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3,234,835

POLYURETHANE STRIPPER

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Filed Apr. 17, 1964, Ser. No. 360,532
6 Claims. (Cl. 83—139)

This invention relates to strippers for punching machines.

Strippers are used with punching machines to prevent a work-piece that has been pierced by a punch from clinging to the punch when it is withdrawn. Conventional strippers are usually of rubber and have the form of an annular cylinder that is open at both ends. The stripper surrounds the punch. As the punch advances towards the work-piece the stripper is progressively compressed and it contracts in length, and as the punch withdraws from the work-piece the stripper returns to its original length and so tends to strip the work-piece from the punch. Rubber strippers are provided with metal end fittings to protect the ends of the stripper from tearing and from abrasion.

Although rubber is widely used in strippers it has a number of disadvantages. For example, rubber tends to deteriorate when subjected to oil so the life of rubber strippers is often reduced because oil is frequently present near punching machines. When punching light gauge relatively soft metals such as aluminum the metal end fitting that contacts the work-piece may mark the surface of the work-piece. Rubber is sometimes unable to provide enough stripping pressure in heavy punching operations.

Strippers of polyurethane have many advantages over rubber strippers and we have devised a stripper that embodies these advantages, some of which are as follows. Polyurethane is relatively immune to oil. Polyurethane has good impact, tear and abrasion resistance; metal end fittings are not required in a stripper made of polyurethane. Polyurethane compositions can be made that are harder than rubber and can provide satisfactory stripping pressure even in heavy punching operations.

Objects of this invention are therefore to provide a simple and economical stripper that is resistant to oil, that has good tear and abrasion resistance and that can provide satisfactory stripping pressure in heavy punching operations.

The foregoing and still further objects and advantages of the invention will become apparent from a study of the following specification taken in conjunction with the accompanying drawings, in which like reference characters indicate corresponding parts throughout the several views, and in which:

FIG. 1 is a perspective view partly in section of a stripper according to the invention; and

FIGS. 2, 3 and 4 are elevations partly in section showing various stages of a cycle of operation of a portion of a punching machine using a stripper of the invention.

MECHANICAL DESCRIPTION

Referring to the drawings, a stripper 10 consists of an elongated solid body of thermosetting polyurethane, specific examples of which are given below. The stripper 10 is substantially cylindrical and has a central longitudinal opening or bore 11 which terminates at an end wall 12.

A punch 13 has a body portion 14 and a working portion 15, and the longitudinal bore 11 of the stripper is slightly undersize (preferably between about 1/1000" and 3/64") relative to the body portion to permit the stripper to be held in tight frictional engagement with the body por-

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tion. The longitudinal bore 11 can be of any configuration but it is usually circular since most punches have circular body portions. The end wall 12 has a small pilot hole 16 that can be enlarged to fit the working portion of the punch. Thus the stripper can be conformed by the user to the particular punch with which it is to be used; this is particularly advantageous when punching light gauge metal because there is a tendency for the metal to reverse dimple when the punch is being withdrawn, if the opening in the lower end of the stripper is substantially larger than the working portion of the punch.

In FIG. 2 the punch 13 is shown approaching a work-piece 17 which rests upon a die 18. The cutting edge 19 of the punch is above the lower edge 20 of the stripper so the latter makes first contact with the work-piece 17.

In FIG. 3 the punch 13 has pierced the work-piece 17 and the stripper is compressed and has contracted in length. Note that the stripper when compressed tends to bulge outwardly at its opposite ends rather than at its middle.

Finally, in FIG. 4 the punch 13 has withdrawn from the work-piece 17 and the stripper has begun to return to its original length, and so provides pressure (stripping pressure) against the work-piece and thereby prevents the work-piece from clinging to the punch as it is withdrawn. Stripping pressure is believed to be a function of the modulus of elasticity of the particular composition of polyurethane; in general harder polyurethane compositions produce higher stripping pressures. As shown in the table below, stripping pressure is also a function of the dimensions of the stripper and of the decrease of length (deflection) due to compression. The useful range of hardness appears to be between about 50 Shore A and 75 Shore D.

The strippers can be formed by casting them in molds and after the polyurethane composition has cured the strippers are removed from the molds and the ends are trimmed.

The following table shows dimensions and stripping pressures for various deflections of typical strippers of the invention. The strippers described in the table are of the polyurethane composition given in Example 1 below.

Punch body diameter in inches	Stripper dimensions in inches		Approximate stripping pressure in lbs. at deflections of—			
	Diameter	Length	1/8"	1/4"	3/8"	1/2"
1/4	3/4	1 1/4	300	650	1,000	
1/4	3/4	1 1/2	250	550	800	
1/4	3/4	1 3/4	175	450	675	
1/4	3/4	2	150	350	600	750
1/4	3/4	2 1/4	350	700	1,100	
1/4	3/4	2 1/2	300	600	850	
1/4	3/4	2 3/4	200	500	750	
1/4	3/4	3	200	400	650	800
1/4	3/4	3 1/4	400	800	1,200	
1/4	3/4	3 1/2	325	650	900	
1/4	3/4	3 3/4	200	500	750	
1/4	3/4	4	200	400	650	800
1/4	3/4	4 1/4	450	900	1,350	
1/4	3/4	4 1/2	350	700	1,050	
1/4	3/4	4 3/4	225	550	800	
1/4	3/4	5	200	425	700	850
1/4	3/4	5 1/4		300	525	650

CHEMICAL COMPOSITION

The polyurethane is selected from the group consisting of polyester diisocyanate reaction products and polyether diisocyanate reaction products. Polyesters and polyethers appear to give similar results.

The polyurethane can be of different compositions; the following examples are illustrative.

Example 1

A prepolymer, marketed under the trademark Adiprene L-167 by E. I. du Pont de Nemours & Company,

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made by reacting polytetramethylene ether glycol with toluene diisocyanate to a final active isocyanate content of 6.0% to 6.6%, is reacted with 4,4' methylene bis (2 chloraniline) in the following proportions:

	Parts by weight
Adiprene L-167	100
4,4' methylene bis (2 chloraniline)	19.5

Cured in air for 3 hours at 212° F. followed by a room temperature maturation period of 3 to 7 days.

Hardness: 95 Shore A.

Example 2

A prepolymer, marketed under the trademark Adiprene L-100 by E. I. du Pont de Nemours & Company, made by reacting polytetramethylene ether glycol with toluene diisocyanate to a final active isocyanate content of 4.0% to 4.3%, is reacted with 4,4' methylene bis (2 chloraniline), in the following proportions:

	Parts by weight
Adiprene L-100	100
4,4' methylene bis (2 chloraniline)	12.5

Cured for 3 hours at 212° F. in hot air followed by a room temperature maturation period of 3 to 7 days.

Hardness: 88 Shore A.

Example 3

A prepolymer, marketed under the trademark Adiprene L-315 by E. I. du Pont de Nemours & Company, made by reacting polytetramethylene ether glycol with toluene diisocyanate to a final active isocyanate content of 9.2% to 9.7%, is reacted with 4,4' methylene bis (2 chloraniline), in the following proportions:

	Parts by weight
Adiprene L-315	100
4,4' methylene bis (2 chloraniline)	2.6

Cured for 3 hours at 42° F. in hot air followed by a room temperature maturation period of 3 to 7 days.

Hardness: 75 Shore D.

Example 4

A prepolymer, marketed under the trademark Adiprene L-420 by E. I. du Pont de Nemours & Company, made by reacting polytetramethylene ether glycol with toluene diisocyanate to a final active isocyanate content of 2.8% to 3.0%, is reacted with 4,4' methylene bis (2 chloraniline), in the following proportions:

	Parts by weight
Adiprene L-420	100
4,4' methylene bis (2 chloraniline)	8.8

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.

Hardness: 80 Shore A.

Example 5

A prepolymer as given in Examples 1 to 4, is reacted with a polyol (1,4 butane diol, trimethylolpropane, triisopropanolamine, diethylene glycol or similar kind), alone or in combination or with 4,4' methylene bis (2 chloraniline), in the following proportions:

	Parts by weight
(a) Adiprene L-100	100
1,4, butanediol	3.5
Trimethylolpropane	1.0

Cured 4 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.

Hardness: 56 Shore A.

	Parts by weight
(b) Adiprene L-100	100
Triisopropanolamine	5.5
4,4' methylene bis (2 chloraniline)	2.0

Cured 4 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.

Hardness: 65 Shore A.

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Example 6

A prepolymer, marketed under the trademark Vibrathane 6001 by Naugatuck Chemical Company, made by reacting an ester glycol with diisocyanate to a final isocyanate content of 2.1% to 2.3%, is reacted with 4,4' methylene bis (2 chloraniline) or 3,3' dichlorobenzidine, in the following proportions:

	Parts by weight
(a) Vibrathane 6001	100
4,4' methylene bis (2 chloraniline)	6.8

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.

Hardness: 74 Shore A.

	Parts by weight
(b) Vibrathane 6001	100
3,3' dichlorobenzidine	6.5

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.

Hardness: 85 Shore A.

Example 7

A prepolymer, marketed under the trademark Vibrathane 6004 by Naugatuck Chemical Company, made by reacting an ester glycol with diisocyanate to a final active isocyanate content of 3.75% to 4.00% is reacted with 4,4' methylene bis (2 chloraniline) or 3,3' dichlorobenzidine, in the following proportions:

	Parts by weight
(a) Vibrathane 6004	100
4,4' methylene bis (2 chloraniline)	11.4

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.

Hardness: 70 Shore A.

	Parts by weight
(b) Vibrathane 6004	100
3,3' dichlorobenzidine	10.8

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 5 days.

Hardness: 85 Shore A.

Example 8

A prepolymer, marketed under the trademark Vibrathane 6005 by Naugatuck Chemical Company, made by reacting an ester glycol with diisocyanate to a final active isocyanate content of 3.1% to 3.3%, is reacted with 4,4' methylene bis (2 chloraniline) or 3,3' dichlorobenzidine, in the following proportions:

	Parts by weight
(a) Vibrathane 6005	100
4,4' methylene bis (2 chloraniline)	9.3

Cured 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.

Hardness: 65 Shore A.

	Parts by weight
(b) Vibrathane 6005	100
3,3' dichlorobenzidine	8.8

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.

Hardness: 65 Shore A.

Example 9

A prepolymer, marketed under the trademark Vibrathane 6006 by Naugatuck Chemical Company, made by reacting an ester glycol with diisocyanate to a final active isocyanate content of 7.0%, is reacted with 4,4' methylene bis (2 chloraniline) in the following proportions:

	Parts by weight
Vibrathane 6006	100
4,4' methylene bis (2 chloraniline)	20

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.

Hardness: 55 Shore D.

Example 10

A prepolymer, marketed under the trademark Multirathane F-66 by Mobay Chemical Company, made by reacting a polyester resin with a polyisocyanate to a final active isocyanate content of 6.3% to 6.7%, is reacted with 1,4 butane diol, diethylene glycol, trimethylol propane (an aromatic diol marketed under the trademark Multirathane XA by Mobay Chemical Company, alone or in combination, in the following proportions:

	Parts by weight
(a) Multirathane F-66	100
Diethylene glycol	4.5
1,4-butanediol	3.1

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 65 Shore A.

	Parts by weight
(b) Multirathane F-66	100
1,4-butanediol	7.0

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 80 Shore A.

	Parts by weight
(c) Multirathane F-66	100
Multirathane XA	14.3

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 94 Shore A.

	Parts by weight
(d) Multirathane F-66	100
p,p' Diphenylmethane diisocyanate	29
1,4-butanediol	19.5

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 55 Shore D.

Example 11

The prepolymer, marketed under the trademark Solithane 291 by Thiokol Chemical Company, made by reacting a polyester with diisocyanate to a final active isocyanate content of 2.7% to 3.3%, is reacted with 4,4' methylene bis (2 chloraniline) or 3,3' dichlorobenzidine, or trimethylol propane or triisopropanolamine alone or in combination, in the following proportions:

	Parts by weight
(a) Solithane 291	100
4,4' methylene bis (2 chloraniline)	9

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 75 Shore A.

	Parts by weight
(b) Solithane 291	100
3,3' dichlorobenzidine	8.7

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 80 Shore A.

	Parts by weight
(c) Solithane 291	100
3,3' dichlorobenzidine	5.25
Triisopropanolamine	0.9

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 70 Shore A.

	Parts by weight
(d) Solithane 291	100
Trimethylolpropane	2.2
Triisopropanolamine	1.1

Cured for 4 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 55 Shore A.

Example 12

A prepolymer, marketed under the trademark Formrez P-211 by Witco Chemical Company, made by reacting a polyester with diisocyanate to a final active isocyanate content of 1.85% to 2.15%, is reacted with 4,4' methylene bis (2 chloraniline), in the following proportions:

	Parts by weight
Formrez P-311	100
4,4' methylene bis (2 chloraniline)	6

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 75 Shore A.

Example 13

A prepolymer, marketed under the trademark Formrez P-311 by Witco Chemical Company, made by reacting a polyester with diisocyanate to a final active isocyanate content of 3.0% to 3.3% is reacted with 4,4' methylene bis (2 chloraniline), in the following proportions:

	Parts by weight
Formrez P-311	100
4,4' methylene bis (2 chloraniline)	9

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 85 Shore A.

Example 14

A prepolymer, marketed under the trademark Formrez P-411 by Witco Chemical Company, made by reacting a polyester with diisocyanate to a final active isocyanate content of 4.0% to 4.3% is reacted with 4,4' methylene bis (2 chloraniline), in the following proportions:

	Parts by weight
Formrez P-411	100
4,4' methylene bis (2 chloraniline)	11.8

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 92 Shore A.

Example 15

A prepolymer, marketed under the trademark Formrez P-611 by Witco Chemical Company, made by reacting a polyester with a diisocyanate to a final active isocyanate content of 6.0% to 6.3% is reacted with 4,4' methylene bis (2 chloraniline), in the following proportions:

	Parts by weight
Formrez P-611	100
4,4' methylene bis (2 chloraniline)	17.5

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 55 Shore D.

Example 16

A prepolymer, marketed under the trademark Formrez P-310 by Witco Chemical Company, made by reacting a polyester with a diisocyanate to a final active isocyanate content of 3.0% and 3.3%, is reacted with 4,4' methylene bis (2 chloraniline), in the following proportions:

	Parts by weight
Formrez P-310	100
4,4' methylene bis (2 chloraniline)	8.5

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 84 Shore A.

Example 17

A prepolymer, marketed under the trademark Formrez P-410 Witco Chemical Company, made by reacting a polyester with a diisocyanate to a final active isocyanate

content of 4.0% to 4.3%, is reacted with 4,4' methylene bis (2 chloraniline), in the following proportions:

	Parts by weight
Formrez P-410	100
4,4' methylene bis (2 chloraniline)	11.8

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 91 Shore A.

Example 18

A prepolymer, marketed under the trademark Formrez P-610 by Witco Chemical Company, made by reacting a polyester with a diisocyanate to a final active isocyanate content of 6.0% to 6.3%, is reacted with 4,4' methylene bis (2 chloraniline), in the following proportions:

	Parts by weight
Formrez P-610	100
4,4' methylene bis (2 chloraniline)	18

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 55 Shore D.

Example 19

A prepolymer, marketed under the trademark Cyanaprene 4590 by American Cyanamid Company, made by reacting a polyester with a diisocyanate to a final active isocyanate content of 2.6% to 2.8% is reacted with 4,4' methylene bis (2 chloraniline), 3,3' dichlorobenzidine, paradihydroxy quinone, triisopropanolamine, trimethylolpropane, 1,4-butanediol, triethylene glycol, alone or in combination, in the following proportions:

	Parts by weight
(a) Cyanaprene 4590	100
4,4' methylene bis (2 chloraniline)	9

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 89 Shore A.

	Parts by weight
(b) Cyanaprene 4590	100
paradihydroxy quinone	6.5

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 77 Shore A.

	Parts by weight
(c) Cyanaprene 4590	100
1,4-butanediol	3

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 75 Shore A.

	Parts by weight
(d) Cyanaprene 4590	100
triisopropanolamine	4.1

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 60 Shore A.

	Parts by weight
(e) Cyanaprene 4590	100
Triethylene glycol	3.6

Cured for 3 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 60 Shore A.

Example 20

A prepolymer, marketed under the trademark Lastane A49 by Zeta, Inc., made by reacting a polyester with a diisocyanate to a final active isocyanate content of 3.2% to 3.5% is reacted with curatives marketed under the trademarks EC106, EC207, EX308, EX485 by Zeta, Inc., or 4,4' methylene bis (2 chloraniline) or 3,3' dichlorobenzidine, in the following proportions:

	Parts by weight
(a) Lastane A49	100
EC106	15

Cured 4 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 60 Shore A.

	Parts by weight
(b) Lastane A49	100
EC207	21.7

Cured 4 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 70 Shore A.

	Parts by weight
(c) Lastane A49	100
EC308	18.8

Cured 4 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 80 Shore A.

	Parts by weight
(d) Lastane A49	100
EC485	18.4

Cured 4 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 85 Shore A.

	Parts by weight
(e) Lastane A49	100
4,4' methylene bis (2 chloraniline)	10.5

Cured 4 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 80 Shore A.

	Parts by weight
(f) Lastane A49	100
3,3' dichlorobenzidine	9.7

Cured 4 hours in air at 212° F. followed by a room temperature maturation period of 3 to 7 days.
Hardness: 85 Shore A.

What we claim as our invention is:

1. A one-piece stripper for stripping a work-piece from a punch of a punching machine when the punch is being withdrawn from the work-piece and adaptable for use with punches of different sizes, the punch having a body portion and a working portion, comprising an elongated, cylindrical solid body of thermosetting polyurethane having a hardness of between about 50 Shore A and 75 Shore D and selected from the group consisting of polyester diisocyanate reaction products and polyether diisocyanate reaction products, a longitudinal central opening of circular cross-section in said elongated body through which the punch can extend, the longitudinal opening being between about $\frac{19}{1000}$ " and $\frac{1}{64}$ " undersize relative to the body portion of the punch to allow the stripper to be held in tight frictional engagement with said body portion, an end wall of substantial thickness terminating said central opening and adapted to provide a variable close fitting opening for the working portion of a punch of any size equal to or less than the size of the longitudinal opening and thereby prevent reverse dimpling of the work-piece and a small pilot hole in the end wall to guide the working portion of the punch, said stripper being devoid of any supporting sleeve to allow substantial compression in length thereby generating sufficient pressure solely in the polyurethane material to remove the work-piece from the punch.

2. A one-piece stripper for stripping a work-piece from a punch of a punching machine when the punch is being withdrawn from the workpiece and adaptable for use with punches of different sizes, the punch having a body portion and a working portion, comprising an elongated solid body of thermosetting polyurethane, a longitudinal central opening in said elongated body through which the punch can extend, the longitudinal opening being slightly undersize relative to the body portion of the punch to allow the stripper to be held in tight frictional engagement with said body portion, and an end wall of substantial thickness terminating said central opening and adapted to provide a variable close fitting opening for the working

portion of a punch of any size equal to or less than the size of the longitudinal opening and thereby prevent reverse dimpling of the work-piece, said stripper being devoid of any supporting sleeve to allow substantial compression in length thereby generating sufficient stripping pressure solely in the polyurethane material to remove the work-piece from the punch.

3. A stripper as claimed in claim 2 composed of thermosetting polyurethane having a hardness of between about 50 Shore A and 75 Shore D and selected from the group consisting of polyester diisocyanate reaction products and polyether diisocyanate reaction products.

4. A stripper as claimed in claim 2 wherein the end wall has a small pilot hole to guide the working portion of the punch.

5. A stripper as claimed in claim 2 wherein the lon-

gitudinal opening is between about $1\frac{1}{1000}$ " and $\frac{1}{64}$ " undersize relative to the body portion of the punch.

6. A stripper as claimed in claim 2 which is cylindrical in shape and the longitudinal opening of which has a substantially circular cross-section.

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