

Jan. 24, 1961

W. F. COUSINO
FEEDING APPARATUS

2,968,982

Filed Nov. 8, 1957

3 Sheets-Sheet 1

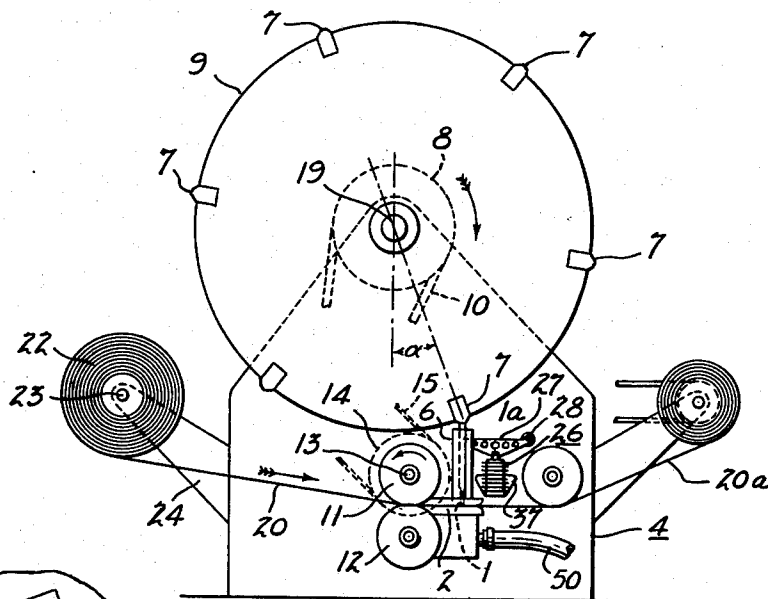


Fig. 1

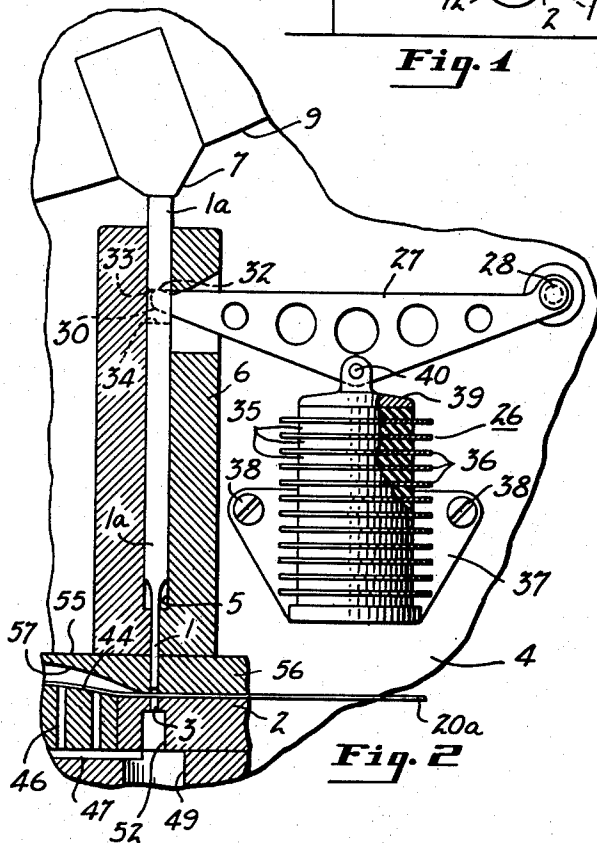


Fig. 2

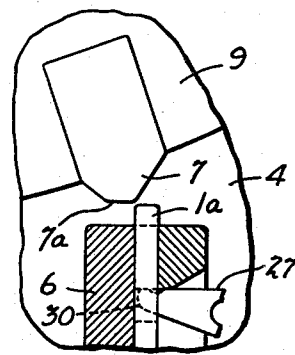


Fig. 3

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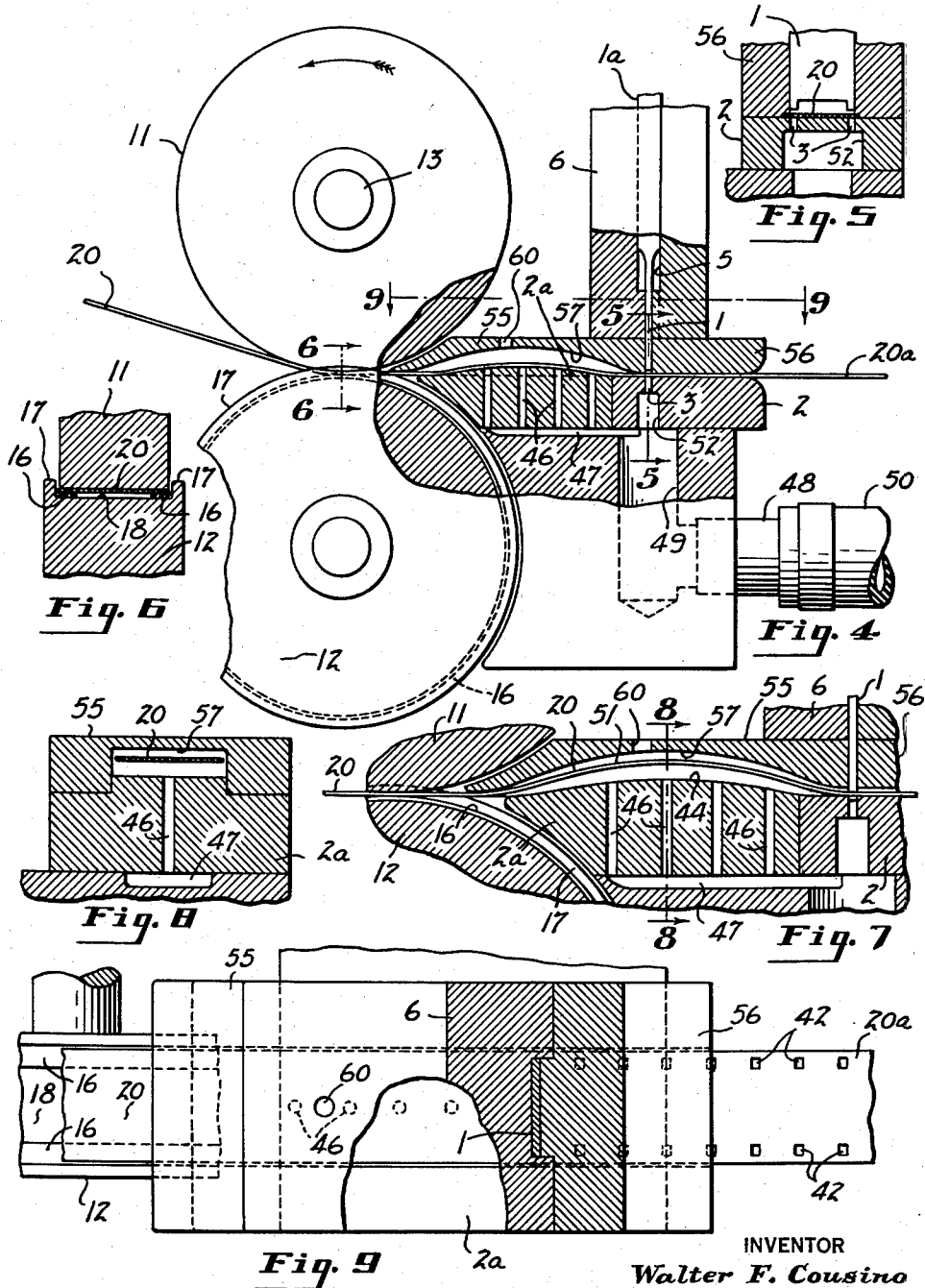
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Filed Nov. 8, 1957

3 Sheets-Sheet 2



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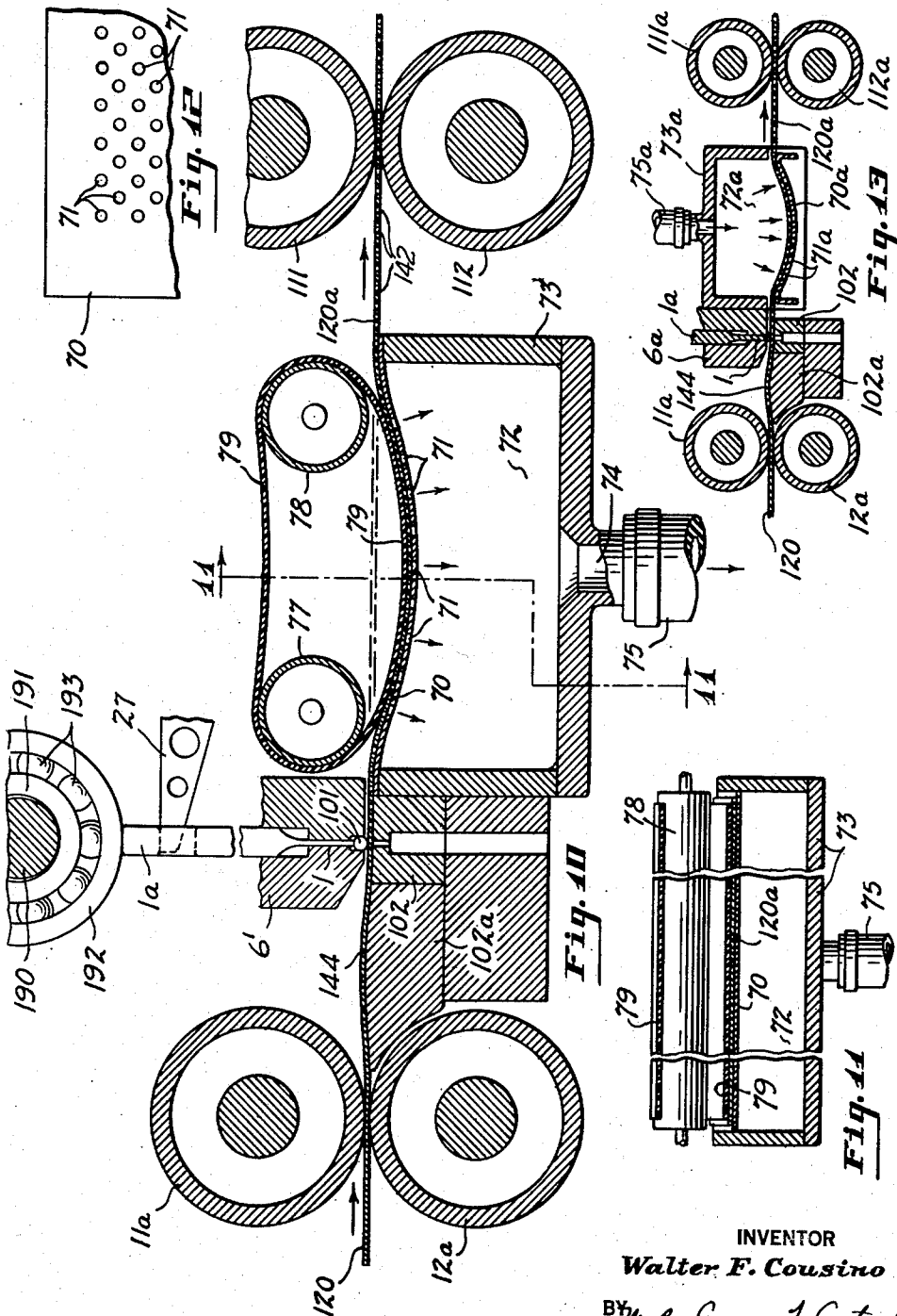
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3 Sheets-Sheet 3



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2,968,982

FEEDING APPARATUS

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Filed Nov. 8, 1957, Ser. No. 695,403

16 Claims. (Cl. 83—262)

The present invention relates to machines in which a traveling sheet of material is periodically acted upon to cut or shape the material as it is fed through the machine and more particularly to a machine having improved feeding means which provides high accuracy and permits high speed operation.

This application is a continuation-in-part of my co-pending application, Serial No. 581,562, filed April 30, 1956, now abandoned, which is a continuation-in-part of my abandoned application, Serial No. 374,953, filed August 18, 1953.

When performing punching, perforating or cutting operations or other fabricating operations on moving sheet material using machines known prior to this invention, it has been almost impossible to obtain both speed and accuracy due to the periodic interruption of the material feed and the inability to control the positioning of the sheet material. It has, therefore, been necessary to perform the successive forming or cutting operations slowly to obtain high accuracy. The result of the slow operation is, of course, high costs which often make the entire operation impractical. In certain perforating operations, for example, the accuracy required could be obtained only with gang punches which are very expensive to operate and to maintain.

The present invention overcomes the prior difficulties in machines which feed the sheet material constantly by providing fluid pressure means which acts on the sheet material to compensate for the intermittent buckling of portions of the tape during each successive forming or fabricating operation. In a punching or perforating machine, for example, the sheet material moving by the punch buckles each time the punch engages the work to form a loop. The fluid pressure means of the present invention creates a pressure differential on the sheet material to accelerate its movement past the punch as the punch moves out of contact with the sheet so as to insure accurate spacing of the indentations or perforations even when the machine is operated at high speed.

An object of the present invention is to provide a simple and efficient machine in which the operation of the feeding mechanism for feeding the sheet material may be continuous without interference with the intended action of the cutting or shaping device so that high accuracy work may be obtained.

Another object of the invention is to provide a simple inexpensive apparatus for perforating strip material which substantially eliminates variation in the spacing of successive perforations.

A further object of the invention is to provide an effective feeding apparatus for strip material which improves the accuracy of punching operations and which has a minimum number of moving parts requiring maintenance.

Another object of the invention is to provide a perforating machine which may be operated at high frequency for a long period of time without extensive maintenance.

Other objects, uses and advantages of the invention will

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become apparent to those skilled in the art from the following description and claims and from the drawings, in which:

Figure 1 is a schematic elevational view on a reduced scale of a perforating machine embodying the present invention, a portion of the strip material being shown in position on the machine;

Figure 2 is a fragmentary view partly in section of a portion of the perforating machine on a larger scale showing the position of the punch at the instant when it is hit by the impact member;

Figure 3 is a fragmentary view of a portion of the punch and the impact member showing the position of the parts shortly after the punch has been hit by the impact member of the impact wheel;

Figure 4 is an elevational view partly in section of the apparatus of Fig. 1 showing a portion of the film or strip therein and a position occupied thereby when the punch is not contacting the film or strip so that the film or strip is free to move past the die opening to the position where the next perforation will occur;

Figure 5 is an enlarged fragmentary view of line 5—5 of Fig. 4;

Figure 6 is a fragmentary sectional view on the line 6—6 of Fig. 4;

Figure 7 is a fragmentary view of a portion of the apparatus of Fig. 4 showing the punch in perforating contact with the die so that the film is not movable over the die opening and showing the build up in the loop of strip material causing it to move away from the curved surface of the guide against fluid pressure;

Figure 8 is a fragmentary sectional view on the line 8—8 of Fig. 7;

Figure 9 is a sectional view on the line 9—9 of Fig. 4;

Figure 10 is a fragmentary longitudinal vertical sectional view showing a modified form of the present invention, the parts being shown in their positions a moment before the punch moves into contact with the strip material;

Figure 11 is a fragmentary transverse vertical sectional view with parts broken away taken on the line 11—11 of Figure 10;

Figure 12 is a fragmentary view of the perforated supporting plate; and

Figure 13 is a fragmentary schematic view similar to Figure 10 but on a smaller scale showing another modified form of the invention.

In an automatic machine, such as a punching or perforating machine, in which a moving sheet of material is progressively acted upon by a punch or other work-engaging device as it is fed through the machine, the travel of the sheet is periodically arrested. In machines of this or equivalent character, it is difficult to position the sheet accurately relative to the work-engaging device particularly when the sheet is moved a substantial distance in the interval between successive operations. According to the present invention this difficulty is overcome by creating a difference in pressure between opposite faces of the moving sheet which tends to accelerate the movement of the sheet material when the work-engaging device releases the sheet.

By way of example, rather than limitation, the feeding means of the present invention is shown in combination with a perforating machine. The present invention provides a way of obtaining an accurate, substantially inertia-free, intermittent feed of the strip material to the perforating element so that a stationary, single-cavity die may be used for each line of perforations to be had in the strip material. All feed rolls and the like, which contact the strip and govern the rate of entry into the perforator, operate in a smooth, continuous manner (usually at a constant speed) so that inertia of the feed

mechanism does not need to be considered. Means are provided in accordance with this aspect of the present invention for stopping and starting the film which means has inertia no greater than that of small portions of the film or strip itself.

Referring particularly to the drawings in which like parts are designated throughout the several views by like numerals of reference, the strip perforator of the present invention comprises a suitable rigid plunger or punch 1 and a rigid die 2 which has an opening 3 of suitable size and shape to suitably match or suitably receive the punch 1. The die 2 is stationary and is carried by a suitable rigid metal base member or frame 4. The punch 1 which may have a portion 1a enlarged is suitably and slidably carried by the walls 5 of the opening of the guide block 6. Suitable intermittent impact means, such, for example, as the projections or impact members 7 carried on the periphery of the continuously and smoothly driven impact wheel 9, are provided for periodically impacting a suitable portion of the punch 1 to impart hammer blows to the punch and to cause the punch to be driven at relatively high speed downward or toward the opening 3 of the die block 2. The impact wheel 9 is suitably rotatably carried by the frame 4 and is driven by suitable means such as belt 10, which is connected to a suitable motor-driven driving member (not shown).

Means are provided for continuously and smoothly moving the film toward the perforating element, such as the punch 1 and the die 2. Such feeding means may comprise the feed rolls 11 and 12, respectively, and is preferably driven at a constant speed. The feed rolls 11 and 12 and the shafts therefore are also rotatably carried by the backing plate or frame 4. Roll 11 is fixedly carried on the rotatable shaft 13, the opposite end of which is attached to the pulley 14, which is driven by the belt 15 from a suitable source not shown, in timed relation to rotation of the impact wheel 9.

The shaft 13 is rotatable in suitable bearings carried by the frame 4 so that rotation of the pulley 14 causes rotation of the feed roll 11. The outer surface of one of the feed rolls, preferably feed roll 12, which may be an idler driven only through contact with the driven roll 11 or the strip material, is provided with an outer peripheral portion 16 of elastic rubber-like material, such as natural or synthetic rubber compound, to provide non-slip contact with the film or strip material to be perforated. The peripheral portions 16 may be suitably disposed in an annular channel formed by the annular side ribs 17 and the center peripheral portion 18 of the wheel 12 as shown particularly in Fig. 6.

The distance between the side ribs 17 is, as shown, preferably slightly greater than the thickness of the wheel 11 so that the ribs 17 may serve as suitable guides for the film or strip material 20. The pulley 14 and the pulley 8 attached to the shaft 19, which also carries the impact wheel 9 and which is journaled in suitable bearings carried by the frame 4, are coordinated or synchronized. They are driven at a relative rate of speed such that film or strip material 20 from a suitable source, such as a reel 22 which is journaled on the shaft 23 carried by the arm 24 attached to the frame 4, will move the requisite distance between the successive periods when the punch 1 is contacted by the successive impact members 7 on the impact wheel 9. The impact members 7 as aforementioned serve as means for driving the punch through the film and toward the opening in the die block 2.

Means, preferably yieldable, such as the spring 26 in connection with the metal arm 27 suitably pivoted and carried on the pin 28 carried by the frame 4, is provided for pressing the punch toward the impact wheel. This means quickly returns the punch to the original position away from perforating contact with the film after each impact so that the film may move free over the lower die block 2. A free end portion 30 of the arm 27 is

provided with a suitable bearing surface 32 which is adapted to contact the upper wall portion 33 of the opening 34 in the upper portion 1a of the punch 1, so the downward movement of the punch 1 when contacted by the impact element 7 will cause similar downward movement of the end portion 30 and bearing surface 32 of the arm 27.

I have found that an exceptionally desirable punch return is provided by the spring 26 which is a composite pack composed of alternate layers of resilient elastic rubber-like material 35 and suitable metal heat-conducting elements 36. The layers 35 may be made of various soft elastic natural or synthetic rubber compounds including conventional tread stock compounds or the like. The elements 36 may be made of aluminum, copper or plated copper, but is preferably made of silver or a silver alloy having greater thermal conductivity than copper. The vulcanized rubber layers 35 being relatively thin, preferably of the order of 1/8 inch or even less, provide excellent damping of vibrations had with rubber without heating up and provide a rapid and accurate return of the punch 1. A solid mass of rubber in the form of a rubber cylinder having sufficient length and sufficient resistance to pressure to permit rapid return of the punch 1a heats up excessively and rapidly deteriorates when the punch is reciprocated at high frequency. However, a spring made with several alternate laminations, as shown, may have all the advantages of rubber without excessive heating during high speed operation. The heat-conducting layers 36, which like the members 35 may be of any suitable shape such as circular, have greater horizontal area than the rubber layers 35 and extend beyond the edges of said layers in order to radiate heat therefrom. One end portion of the composite spring 26 may be carried or fixed on the backing member 4 by the bracket 37. The bracket 37 may be removed from the backing member by removal of the screws 38. The other end portion 39 of the spring 26 may be pivotally attached to the arm 27 by means of the pin 40.

The rigid punch 1 and the rigid punch block 6 which guides the movement thereof are, in accordance with one aspect of the present invention, positioned with respect to the center of the rotary impact wheel 9 so that there is substantial component of movement of the impact members 7 in the direction of the line of movement of the punch 1 at the moment impact is made. This is accomplished by spacing the shaft 19 (i.e., the axis or center of rotation of the impact wheel) away from a vertical plane containing the line of movement of the punch 1, which plane is parallel to the axis about which the impactor rotates. The angle alpha (α) between the radius of the impact wheel through the impact member 7 at the moment the latter moves into contact with the punch 1 and the radius of the impact wheel which is parallel to the direction of movement of the punch (i.e., parallel to the plane of said punch) should ordinarily be about 15° to 25°. Some downward component of movement is bad when the angle alpha is as small as 1° or 2°. Because of the hammer action of the impact members 7, high speed operation of the punches 1 may be had even if the angle alpha is small. As the angle alpha is increased the downward movement of the punch 1 required to clear the impacting means 7 is also increased. The preferred size of the angle alpha in a machine of the type shown herein, is, therefore, determined by the amount of movement required for punch, which is to some extent determined by the thickness of material to be perforated. It is generally impractical for the angle alpha to be greater than 35° to 40° because of the great degree of movement required for punch 1. In the case of thin film, such as motion picture film, or the like, where relatively small movement in punch 1 is required, the angle alpha may be small while still retaining a sufficient component of movement of the impact members 7 in the direction of punch movement. While opera-

tion of the apparatus shown herein may be had when the angle alpha is zero, the side thrust on punch 1 is much greater than desired and considerably more wear and upkeep of the parts occur. However, these objections may be overcome by inserting a bar or the like between the impact wheel and the punch to transmit the hammer blows from the impact members on side wheel to the punch as disclosed, for example in my application Serial No. 307,479, filed September 2, 1952, now abandoned, and in my application, Serial No. 533,611, filed September 12, 1955. My application Serial No. 657,472, now Patent No. 2,857,968, is a continuation-in-part of application Serial No. 533,611.

It is seen from the above that the film or strip material 20 is fed at a constant speed in a continuous manner toward the punch 1 and the die 2 which are adapted to contact the film intermittently in accordance with this relative spacing of the impact members 7 and rotation of the impact wheel 9.

Inasmuch as no means is provided for moving the punch 1 and die opening 3 in the direction of and at the speed of the film as it comes from the feed device, it is seen that the film or strip material 20 must be stopped when contact is made between it and the punch 1 to cut the perforations 42 in the perforated film portion 20a. In accordance with the present invention a curved guide means is provided for forming a small bow or loop in the strip material between the punch and the continuous feeding means, such as the rolls 11 and 12. Such means may include a surface portion 44 elevated so as to move the portion of the film between the feed rolls and the punch out of a straight line as best shown in Figs. 4 and 7. The surface 44 is preferably arcuately shaped and is provided with means associated with fluid pressure to reduce the size of or increase the radius of the loop between the periods when contact is made by the punch with the strip material. Air or other fluid may be used to provide the pressure differential necessary to deflect the strip material. As shown in Figs. 1-9 a vacuum or low-pressure area is provided which would tend to cause the film or strip material 20 to be pulled toward the surface 44 and decrease the amount of material in the said loop.

The surface 44 may be provided as part of a suitable guide which may be an extended portion 2a of the lower metal die block 2. The vacuum may be produced by withdrawing air or fluid through one or more openings 46 which extend up under the imperforate film or strip material 20. The openings 46 are connected to suitable conduit 47 which is suitably connected to the pipe 48 by means of the passage 49. Differential pressure on the surfaces of the said loop may be provided by a suitable vacuum pump, such, for example, as an ordinary household vacuum cleaner, connected through the conduit 50 to the pipe 49. The passageway 49 is also connected through the passageway 52 to the underside of the die openings 3 to withdraw portions of the strip material punched out by the punch.

Although not essential, it is preferable that the loop 51 of the film 20 be substantially covered by a cover member which may be an extension 55 of the upper metal die block or stripper plate 56 which has portions suitably separated from the lower die block 2 to permit the passage of the film 20 therebetween. The smooth arcuate inner surface 57 of the cover portion 55 is spaced from the arcuate surface 44, which projects into the normal straight line between the feed rolls and the space above the die opening, to permit substantial up and down movement of the loop 51 without making contact with these surfaces. A vent opening 60 may be provided in the cover 55.

In the operation of the perforator of the present invention, the strip material is passed from the reel 22 through the feed rolls 11 and 12 which are driven continuously at a constant speed, which speed is coordinated with

that of the impact wheel 9 to suitably space the perforations. From the feed rolls the strip is passed over the surface 44 on the guide into the space between the lower die block 2 and the upper die block 56, which space preferably has a height not substantially greater than twice the thickness of the strip material. The edges of the die blocks 2 and 56 including the extensions thereover serve as side guide members for the strip or film and cause the desired portion of the strip or film to pass over the openings 3 of the die.

Rotation of the impact wheel 9 causes periodic impact between the surface 7a of an impact member 7 and the top edge of the punch 1 as shown particularly by reference to Figures 2 and 3 of the drawing A. The impact on the punch imparts a hammer blow to the punch and causes the punch to be moved downwardly against the strip 20 to cause the end portion 1 to enter slightly within the opening 3 of the lower die block 2 and to remove a portion of the strip so as to form the perforated strip 20a.

The rotary impactor or impact wheel and the feed device, such as the feed rolls 11 and 12, are preferably suitably driven from any suitable common source (which may be pulleys mounted on a common shaft, not shown) so that the speed of the impact wheel and the number of impacts is coordinated with the travel of the strip material toward the die. The loop forming means in the guides permits a change in the size of the material in the loop between the die and the feed, when the punch is in perforating contact with the flexible strip material. Both the natural spring in the strip material and the fluid pressure operate to reduce the size of the loop 51 and increase the radius of curvature thereof when the punch is removed from the strip. There is, therefore, a starting and stopping of the strip material at the die which is free of external inertia (i.e., free of inertia except that of the film itself). The result is intermittent perforation of strip material with an unexcelled accuracy of spacing of successive perforations. The perforated strip material 20a may be wound up on the windup reel during operation of the machine.

Heretofore, moving picture film has been perforated by punch-press-type apparatus utilizing a die having a gang of punches and a gang of dies spaced in accordance with the spacing desired in the perforations. The spacing of successive sprocket holes in the film has been quite variable but due to the fact that there is a time interval between showing of successive pictures the variation has not caused any major difficulties or objections in the projection of the picture.

With the advent of television and the requirement for as long a period of scanning as possible in order to obtain maximum detail and contrast, many attempts have been made to eliminate the black-out period normally had between successive pictures in the moving picture industry. Continuous exposure means such as an apparatus involving suitable rotating prisms has been developed but the variations of spacing between sprocket holes in the film has caused noticeable blurring of the picture. Some blurring even occurs with the interposed black-out period caused by the closing of the shutter between successive pictures. Film manufacturers realizing the difficulties caused by the improper spacing of the sprocket holes have heretofore searched in vain for a suitable commercial method and apparatus for more accurately positioning perforations. They have also been desirous of finding apparatus which would reduce the upkeep and expense had with the gang punch and die as previously used.

A machine of the type shown in Figs. 1 to 9 solves the problem for the motion picture industry and permits frequencies up to 2000 per minute without substantial loss of accuracy.

The feeding means of the present invention may be used with flexible strips having a width of several feet,

strips of cloth or plastic, or with narrow strips of motion picture film or the like.

In the perforating machine of Figures 1 to 9, the vacuum feed means is located upstream of the punch 1, but it will be understood that such means may be on either side of the punch. Figures 10 to 13 show in schematic form a feed system wherein the fluid pressure differential is created downstream of said punch rather than upstream thereof. Pulling of the sheet material over the die is sometimes preferred for certain types of fabric which can be stretched or deformed, particularly fabric-reinforced plastic sheets. The plunger 1 of the modified perforating machine of Figs. 10 and 11 obviously may be reciprocated in its guide block 6' by the hammer blows of the projections 7 of the rotating impact wheel 9 as in Figs. 1 to 9 but as shown in Figure 10 an eccentric wheel of the type shown in my copending application Serial No. 657,472, now Patent No. 2,857,968 is provided to effect such reciprocation. A ball-bearing eccentric is provided including a crankshaft 190, mounted on the frame for rotation about a horizontal axis, and an inner sleeve 191, mounted on the eccentric portion of the crankshaft. The eccentric includes an externally cylindrical outer sleeve 192 for engaging the enlarged portion 1a of the plunger 1, the sleeves 191 and 192 serving as inner and outer races to hold the balls 193 of the bearing in place.

The feed rolls 11a, 12a, 111 and 112 are driven at the same constant peripheral speed in timed relation to the rotation of the impact wheel 9 so that the strip 120 enters the first pair of feed rolls at a constant speed and the perforated strip 120a leaves the last pair of feed rolls at the same speed.

The work-engaging member may be of various types. In the machine of Figs. 1 to 9 the punch 1 engages the sheet and cuts through the same. In the machine of Figs. 10 and 11, a work-engaging member 101 is interposed between the punch and the sheet. This member is pressed against the top marginal edge of the die opening each time the punch 1 is reciprocated by the eccentric means 192 and the lever 27 to pinch off portions of the sheet material.

Since the movement of the strip is stopped when the punch member 101 engages the strip, the portion of the strip between the punch and the feed rolls 11a and 12a bows upwardly a small amount during the period of time when the punch member 101 engages the strip. It may be desirable to provide a smoothly curved convex upper surface 144 on the tape-supporting block 102a to facilitate forming of a loop in the strip material between the first pair of feed rolls and the punch member, but a flat upper surface on the block 102a would also provide excellent results.

In order to locate the perforations 142 of the strip 120a accurately, it is necessary to pull any excess strip material between the feed rolls 11a and 12a and the punch past the punch while the punch is above the strip and before the member 101 again engages the strip so that the strip is against the surface 144 as shown in Fig. 10. This is accomplished by applying fluid pressure to the perforated strip 120a leaving the punch to deflect the strip. As shown herein, a vacuum feed means is employed including a smooth arcuately curved rigid tape support 70 of thin sheet metal having a multiplicity of perforations 71 therein to permit air flow into the vacuum chamber 72. The rectangular metal vacuum box 73 forming the chamber 72 has a central opening 74 leading to a suction conduit 75 which is connected to a vacuum pump or other suitable air removal means.

The support 70 is shown, for convenience, in Figs. 10 and 11 as being relatively long compared to the size of the punch, but it will be understood that such support may function properly when of much smaller size.

When the punch 1 is operated at an extremely high frequency (for example, 1000 to 3000 reciprocations per minute), it is necessary for the vacuum feeding means

to function in a very short period of time between successive operations of the punch to pull the strip 120 against the surface 144. However, such means can function at these high frequencies where the inertia of the strip is low since it has only the inertia of the strip to overcome.

When the member 101 engages the strip to cut one of the perforations 142, part of the strip stops moving while the portions at the feed rollers continue to move at a constant speed. This results in movement of an imperforate portion of the tape upwardly away from the surface 144 and a movement of a perforated portion of the tape upwardly away from the central portion of the metal sheet 70. When the member 101 moves in a direction away from the strip material, the air pressure on top of the moving perforated strip pushes the moving strip toward the metal sheet 70 and imparts additional forward movement to the strip so that the portion of the strip between the feed rolls 11a and 12a and the member 101 moves against the surface 144 as shown in Fig. 10 before the punch again grips the strip material.

Usually the perforations 142 in the strip 120a are spaced far enough apart so that they do not register with many of the perforations 71 of the support 70 or are of relatively small size so that sufficient pressure differential may be maintained between the upper and lower surfaces of the moving strip material to obtain efficient operation and accurate perforating without covering the perforations and without an extremely expensive vacuum pump. However, where the perforations are large and occupy a large proportion of the total area of the strip 120a, means may be provided to restrict the flow of air through the perforations 142.

As herein shown, a pair of horizontal idler rollers 77 and 78 are mounted above the metal sheet 70 for rotation about horizontally aligned axes, and a thin endless imperforate belt 79 having a width slightly less than that of the strip 120a and a thickness about equal to that of said strip is mounted on said rollers for engaging said strip. Air pressure holds the belt 79 against the strip 120a and causes the belt to move at the same speed as the strips whereby the rollers 77 and 78 are driven by the belt. However, it will be understood that said rollers may, if desired, be driven directly from the feed rolls 111 and 112 and at the same peripheral speed as that of said feed rolls, and that such belt is unnecessary and may be omitted in most perforating operations where the air flow through the perforations of the strip presents no serious problem.

Figure 13 shows a portion of a perforating machine which is similar to that of Figures 10 and 11 except for the vacuum feed means which is replaced by a rectangular box 73a having a pressure conduit 75a leading to the pressure chamber 72a and by an arcuately curved concave sheet metal support 70a having a width corresponding to the width of the strip 120a. The support is preferably provided with perforations 71a so that air is not trapped below the perforated strip. The punch 1 of the machine of Fig. 13 may be reciprocated into and out of the die 102 by the impact wheel 9 as in Figs. 1 to 9 or by an eccentric wheel as shown in Fig. 10.

The fluid pressure means of Figure 13 functions the same as that of Figures 10 to 12 (with the belt 79 omitted) except that the pressure differential is created by applying superatmospheric pressure to the top surface of the strip rather than sub-atmospheric pressure to the lower surface of the strip.

It is to be understood that, in accordance with the provisions of the patent statutes, variations and modifications of the specific devices herein shown and described may be made without departing from the spirit of the invention.

Having described my invention, I claim:

1. The combination of a web supporting member, a

web-engaging member, means for reciprocating one of said members toward and away from the other of said members for operating on the web, continuously-driven feeding means for moving a web of flexible sheet material between said members, said members interrupting the movement of the web temporarily each time said members are moved toward each other and into operating engagement with the web, guide means between said web-engaging member and said feeding means having a curved web-engaging surface against which the web may bow, the bowed portion of the web moving away from said curved surface when said members interrupt the movement of the web, and fluid pressure means for creating and maintaining a fluid pressure differential on the opposite side faces of said bowed portion of the web to urge the sheet material toward said curved surface, said fluid pressure means accelerating the movement of the web past said web-engaging member when said members separate to release the web.

2. Apparatus as defined in claim 1 wherein said curved surface is concave and said feeding means pulls the web past said members.

3. Apparatus as defined in claim 1 wherein said curved surface is convex and said feeding means pushes the web toward said members.

4. A perforating machine comprising a rigid frame, a punch mounted for reciprocation on said frame, a die carried by said frame for receiving the end portion of said punch, means reciprocating said punch including an actuating wheel mounted for rotation on said frame, means for continuously feeding strip material over said die to be perforated by said punch, means for rotating said wheel at high velocity and for driving said feeding means and said wheel at uniform speeds so as to impart a high frequency reciprocation to said punch, guide means between said die and said feeding means having a smoothly curved strip-engaging surface on which the strip material may buckle to form a loop, said surface directing the loop between the punch and the feeding means, said loop moving away from said curved surface when said punch acts upon the strip material at said die, and fluid pressure means for creating and maintaining a pressure differential on said loop to press said strip material in said loop against said curved surface, said fluid pressure means accelerating the movement of strip material past the die when the punch releases said strip material.

5. A perforating machine as defined in claim 4 wherein said feeding means includes a pair of feed rolls engaging the perforated strip material and said guide means comprises a perforated plate between said die and said feed rolls having a concave upper surface for engaging the perforated strip material.

6. A perforating machine as defined in claim 5 wherein said fluid pressure means includes a vacuum chamber below said guide means and means for removing air from said chamber.

7. A perforating machine as defined in claim 5 wherein said fluid pressure means includes a pressure chamber above said guide means and means for maintaining a super-atmospheric pressure in said chamber.

8. A perforating machine as defined in claim 4 wherein said feeding means comprises a pair of feed rolls engaging the strip material upstream of the punch to feed the same toward the punch, and wherein said guide means has a convex upper surface projecting into the straight line of feed between said die and said feed rolls.

9. Apparatus for perforating strip material comprising a punch, a suitable die opposing said punch, means for guiding said punch to permit reciprocal movement thereof with respect to said die, an impactor for periodically impacting said punch to thrust it toward said die, yieldable means for holding said punch toward said impactor and for returning it after impact to position for subsequent impact by said impactor, feed rolls for

smoothly regulating the feed of said strip material past said punch, means for coordinately driving said feed rolls and said impactor, guide means for guiding said strip material between said die and said punch, said guide means having a surface protruding into the straight line of feed between said feed device and said punch and die to cause a loop in said strip material and permitting the increase in the size of said loop when said punch and die act upon said strip material, and fluid pressure means for creating and maintaining a difference in pressure between the opposite faces of the strip material so as to deflect the material and cause a decrease in the size of said loop when said punch moves in a direction away from said strip material to release the strip material, whereby said loop permits substantially inertia-free intermittent movement of said strip material between said punch and said feed device.

10. Apparatus for perforating strip material comprising a punch, a suitable die opposing said punch, punch guide means to permit reciprocal movement of said punch relative to said die, a rotary impactor having punch impacting means of minor duration extent relative to the arc of said impactor between successive impacting means for periodically thrusting said punch toward said die, means for holding said punch toward said impacting means and for returning it after impact by said impacting means, a device for continuously feeding said strip material toward said punch, suitable means for driving said feed device and said impactor, guide means for guiding said strip material between said die and said punch, said guide means having a curved surface projecting into the straight line of feed between said feeding device and the space between said punch and die to cause said strip material to buckle in the direction of least rigidity to form a loop, fluid pressure means for providing fluid pressure on said loop in a direction tending to reduce the amount of strip material in said loop, whereby said loop tends to build up against said fluid pressure during the interval when the punch and die act upon said strip material and said loop tends to decrease in size with the aid of said fluid pressure when said punch and die release said strip material to suddenly accelerate the movement of such feed strip material without appreciably greater inertia than the strip material itself, said fluid pressure means comprising a source of fluid pressure and passage means from said source to the surface of said loop for maintaining a pressure differential between the opposite surfaces of said loop.

11. A perforating machine comprising a rigid frame, a punch mounted for reciprocation on said frame, a die carried by said frame for receiving the end portion of said punch, means for imparting hammer blows to said punch including an impact wheel mounted for rotation on said frame and having one or more impact members thereon occupying a very small fraction of the periphery of said wheel, means for retracting said punch between successive actuations thereof by the impact members, means including a pair of feed rolls for continuously feeding strip material over said die to be perforated by said punch, means for rotating said impact wheel at high velocity and for driving said feed rolls in synchronism with said wheel so as to impart a high frequency reciprocation to said punch, guide means between said die and said feed rolls having a rounded portion projecting into the straight line of feed between said die and said feed rolls to cause said strip material to buckle and to form a loop, said rounded portion having a smoothly curved surface for directing the loop between the punch and the feed rolls, said loop moving away from said curved surface when said punch engages the strip material at said die, and fluid pressure means for providing and maintaining a pressure differential on said strip material tending to deflect the traveling strip material and move the strip material in said loop against said curved surface, said fluid pressure means accelerating the move-

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ment of the strip material past the die while the punch is out of contact with said strip material.

12. Apparatus for perforating strip material comprising a punch, a die opposing said punch, means for guiding said punch for reciprocal motion relative to said die, a rotatably mounted impact wheel provided with a projection on its peripheral portion adapted to strike the punch a series of blows having substantially instantaneous dwell periods, said projection being rigid in the direction of the movement of said punch at the moment of impact whereby the energy of the entire impact wheel is available for driving said punch at high speed, said wheel being mounted relative to said punch so that each projection on the wheel strikes the punch with a substantial impact force component in the direction of the line of movement of the punch, means for continuously feeding strip material towards said punch, means for driving said feed means and said impact wheel, guide means for guiding said strip material between said die and said punch having a surface projecting into the straight line of feed between said feed means and the space between said punch and die so as to cause said strip material to buckle in the direction of least rigidity to form a loop and fluid pressure means maintaining a fluid pressure on the strip material so as to accelerate the movement of the strip material past the die when said punch is moved in a direction from the die to release the strip material.

13. A perforating machine comprising a rigid frame, a punch mounted for reciprocation on said frame, a die carried by said frame for receiving the end portion of said frame, means for imparting hammer blows to said punch including an impact wheel mounted for rotation on said frame and having one or more impact members thereon occupying a very small fraction of the periphery of said wheel, means for retracting said punch between successive actuations thereof by the impact members, means for continuously feeding strip material toward said punch and over said die, means for rotating said impact wheel at high velocity and for driving said feeding means in synchronism with said wheel so as to impart a high frequency reciprocation to said punch, guide means between said die and said feeding means having a rounded portion projecting into the straight line of feed between said die and said feed rolls to cause said strip material to buckle and to form a loop, said rounded portion having a smoothly curved surface for directing the loop between the punch and the feeding means, said loop moving away from said curved surface when said punch engages the strip material at said die, and fluid pressure means for providing and maintaining a pressure differential on said strip material tending to press said strip material in said loop against said curved surface, said fluid pressure means accelerating the movement of the strip material past the die when the punch releases said strip material.

14. A machine of the character described comprising a frame, a die mounted on said frame, punch means having a strip-engaging portion and mounted for reciprocation on said frame toward and away from said die, means for reciprocating said punch means, continuously driven feeding means for moving strip material over said die to be acted upon by the strip-engaging portion of said punch means, guide means between said die and said feeding means having a curved strip-engaging surface on which the strip material may buckle to form a bow, said surface directing the bow between the die and the feeding means, said bow moving away from said curved surface when the punch means acts upon said die to interrupt temporarily the movement of the strip at said die, and fluid pressure means including a source of fluid at non-atmospheric pressure and conduit means leading from said source to said bow for creating and maintaining a pressure differential on said bow to press

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said strip material in said bow toward said curved surface, said fluid pressure means acting on the strip material to accelerate the movement of strip material past the die when the punch means moves in a direction away from said die to release the strip material.

15. In apparatus of the character described, the combination of a punch, a die opposing said punch, means for guiding said punch for reciprocal motion relative to said die, means for feeding strip material generally along a straight line between said feed means and the space between said punch and die and for imparting a resultant thrust to said strip material substantially in the direction of said straight line, means for guiding said strip material between said die and said punch having a surface projecting across said straight line so as to cause said strip material to buckle slightly and form a bow, fluid pressure means comprising a source and conduit means for conveying fluid between said source and said bow for providing a fluid pressure differential on said bow tending to hold the strip material in said bow against the projecting surface of said guide means, and means for reciprocating said punch at regular intervals during feeding of the strip material to cause the punch to act upon the strip material periodically and to interrupt movement of the strip material so as to cause said bow to lift from the projecting surface of said guide means, said fluid pressure means applying a force that moves said bow toward the projecting surface of said guide means to accelerate the movement of strip material past the die when said punch releases the strip material.

16. In apparatus of the character described, the combination of a punch, a die opposing said punch, means for guiding said punch for reciprocal motion relative to said die, a pair of feed rollers, means for guiding a web of sheet material generally along a straight line substantially from the bight of said feed rollers to the point of contact of the punch and the die, said last-named means having a web-engaging surface projecting across said straight line to cause the web to buckle slightly and form a bow, said feed rollers engaging the opposite side faces of the web and applying forces to the web having a resultant substantially in the direction of said straight line, guide means located adjacent fixed points spaced along the length of said straight line for limiting the length of the bowed portion of the web, means for reciprocating the punch at regular intervals into and out of operating engagement with the web periodically to interrupt movement of the web and to cause said bowed portion to move away from said web-engaging surface, and fluid pressure means for creating a fluid pressure differential between opposite faces of the bowed portion of the web to press said bowed portion toward said web-engaging surface and to accelerate the movement of the web past said punch at the instant the punch and die separate to release the web.

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