lower sections 13 and 14 secured together in end to end relation as by bolts 15. Both sections are constructed with external strengthening ribs 16 and the upper section is formed internally to provide a slideway for a vertically reciprocatory head 17.

The head 17 carries the band engaging portion of the die mechanism 12 which, as herein shown, comprises a series of segmental die blocks 20 (Figs. 1-4) each mounted on a radially movable carrier 21. The inner ends 22 (Figs. 3 and 4) of the die blocks are formed with arcuate contours on radii centered on the axis of the head so that the blocks, in their inner position, define a cylindrical cavity having a diameter corresponding to that of the band after it has been pressed into its groove. An appropriately dimensioned set of die blocks is required, of course, for each size of shell banded in the machine. To facilitate interchange, the die blocks are therefore removably secured to the carriers as by machine screws 23.

The carriers 21 are all alike and as herein shown, each comprises a generally rectangular metal block 24 having laterally projecting flanges 25 on opposite lower side edges. These flanges fit into a guideway 26 on the head, one of which is provided for each carrier for guiding the same toward and from the shell. In the particular machine illustrated, the guideways are formed by

wedge shaped spacers 27 and segmental retaining plates 28 arranged in spaced relation and bolted to the face of an annular bed plate 29 (Fig. 1) carried by the head. The spacers are arranged to provide a series of substantially equally spaced radially disposed slots dimensioned to slidably receive the flanged portions of the carriers 21. The plates 28 are constructed so as to extend over the edges of the spacers 27 and thus overlie the sides of the slots defined by the spacers. In this position the edges of the plates act to engage the carrier flanges 25 and thus retain the carriers in the guideway.

Each carrier is moved radially in its guideway in response to the axial reciprocation of the head 17, and for this purpose a toggle mechanism is advantageously employed. This toggle mechanism comprises as herein shown a pin 31 fastened between spaced rearwardly projecting ears 32 on the carrier block 24 and connected by a link with a pin 33 mounted on a channel shaped stationary block 34 bolted or otherwise rigidly secured to a thrust ring 35 firmly anchored to the top of the upper base section 13. An annular plate 36 bolted to the ring 35 engages the upper end of the stationary blocks 34 to relieve the attaching bolts of strains due to the actuation of the toggle mechanism.

The link connection between the pins 31 and 33 preferably comprises a pair of tension links 37 engaging the projecting ends of the pins and a compression link 38 having semicylindrical sockets at each end engaging the central portions of the respective pins. While the links 37 can transmit compression as well as tension stresses, the major portion of the compression load is carried by the links 38 which, because of their relatively large cross section, are less susceptible to distortion under compression than the links 37.

Suitable means is provided on the head for holding the shell 7 in an upright position concentrically of the die blocks 20 and for holding the band 6 in alignment with the groove 8 in the shell. This means as herein shown, comprises a cylindrical holder 40 mounted in a central recess in the head and projecting through the aperture of the bed plate 29. The holder is formed internally with a cup-shaped socket adapted to receive the base of the shell 7, which as explained hereinbefore, is usually slightly tapered as shown in Fig. 1. Encircling the upper end of the holder is a cylindrical flange 41 having its upper edge disposed in the same plane as the lower side wall of the groove 8 in the shell. The band 6 when initially slipped over the shell rests on this flange as shown in Fig. 1 which is thus effective to position the band in alignment with the groove. The outer wall of the flange is recessed to provide clearance for the die blocks 20 in their inward movement.

As hereinbefore indicated it is of primary importance that the bands be compressed uniformly and at a gradually decreasing rate, with an ample time allowance to permit the flow of the metal of the band and with a predetermined maximum force sufficient to insure interengagement of the metal of the band with the roughened surface of the bottom 11 of the groove 8. In the attainment of this result I employ hydraulic means co-acting with the toggle mechanism, such means being capable of accurate regulation so as to impart a uniform constant rate of movement to the head, and being likewise readily adjustable

with respect to the rate at which the pressure is applied.

The hydraulic means as herein shown, comprises a cylinder 44 mounted in a vertical position in the lower base section 14. A head 45 closes the upper end of the cylinder. The cylinder is provided with a working piston 46 having a piston rod 47 extending upwardly through a stuffing box 48 on the cylinder head 45 and projecting through an aperture in the top wall of the head 17 for connection therewith. The connection is provided in the present instance by clamping nuts 49 and 50 threaded on the projecting end of the piston rod on opposite sides of the head, the nut 49 forming the base of the recess for the holder 40. With this arrangement, the limit positions of the head may be readily adjusted by turning the nuts on the piston rod. It will be observed that the holder 40 is provided with an aperture in its base to accommodate the projecting end of the piston rod.

Pressure fluid is supplied to the cylinder 44 for shifting the piston and head 17 by a suitable pressure fluid pump P (Fig. 5) driven by a motor M. The pressure fluid is delivered to the cylinder through the hydraulic circuit shown diagrammatically in Fig. 5 which includes suitable valves and other control instrumentalities for governing the operating cycle of the machine in the manner required for proper application of the driving bands. More particularly, the controls are arranged to impart automatically first a relatively rapid movement to the head 17 in which the die blocks 20 are moved quickly into engagement with the band, and then a slow compressing movement at a uniform constant speed during which the die blocks are advanced with a force gradually increasing to a predetermined maximum but at a gradually decreasing rate due to the action of the toggle mechanism.

Referring now to Fig. 5, the pump P is arranged to draw fluid from a sump or reservoir R and deliver it under pressure through a duct 51 to a reversing valve RV. A relief valve V prevents excessive pressure in the system. The reversing valve may be of any suitable and well known construction, and, in the present instance, is arranged for manual operation by means of a hand lever 52. With the valve in the position shown in Fig. 5, pressure fluid from the duct 51 is directed by way of a duct 53, normally open shut-off valve SV, duct 54, check valve V1 and duct 55 to the lower end of the cylinder 44. The piston 45 is thus shifted upwardly and, through the toggle mechanism, acts to close the die blocks together on the driving band and shell.

The valve SV is arranged to be closed by a solenoid S when the solenoid is energized. Current is supplied to the solenoid from any suitable source by way of line conductors L-1 and L-2 under control of a switch SW arranged to be actuated in timed relation to the closing of the die mechanism. As herein shown, the switch is closed at a predetermined point in upward movement of the head 17 through the medium of a cam 56 conveniently mounted on the piston rod 47. The cam is preferably adjustable so that the point at which the switch is closed may be varied as required.

Upon closure of the valve SV, pressure fluid is supplied to the lower end of the cylinder 44 through a by-pass circuit including a duct 57 in which is interposed a metering or feed control valve MV which substantially reduces the

volume of pressure fluid delivered to the cylinder. The valve MV is preferably manually adjustable so that the rate of feed can be varied as required.

In practice, the switch SW will be set to close substantially at the time the die blocks reach the position shown in the upper part of Fig. 3, that is, at the instant the die blocks engage the band 6. In other words, the die blocks are quickly closed on the driving band with a consequent saving in operating time. Thereafter the head is raised slowly at a uniform constant speed adjusted in accordance with the size of the band being operated upon. With the rate of movement of the head thus controlled, coupled with the gradually decreasing rate of movement of the die blocks due to the movement of the toggles from an initial inclined position substantially into dead center position, ample time is insured for the compressing operation.

The amount of pressure applied to the head is maintained at a predetermined maximum to obtain uniformity in operation by an adjustable relief valve V2 connected in a branch circuit with the duct 55 by a duct 59. This valve may be set to open at any predetermined pressure and, on opening, returns pressure fluid to the reservoir R through a drain duct 60. A pressure gauge 61 of any suitable character may be connected with the duct 59 to indicate the effective pressure on the piston 46 for the guidance of the attendant.

In the upward movement of the piston 46, spent pressure fluid is discharged from the upper end of the cylinder 44 through a drain duct 62, reversing valve RV and drain duct 60. When the reversing valve is manually operated to its alternate position, pressure fluid is directed through the duct 62 to the upper end of the cylinder, thus shifting the piston downwardly and retracting the die blocks. In order to allow quick return of the piston and avoid unnecessary delay between operations, spent pressure fluid from the lower end of the cylinder 44 is discharged through a by-pass duct 63 and reversing valve RV to the drain duct 60. A check valve V3 is interposed in this by-pass duct to direct the flow of pressure fluid through the valves SV and MV in the first part of the operating cycle.

When it is desired to operate the piston 46 through its full stroke without the delayed action above described, the circuit for the solenoid S is temporarily disabled by means of a manually operable switch SW1 interposed in the line conductor L-2. Under these conditions, the movements of the piston and head are under sole control of the manually operable reversing valve RV.

In the operation of the machine, the shell 7 to be banded is placed in the holder 40 while the head is in the lower or inactive position shown in Fig. 1. In this position the die blocks of course, will be fully retracted. No particular skill is required in placing the shell in the machine since the holder 40 is arranged to position the same in correct relationship to the die mechanism. The band 6 is then slipped over the shell and allowed to rest on the upper end of the flange 41. This serves to position the band in exact alignment with the groove 8.

The attendant may now actuate the starting lever 52 to operate the valve RV to the position shown in Fig. 5, whereupon the piston 46 and the head 17 are moved upwardly at a rapid rate to close the die blocks together on the band 6.

As the die blocks reach the position shown in the upper portion of Fig. 3, that is, upon their engagement with the band, cam 56 closes the switch SW to energize the solenoid S and thus close the valve SV. The supply of pressure fluid to the cylinder is now controlled by the metering valve MV and movement of the head proceeds at a relatively slow constant rate. The die blocks however, are advanced at a gradually decreasing rate as the toggle links move from the inclined position shown in Fig. 1 substantially into horizontal or dead center position. This gradual deceleration of the die blocks prolongs the compressing operation so as to allow the necessary time for the flowage of the metal of the band. At the same time a corresponding multiplication of power is obtained to insure that the band will be forced home.

When the ring is fully seated in the groove as evidenced by the completion of the forward movement of the die blocks, an indication is given to the operator by the gauge 61 or by the opening of the relief valve V2. The attendant may then operate the reversing valve to its alternate position and thereby return the head to its lower position which causes a retraction of the die blocks. With the die blocks retracted, the banded shell may be lifted from the holder and another shell and band placed therein for the next operation.

It will be apparent from the foregoing, that the invention provides a shell banding machine of novel and improved construction. By reason of the novel die actuating mechanism and controls therefor, the die mechanism is rapidly closed upon the driving band and then advanced at a gradually decreasing predetermined rate according to the size of the band, the maximum force finally exerted being the exact predetermined pressure required to force the band home and insure binding engagement with the bottom of the groove. Thus the band is forced firmly and accurately into the groove provided for its reception without any effort on the part of the attendant other than starting the operating cycle. The point at which the change in the rate of movement of the head takes place is determined by the setting of the machine and requires no attention on the part of the attendant. Moreover, due to the provision of a single actuator, the die blocks act uniformly on the band around its entire periphery and thus insure proper seating of the band in the groove.

I claim as my invention:

1. A shell banding machine having, in combination, a movable head, means carried by the head for supporting a peripherally grooved shell with a driving band in alinement with the groove, an annular die mechanism adapted to be closed on the band to press the same into the groove in the shell, actuating means for said die mechanism operable in response to the movement of the head, pressure fluid actuated means for advancing and retracting the head, a two posi-

tion valve controlling the supply of pressure fluid to said pressure fluid actuated means operable in one position to effect a relatively rapid advance of the head and in the other position to effect a substantially slower advance of the head, a solenoid operative when energized to shift the valve from said one position to the other, and a switch actuated in timed relation to the advance of the head for energizing said solenoid substantially simultaneously with the engagement of the die mechanism with the driving band.

2. A shell banding machine having, in combination, a movable head, means carried by the head for supporting a peripherally grooved shell with a driving band in alinement with the groove, an annular die mechanism adapted to be closed on the band to press the same into the groove in the shell, actuating means for said die mechanism operable in response to the movement of the head, pressure fluid actuated means for advancing and retracting the head, a two position valve controlling the supply of pressure fluid to said pressure fluid actuated means operable in one position to effect a relatively rapid advance of the head and in the other position to effect a substantially slower advance of the head, and means actuated incident to the reciprocation of the head for controlling the position of said valve.

3. A shell banding machine having, in combination, means for supporting a peripherally grooved shell with a driving band encircling the same and alined with the groove, die mechanism including an annular series of die blocks supported for radial movement toward and from the shell, common pressure fluid actuated means for moving all of said die blocks simultaneously toward the band, a valve controlling the supply of pressure fluid to said last means normally set to effect a rapid movement of the die blocks toward the band, and means operative automatically for resetting said valve substantially simultaneously with the engagement of the band by said die blocks to effect a substantially slower movement of the die blocks through the remainder of their travel.

4. A shell banding machine comprising, in combination, a head movable between retracted and operated positions, means carried by the head for holding a peripherally grooved shell, means for holding a driving band in alinement with the groove in the shell, die mechanism adapted when partially operated to engage the driving band and when fully operated to press the band into the groove in the shell, actuating means for said die mechanism operated in response to the movement of the head to operated position, power actuated means for moving the head, and control means for regulating said power actuated means to effect an initial rapid movement of the head for partially operating the die mechanism followed by a substantially slower movement of the head to complete the operation of the die mechanism.

CARL C. GROTNES.