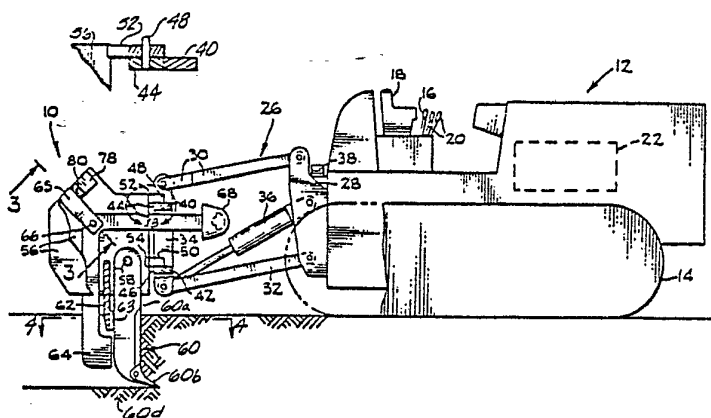




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification: A10B 35/00; E01C 23/06	A1	(11) International Publication Number: WO 79/01066 (43) International Publication Date: 13 December 1979 (13.12.79)
(21) International Application Number: PCT/US79/00306 (22) International Filing Date: 9 May 1979 (09.05.79) (31) Priority Application Number: 905,372 (32) Priority Date: 12 mai 1978 (12.05.78) (33) Priority Country: US (71) Applicant: THE GURRIES COMPANY [US/US]; 884 Freeport Boulevard, Sparks, NV 89431 (US). (72) Inventor: GURRIES, Raymond, A.; 1420 Eli Drive, Reno, NV 89511 (US). (74) Agents: PARKER, Robert, L., et al; 201 South Lake Avenue, Pasadena, CA 91101 (US).		(81) Designated States: AT, AT (European patent), BR, CH, CH (European patent), DE, DE (European patent), DK, FR (European patent), GB, GB (European patent), JP, SE, SE (European patent), SU. Published with: <i>International search report</i> <i>Amended claims</i> Date of publication of the amended claims: 27 December 1979 (27.12.79)

(54) Title: **RIPPING TOOL DRIVING APPARATUS**



(57) Abstract

A ripping tool (60) positioned below the earth's surface is driven by the output of a vibrating, preferably resonant, force transmitting beam (64) which has lateral dimensions smaller than those of the ripping tool and is positioned below the earth's surface. The beam is configured to have a single resonant node when restrained from vibrating at such node and is supported (66) so that the single node is above the earth's surface and restrained from vibrating. The output of the beam is enlarged in thickness to form a hammer. A protective gap is maintained by a tool stop (62) between the tool and the output of the force transmitting beam. The width of the tool stop is precisely controlled by shimming (63) the tool stop and/or the supports for the force transmitting beam.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT

AT	Austria	LU	Luxembourg
BR	Brazil	MC	Monaco
CF	Central African Republic	MG	Madagascar
CG	Congo	MW	Malawi
CH	Switzerland	NL	Netherlands
CM	Cameroon	RO	Romania
DE	Germany, Federal Republic of	SE	Sweden
DK	Denmark	SN	Senegal
FR	France	SU	Soviet Union
GA	Gabon	TD	Chad
GB	United Kingdom	TG	Togo
JP	Japan	US	United States of America

AMENDED CLAIMS

(Received by the International Bureau on 4 December 1979 (04.12.79))

Claim 1 (cancelled)

Claim 2 (cancelled)

Claim 3 (cancelled)

Claim 4 (cancelled)

Claim 5 (cancelled)

Claim 6 (cancelled)

Claim 7 (cancelled)

- 1 8. Ripping tool driving apparatus having a movable
tool carrier, a ripping tool having a cutting surface
mounted on the carrier for reciprocal movement below the
earth's surface, a force transmitting member with an output
5 and an input, a source of vibrations coupled to the input
of the member to vibrate the output thereof, and means for
mounting the member on the carrier so vibrations are coupled
from its output to the ripping tool, characterized in that
the lateral dimensions of the output of the member are smaller
10 than those of the ripping tool and the output of the member
is located near the cutting surface of the ripping tool.

9. The apparatus of claim 8, in which the vibrations
coupled to the input of the member are at or near the resonant
15 frequency thereof.

10. The apparatus of claim 9, in which the force
transmitting member has a single central node when restrained
from vibrating at such node, and the mounting means mounts
20 the member so as to restrain its single node when vibrating.

11. The apparatus of claim 10, in which the force
transmitting member comprises first and second straight
integral divergent legs that meet at a juncture and the
25 mounting means supports the member at the juncture.

Claim 51 (cancelled)

Claim 52 (cancelled)



12. The apparatus of claim 11, in which the legs .
diverge at an angle of approximately 90 degrees.

30 13. The apparatus of claim 11, in which the mounting
means pivotally supports the juncture of the member and
additionally comprises stop means for limiting rotation
thereof.

Claim 14 (cancelled)

Claim 15 (cancelled)

Claim 16 (cancelled)

Claim 17 (cancelled)

Claim 18 (cancelled)

Claim 19 (cancelled)

Claim 20 (cancelled)

Claim 21 (cancelled)

Claim 22 (cancelled)

Claim 23 (cancelled)

Claim 24 (cancelled)

Claim 25 (cancelled)

Claim 26 (cancelled)

Claim 27 (cancelled)

1 28. A force delivery system having a resonant force
transmitting member with an output and an input, means for
supporting the resonant member, and a source of vibrations
coupled to the input of the resonant member at or near
5 the resonant frequency thereof, characterized in that the
resonant member is bent, and configured to exhibit a
single central node when restrained at such node at the
frequency of the vibrations and the supporting means supports
the resonant beam at the single node.

29. The system of claim 28, in which the resonant member comprises first and second straight integral divergent legs that meet at a juncture.

15 30. The system of claim 29, in which the legs diverge at an angle of approximately 90 degrees.

31. The system of claim 37, in which the resonant member has an integral ear extending from the juncture.

20

32. The system of claim 31, in which the supporting means comprises means for pivotably supporting the resonant member at the single node and stop means for limiting rotation of the ear.

25

33. The system of claim 32, additionally comprising shims disposed between stop means and the ear to adjust the position of the output of the resonant member.

30 34. The system of claim 32, in which the ear extends along a plane that bisects the angle formed by the divergent legs.

35



-28-

1 35. A material working machine having a work tool,
a force transmitting beam having an output coupled to the
work tool and an input, means for supporting the beam, and
means for coupling vibrations to the input of the beams so
5 as to drive the work tool through vibration of the output
of the beam, characterized in that the force transmitting
beam has two straight divergent legs that meet at a juncture
and form an angle of approximately 90 degrees and the
coupling means vibrates the input of the beam transverse
10 to the one leg, the output of the beam transverse to the
other leg.

 36. The machine of claim 35, in which the legs are
integral.
15

 37. The machine of claim 35, in which the legs are
equal in length.

 38. The machine of claim 35, in which the output of the
20 beam has an enlarged thickness.

 39. The machine of claim 35, in which the supporting
means restrains the juncture from vibrating.

25 40. The machine of claim 35, in which the vibrations
are at or near the resonant frequency of the beam.

 41. The machine of claim 40, in which the supporting
means restrains the juncture from vibrating.
30

 42. The machine of claim 41, in which the beam has
an integral ear extending from the juncture between the legs
and the supporting means comprises means for rotatably
supporting the beam at the juncture and stop means for
35 abutting the ear to position the output of the beam.



1 43. A material working machine having a tool holder, a
tool movably attached to the tool holder and adapted to move
forward and backward relative to the tool holder along a work
path, a resonant member supported by the tool holder, the
5 resonant member having an output backwardly spaced from the
tool and an input means for applying an oscillatory,
resonance causing force to the input of the resonant member
for a given period of time to cause the output to oscillate
forward and backward relative to the tool holder about a
10 neutral position and to strike the tool on forward oscillations,
and means for applying a unidirectional force to the tool
holder for the given period of time to advance the tool
intermittently along the work path as the resonant member,
resonates, wherein the improvement comprises means for stopping
15 the backward movement of the tool before the tool reaches
the neutral position of the output of the resonant member
when the tool encounters an immovable object during the
given period of time.

20 44. The material working machine of claim 43, in which
the stopping means comprises a stationary bar supported by
the tool holder between the output of the resonant member
and the tool.

25 45. The machine of claim 44, in which the bar is so
located that the spacing between the bar and the neutral
position of the output of the resonant member is approxi-
mately 1/8 of the total peak-to-peak amplitude of the
oscillations of the output of the resonant member.

30

 46. The machine of claim 45, additionally comprising
a plurality of shims mounted on the bar facing toward the
tool.

35



Claim 47 (cancelled)

Claim 48 (cancelled)

Claim 49 (cancelled)

Claim 50 (cancelled)

Claim 51 (cancelled)

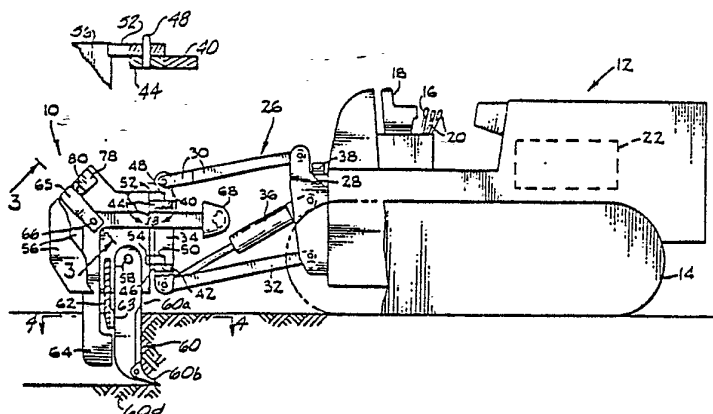
Claim 52 (cancelled)





INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification: A10B 35/00; E01C 23/06	A1	(11) International Publication Number: WO 79/01066 (43) International Publication Date: 13 December 1979 (13.12.79)
(21) International Application Number: PCT/US79/00306 (22) International Filing Date: 9 May 1979 (09.05.79) (31) Priority Application Number: 905,372 (32) Priority Date: 12 mai 1978 (12.05.78) (33) Priority Country: US (71) Applicant: THE GURRIES COMPANY [US/US]; 884 Freeport Boulevard, Sparks, NV 89431 (US). (72) Inventor: GURRIES, Raymond, A.; 1420 Eli Drive, Reno, NV 89511 (US). (74) Agents: PARKER, Robert, L., et al; 201 South Lake Avenue, Pasadena, CA 91101 (US).		(81) Designated States: AT, AT (European patent), BR, CH, CH (European patent), DE, DE (European patent), DK, FR (European patent), GB, GB (European patent), JP, SE, SE (European patent), SU. Published with: <i>International search report</i> Published before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: RIPPING TOOL DRIVING APPARATUS**(57) Abstract**

A ripping tool (60) positioned below the earth's surface is driven by the output of a vibrating, preferably resonant, force transmitting beam (64) which has lateral dimensions smaller than those of the ripping tool and is positioned below the earth's surface. The beam is configured to have a single resonant node when restrained from vibrating at such node and is supported (66) so that the single node is above the earth's surface and restrained from vibrating. The output of the beam is enlarged in thickness to form a hammer. A protective gap is maintained by a tool stop (62) between the tool and the output of the force transmitting beam. The width of the tool stop is precisely controlled by shimming (63) the tool stop and/or the supports for the force transmitting beam.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT

AT	Austria	LU	Luxembourg
BR	Brazil	MC	Monaco
CF	Central African Republic	MG	Madagascar
CG	Congo	MW	Malawi
CH	Switzerland	NL	Netherlands
CM	Cameroon	RO	Romania
DE	Germany, Federal Republic of	SE	Sweden
DK	Denmark	SN	Senegal
FR	France	SU	Soviet Union
GA	Gabon	TD	Chad
GB	United Kingdom	TG	Togo
JP	Japan	US	United States of America

1

5

-1-

10

RIPPING TOOL DRIVING APPARATUS

Cross Reference to Related Applications

This application is a continuation-in-part of my
copending application Serial No. 905,347 filed May 12, 1978
15 and my application Serial No. 973,187 filed December 26,
1978, the disclosures of which are incorporated fully
herein by reference.

Background of the Invention

20 The present invention relates generally to power
driving mechanisms, and more particularly to apparatus
utilizing a vibratory member for driving a ripping tool
into earth, rock, or other earthen material.

Apparatus is known in which a ripping tool is driven
25 by a vibratory member. For example, Bodine Patent 3,336,082
discloses a rock ripping tooth that is integral with the
lower end of a straight resonant beam. Cobb et al Patents
3,770,322 and 4,003,603 describe a ripping tool that is
mounted for reciprocal motion; a source of oscillatory
30 force is coupled by a non-resonant force transmitting rod
to a hammer that periodically strikes the tool. Shatto
Patent 3,633,683 discloses a pivotally mounted ripping tool
that is driven by a hammer located above the earth's
surface. The hammer is attached to the lower end of a
35 straight resonant beam to which a source of vibrations is



-2-

1 coupled. The requirement that the support for the force trans-
mitting beams be above ground and the ripping tool be below
ground makes difficult the design of apparatus for efficiently
driving the ripping tool, because of the restraints on the
5 component location and space occupancy.

Summary of the Invention

According to the invention, a reciprocally mounted ripping
tool is driven by a vibrating, preferably, resonant, force
10 transmitting member, the output of which has smaller lateral
dimensions than the ripping tool. The force transmitting
member is supported so its output lies below the earth's
surface in close proximity to the cutting surface of the
ripping tool. The lateral thickness of the ripping tool
15 serves to divert the earthen material outwardly away from
the path of the output of the force transmitting member.
Preferably, the shank of the ripping tool lying above its
cutting surface has its centrally located vertical leading
edge that helps cut through the earthen material and divert
20 it outwardly away from the force transmitting member.

A feature of the invention is a resonant force trans-
mitting member having a single node. The force transmitting
member is supported so that the single node is above the
earth's surface while its output is located below the earth's
25 surface in proximity to the cutting surface of the ripping
tool. The use of a resonant force transmitting member having
a single node shrinks the longitudinal space requirements
for the resonant member for a given tool driving stroke.

Another feature of the invention is a tool stop between
30 the tool and the output of the force transmitting member
that maintains a protective gap independent of the relative
magnitude of the vibratory force and the tractive force. The
tool stop limits the backward movement of the tool so it
cannot reach the neutral position of the output. Preferably,
35 the tool stop and/or the supports for the force transmitting
member are shimmed to precisely set the protective gap width.

-3-

1 Brief Description of the Drawings

The features of a specific embodiment of the best mode contemplated of carrying out the invention are illustrated in the drawings, in which:

5 FIG. 1 is a side elevational, partially cut away view of tool driving apparatus embodying the invention, with portions broken away;

FIG. 1A is an enlargement of a portion of FIG. 1;

10 FIG. 2 is a top plan view of the left, operative portion of the apparatus illustrated in FIG. 1;

FIG. 3 is a fragmentary sectional view taken along line 3-3 of FIG. 1;

FIG. 4 is a fragmentary sectional view taken along line 4-4 of FIG. 1;

15 FIG. 5 is a graphical illustration of the operating characteristics of the described tool driving apparatus;

FIG. 6 is a fragmentary sectional view of a slightly modified version of the apparatus in FIG. 3; and

20 FIG. 7 is a side view of an alternative version of a portion of the apparatus of FIG. 1.

25

30

35



-4-

1 Detailed Description of the Specific Embodiment

Tool driving apparatus employing a vibrating member in a fashion that such vibration of the beam or other force transmitting member will be maintained, regardless of various other forces applied during operation of the apparatus. To achieve such objective, a ripping tool is supported for pivotal motion from a tool frame adjustably supported at the rear of a mobile carrier in the form of a more or less standard tractor, the pivotal support being essentially transverse to the direction of motion of the tractor so that the tool, in turn, swings forwardly and rearwardly along the general direction of tractor motion. The tool frame, through its adjustable support, can be raised or lowered, and when lowered, the ripping tool can lie several feet below the surface of the earth or other material being engaged thereby.

To impart earth-cutting reciprocal motion to the ripping tool, a resonant member is utilized, and, more particularly, takes the form of an angle beam having a pair of legs supported in angular relationship from a pivotal support carried by the side plates of the tool frame so that one leg projects substantially vertically downward to lie adjacent the rear surface of the ripping tool whereas the other leg extends from the first leg at a divergent included angle of approximately ninety degrees and thus substantially horizontally forward between the frame plates, to mount at its extremity a sonic generator, eccentric weight oscillator or other means for energizing resonant vibration of the angle beam. The pivotal support therefor is at a central node position so that substantially no vibration is transmitted back to the supporting frame. The angle beam has lateral dimensions no greater than that of the ripping tool so that it can lie beneath the surface of the earth or other material being cut by the ripping tool without interfering with the operation.

-5-

1 A short ear extends from the angle beam upwardly
from its node position and lies adjacent a stop member
disposed between the plates, thus to restrict the pivotal
motion of the angle beam about its pivot rod in one
5 direction. Shims, or other means, can be used to provide
for adjustment of the position of shim engagement of the
ear, and thus define the neutral position of the resonant
angle beam, and more particularly the lower tool engaging
portion thereof. In turn, the tool is restricted by a
10 stop with adjustment shims so that it cannot swing backward
into contact with the adjacent portion of the angle beam
when in its defined neutral position. Thus, regardless
of forces on the ripping tool, the resonant beam is able
to swing to and fro in its resonant vibration when appro-
15 priately energized by the sonic generator, eccentric weight
oscillator, or other means, and no possibility of clamping
the beam exists.

With reference to FIGS. 1 and 2, the ripping tool
assembly 10 is mounted at the rear of a more or less con-
20 ventional tractor 12 supported on mobile support means in
the form of spaced endless tracks 14 for motion in a forward
direction determined by a conventional steering mechanism
16 accessible to an operator seated on a driver's seat 18,
with suitable adjacent controls 20 to effect not only the
25 steering but the application of power to the endless tracks
from a conventional engine 22, and also energization of
hydraulic pumps 38 and 74 connected to certain hydraulic
elements of the ripping tool assembly 10, as will be described
hereinafter.

30 A heavy plate is mounted at the rear of the tractor 12
to carry at laterally spaced and substantially parallel
positions a pair of parallelogram units 26, each including
a rigid upstanding leg 28 at the rear of the tractor, the
tops and bottoms of which carry pivotally supported legs 30,
35 32. Legs 30, 32 extend rearwardly, to in turn pivotally



-6-

1 support the upper and lower ends of a vertical rear leg 34
of each parallelogram unit 26 at their rear extremities.
A double-acting hydraulic ram 36 is pivotally connected
between the lower end of the rear legs 34 and the middle
5 of the front legs 28 by a cross rod 31 and another cross
rod, not shown, so as to effect a raising or lowering of
the rear legs of the parallelogram unit upon application
of hydraulic fluid from previously mentioned pump 38 when
actuated by the machine operator.

10 Rigid cross members 40, 42 extend transversely between
the rear extremities of the parallelogram units 26 at both
top and bottom to mount centrally brackets 44, 46 with
aligned substantially vertical pivot pins 48, 50. Pins 48,
50, extend through aligned holes in brackets 52, 54 which
15 are joined rigidly to side plates 56 of the ripping tool
assembly 10. Thus, the ripping tool assembly 10 can pivot
about the generally upright axis defined by the pins 48,
50 to accommodate turning of the tractor 12.

The side plates 56 extend in spaced parallelism
20 rearwardly from the supporting parallelogram units 26 and
carry therebetween several elements, including a horizontal
pivot pin 58 which supports a ripping tool 60 therefrom for
pivotal motion in forward and backward directions. The
ripping tool 60 has a substantially conventional configura-
25 tion, with a long shank 60a extending substantially
vertically downwardly from the supporting pivot pin 58 and
a forwardly and angularly projecting tooth 60b at its lower
extremity. A retaining pin 60d holds tooth 60b in fixed
position at the end of shank 60a. As illustrated in FIG.
30 4, the front surface of shank 60a converges to form a centrally
located vertical leading wedge shaped edge 60c that helps
to cut through the earth. It may be mentioned at this point
that while but a single ripping tool 60 is herein shown,
a series of parallel tools can be suspended if desired,
35 each having a similar configuration. When the parallelogram



-7-

1 unit is lowered into an operative position, the tool 60
can extend as much as several feet into the underlying earth
or other surface, as shown in FIG. 1, to provide the ripping
action upon appropriate actuation of the tool driving apparatus
5 and forward motion of the tractor, as will be described
in detail hereinafter.

The ripping tool 60 is completely free to pivot forwardly into contact with the earth or other material to be worked upon, but, in accordance with the present invention,
10 a stop member 62 with removable shims 63 is disposed between the side plates 56 of the frame, to limit its backward motion to a particular position to be described hereinafter, which will not interfere with normal machine operation.

15 The tool driving apparatus includes a resonant force transmitting member 64 in the form of an angle beam composed of solid steel or other resilient material and having a pair of straight integral legs extending in divergent paths at or near approximately ninety degrees from their point of
20 juncture. The legs of angle beam 64 are preferably equal in length and the vertical end thereof is enlarged in thickness, as illustrated in FIG. 1, to form a hammer that increases the mass at the region of impact with ripping tool 60. Stop member 62 comprises a rigid bar fixed to
25 side plates 56 of ripping tool assembly 10 between ripping tool 60 and the rest position of the vertical end of resonant member 64.

To mount the resonant angle beam 64, an integral ear 76 projects outwardly from the juncture of the legs
30 of the angle beam so as to bisect the angle between the beam legs. As used herein the term "integral" means that the entire resonant member 64, i.e., the legs and ear 76, is cast or forged as a single unit in a one piece construction. Parallel plates 65 are attached as by welding to opposite
35 sides of ear 76. Holes in the plates 65 aligned with the juncture of the beam receive stub shafts 66 welded or



-8-

1 otherwise fixedly secured to the plates 65. The shafts
2 66 are pivotally supported in bushings 67, which are in
3 turn mounted in hard rubber hubs 69 supported in the side
4 plates 56. Thus, although a pivotal support is provided
5 for the beam, it is somewhat flexible and in no way interferes
6 with the resonant vibration of the resonant angle beam 64.

7 In operative disposition, the one leg of resonant
8 angle beam 64 extends substantially vertically so the portion
9 of enlarged thickness at its lower extremity, lies closely
10 adjacent the rear face of the ripping tool 60 at its lower
11 extremity, to provide, upon beam actuation, a repeated
12 cyclical series of blows to the rear of the ripping tool,
13 so as to drive tooth 60b repeatedly into the adjacent earth
14 or other earthen material. The tool engaging portion of
15 angle beam 64 lies below the earth's surface near tooth
16 60b, to provide optimum force transfer thereto. As shown
17 in FIG. 1, the tool engaging portion of angle beam 64 thus
18 lies below tracks 14. As shown in FIG. 4, the lower end
19 of the resonant angle beam 64 has a transverse, i.e., lateral,
20 dimension less than that of the adjacent ripping tool 60.
21 Therefore, when earth has been dislodged by the tool, sub-
22 stantially no earth contact with the beam will occur. The
23 earth is diverted outwardly by ripping tool 60 much as a
24 mobile snow shovel pushes snow out of its path.

25 Means are provided to energize the resonant angle beam
26 64 to resonant vibration, and preferably takes the form of a
27 sonic generator or eccentric weight oscillator 68, as shown in
28 my copending application Serial No. 973,161, filed on
29 December 26, 1978, herewith, the disclosure of which is
30 incorporated fully herein by reference. Oscillator 68 is
31 connected to the end of the horizontal leg of the resonant
32 angle beam for actuation by a hydraulic motor 70 through a belt
33 drive 71. Motor 70 is attached to one of the side plates 56,
34 and fluidically connected to hydraulic pump 74 for actuation
35 under control of the machine operator. Oscillator 68 is driven
36 by motor 70 such that the eccentric weights rotate at or near

-9-

1 the resonant frequency of angle beam 64, which typically is
of the order of 100 cycles per second.

It is to be particularly noted that this form of resonant
angle beam 64 has but a single central node, namely, at
5 the beam juncture and ear 76 along a line bisecting the
angle of beam 64, when the beam is supported so it is restrained
from vibrating at the juncture as shown. The legs of
the beam resonate about this single node, with anti-nodes at
the ends of the legs. A relatively long lever arm is provided
10 by each of the beam legs so that a considerable stroke,
particularly of the lower end of the tool actuating leg,
is produced without the necessity of a resonant member or
beam of excessive longitudinal dimensions. For example,
the cyclical reciprocating stroke with an angle beam
15 having a leg length of no more than five feet can have an
output amplitude adjacent the ripping tool of one inch or more.
Further, the single node and the associated node support struc-
ture are spaced far from the ends of the beam in comparison to
a straight resonant beam having two nodes, as disclosed in my
20 above referenced copending application. This is important in
a ripper, where the node support must be above ground level
and the ripping tool must be underground. In addition, since
the ends of the beam are at an angle to each other, the
sonic generator is located in a plane displaced a substantial
25 distance from the plane in which the tool is located, as
illustrated in FIG. 1.

The weight of oscillator 68 urges resonant angle beam 64
to pivot or rotate about pin 58 in a clockwise direction, as
viewed in FIG. 1. A stop member 78 is attached to side plates
30 56 and extends therebetween adjacent to the end of ear 76 in
the path of its clockwise rotation, as viewed in FIG. 1.
Removable shims 80 are mounted on the surface of stop member
78 facing toward ear 76. Stop member 78 is shimmed so that
the end of resonant angle beam 64 adjacent to tool 60 is
35 located in a desired position, usually so the upright leg



-10-

1 thereof is vertical when the beam is in its neutral position.
The neutral position of the beam is its position when at
rest, i.e., when not resonating or being deflected.

When oscillator 68 is operating, it applies a
5 reciprocating force to the end of the horizontal leg
at or near the resonant frequency of angle beam 64. While
resonant angle beam 64 resonates, the juncture of its
legs, which is the single node, remains stationary and the
end of its vertical leg reciprocates in forward and back-
10 ward directions, striking tool 60 each time it moves forward
in its reciprocating excursion. A changing gap is formed
between the end of the vertical leg of resonant angle
beam 64 and tool 60 -- as the vertical leg reciprocates
in a forward direction the gap tends to close and as the
15 vertical leg reciprocates in a backward direction the
gap tends to open, disregarding the continuous forward
movement of the frame.

Ripping tool 60 comprises a work tool that moves along
through the soil, which comprises the work path. Ripping
20 tool assembly 10 functions as a tool holder or carrier.
Continuous unidirectional force is applied thereto by tractor
12 in a direction parallel to the work path. Oscillator 68
generates a reciprocating force, at least one component of
which acts parallel to the work path. Resonant angle beam
25 64 comprises a force transmitting member, the end of its
horizontal leg comprising an input to which the reciprocating
oscillator force is applied, and the end of its vertical
leg comprising an output from which the reciprocating force
is transferred to the tool. The tool advances intermittently
30 along the work path responsive to the continuous uni-
directional force applied by tractor 12 and the reciprocating
force applied by oscillator 68.

A minimum protective gap is established between the
neutral position of resonant angle beam 64 and tool 60 by
35 stop members 62 and 78. As a result, when tool 60 encounters



-11-

1 an immovable object, which prevents its further advance,
tractor 12 continues to advance until tool 60 abuts stop
member 62. In other words, stop member 62 limits the back-
ward movement of tool 60 so it cannot reach the neutral
5 position of the beam output. Thus, the end of the vertical
beam leg cannot become clamped by tool 60 when tool 60
encounters an immovable object, and destroy the components
of the ripping tool assembly. In my referenced copending
application a different way is disclosed for establishing
10 a protective gap between the output of the beam and the
tool when the tool encounters an immovable object, namely,
the use of substantially more reciprocating oscillator force
than the continuous unidirectional force provided by the mobile
carrier. In a number of applications, however, requiring that
15 the mobile carrier supply a very large continuous unidirectional
force, such as a shovel bucket or a rock ripper, it is im-
practical to furnish sufficient reciprocating oscillator force
to establish the gap in the manner described in the referenced
copending application.

20 Recognizing that small variations in relative spatial
position between components cannot be avoided in the manufac-
ture and assembly of the components of ripping tool assembly
10, the length of the minimum protective gap is adjusted from
machine to machine by shims 63 on stop member 62 and shims
25 80 on stop member 78. Instead of shimming both stop members
62 and 78, one or the other of these stop members alone could
be shimmed to establish the minimum protective gap. In a
typical example, the peak-to-peak excursion of the beam output
might be 2 inches, and the minimum protective gap might
30 be 1/4 of an inch, so that the power stroke of the beam
output would be 3/4 of an inch. The minimum protective
gap should be no larger than necessary to prevent cessation
of resonance when the tool encounters an immovable object,
because the larger this gap, the smaller the power stroke,
35 i.e., the portion of the beam output excursion in which
it contacts the tool.



-12-

1 If resonant angle beam 64 is driven at or near its
resonant frequency without restraining the beam juncture from
vibrating as disclosed herein, it has two nodes near its
ends, as in the case of a straight resonant beam. Under
5 some circumstances, it may be desirable to operate a resonant
angle beam in this way, i.e., with two nodes, by supporting
the beam at these two nodes, rather than at the beam juncture.

For an explanation of how stop members 62 and 78 protect
ripping tool assembly 10, reference is made to FIG. 5,
10 wherein the central horizontal line N represents the neutral
position of the resonant angle beam 64, and more particularly
the output thereof, and the dashed horizontal line S spaced
thereabove, represents the rearmost position attainable by
the ripping tool 60 when in engagement with stop member
15 62. The distance between N and S represents the minimum
protective gap. The normal resonant swing of the output
of the resonant angle beam 64 is represented by the solid
line sine wave indicated at R. When the tool encounters
a very hard material and can no longer advance, it moves
20 against stop member 62, thereby limiting the excursions
of the beam output to an amount equal to the minimum
protective gap forward and backward of the neutral position,
as represented by the dashed line sine wave R'. This limited
excursion is enough to maintain angle beam 64 in resonance and
25 accordingly prevent destruction of the assembly.

As shown in the described embodiment and particularly
in FIG. 3, the short connection of the stub shafts 66
in the plates 65 provides a relatively weak support.
Consequently, a slightly modified stronger mounting arrangement
30 as shown in FIG. 6 can be utilized. As there shown, parallel
side plates 82 are welded to an outwardly projecting ear
84 formed at the juncture of the legs of the angle beam
85 and extend adjacent the sides of the resonant angle
beam 85 beyond its inner edge to support a tube 86 in aligned
35 holes. Tube 86 in turn, carries a single shaft 88, mounted



-13-

1 by bushings 90, and rubber hubs 92 in the side plates 94
of the frame. Tube 86 and beam 85 are fixed relative to
shaft 88, which is rotatable in bushings 90 about side plates
94 of the frame.

5 While the tool driving apparatus has been described
specifically in connection with a ripping tool, it will be
apparent that it can also be applied to a cutter blade as
of the type generally shown in my prior application referred
to hereinabove, and also to a shovel bucket or other members
10 of various types requiring considerable force in their
operative functions. Consequently, the term "tool" is to
be broadly construed.

The described embodiment of the invention is only con-
sidered to be preferred and illustrative of the inventive
15 concept; the scope of the invention is not to be restricted
to such embodiment. Various and numerous other arrangements
may be devised by one skilled in the art without departing
from the spirit and scope of this invention. For example,
a non-resonant force transmitting member could be employed
20 with advantage in some situations, although a resonant
member is preferable. Furthermore, the advantages of
having a resonant member with a single node located above
the earth's surface can be achieved when the output of the
beam strikes the tool from a position above the earth's
25 surface.

30

35



-14-

1 WHAT IS CLAIMED IS:

1. Material cutting apparatus which comprises
a ripping tool arranged to dig a trench in the
earth or other material,
5 a frame movably supporting said tool for earth
engagement,
a resonant member supported adjacent said tool
for intermittent driving contact therewith, and
means for energizing resonant vibration of said
10 resonant member, said resonant member being supported so
that its tool-engaging portion lies behind said tool in its
direction of cutting motion into the earth, has lateral
dimensions less than those of said tool, and engages said
tool below the surface of the earth.

15 2. Material cutting apparatus according to claim 1,
which comprises mobile support means for said frame, said
tool, and said resonant member, the mobile support means
lying on the earth surface above the tool engaging portion
20 of the beam.

3. Material cutting apparatus according to claim 2,
which comprises means supporting said tool and said
resonant member for adjustment substantially perpendicularly
25 relative to the surface of the earth being cut.

4. Material cutting apparatus according to claim 1,
wherein said resonant member constitutes an angle beam
having the extremity of one leg arranged to provide the
30 tool-engaging portion thereof.

5. Material cutting apparatus according to claim 1,
wherein said energizing means constitutes an eccentric
weight oscillator connected to one end of said resonant
35 member.



-15-

1 6. Material cutting apparatus which comprises
 a ripping tool arranged to dig a trench in the
 earth or other material,
 a frame movably supporting said ripping tool for
5 earth engagement,
 a resonant member supported adjacent said ripping
 tool for driving contact therewith in a forward direction,
 means for energizing resonant vibration of said
 resonant member,
10 stop means engaging said resonant member to define
 the neutral disposition thereof, and
 stop means restricting rearward motion of said
 ripping tool to a position spaced from the neutral position
 of said resonant member.

15

 7. Material cutting apparatus which comprises
 a ripping tool arranged to dig a trench in the
 earth or other material below the earth's surface;
 a resonant member having a single node when
20 restrained from vibrating at such node, one end of the
 resonant member being coupled to the ripping tool adjacent
 said tool for driving contact therewith;
 means for supporting the single node of the
 resonant member above the earth's surface to restrain the
25 single node from vibrating; and
 means for energizing resonant vibration of said
 resonant member, said energizing means constituting an
 eccentric weight oscillator connected to the other end of
 said resonant member.

30

35



-16-

1 8. Ripping tool driving apparatus having a movable
 tool carrier, a ripping tool having a cutting surface
 mounted on the carrier for reciprocal movement below the
 earth's surface, a force transmitting member with an output
5 and an input, a source of vibrations coupled to the input
 of the member to vibrate the output thereof, and means for
 mounting the member on the carrier so vibrations are coupled
 from its output to the ripping tool, characterized in that
 the lateral dimensions of the output of the member are smaller
10 than those of the ripping tool and the output of the member
 is located near the cutting surface of the ripping tool.

 9. The apparatus of claim 8, in which the vibrations
 coupled to the input of the member are at or near the resonant
15 frequency thereof.

 10. The apparatus of claim 9, in which the force
 transmitting member has a single central node when restrained
 from vibrating at such node, and the mounting means mounts
20 the member so as to restrain its single node when vibrating.

 11. The apparatus of claim 10, in which the force
 transmitting member comprises first and second straight
 integral divergent legs that meet at a juncture and the
25 mounting means supports the member at the juncture.

 12. The apparatus of claim 11, in which the legs
 diverge at an angle of approximately 90 degrees.

30 13. The apparatus of claim 11, in which the mounting
 means pivotally supports the juncture of the member and
 additionally comprises stop means for limiting rotation
 thereof.

35



-17-

1 14. The apparatus of claim 13, in which the member
has an integral ear extending from the juncture and the stop
means limits rotation of the ear.

5 15. The apparatus of claim 8, in which the output of
the member vibrates about a neutral position, the apparatus
additionally comprising a tool stop mounted on the carrier
to prevent the tool from moving to the neutral position of
the output of the member.

10 16. The apparatus of claim 8, in which the output of
the member has an enlarged thickness forming a hammer.

15 17. The apparatus of claim 8, in which the ripping
tool has a shank on which a centrally located vertical
leading edge is formed.

20 18. Ripping tool driving apparatus having a ripping
tool positioned below the earth's surface, a resonant force
transmitting beam having an output coupled to the tool to
drive the ripping tool into the adjacent earthen material and
an input, means for supporting the resonant member, and
a source of vibrations coupled to the input of the resonant
member at or near the resonant frequency thereof, characterized
25 in that the resonant member is bent and configured to
exhibit a single central node when restrained from vibrating
at such node at the frequency of the vibrations, and the
supporting means supports the resonant beam at the single
node above the earth's surface.

30 19. The apparatus of claim 18, in which the resonant
member comprises first and second straight integral divergent
legs that meet at a juncture.

35



-18-

1 20. The apparatus of claim 19, in which the mounting
 means supports the member at the juncture.

 21. The apparatus of claim 20, in which the mounting
5 means pivotally supports the juncture of the member and
 additionally comprises stop means for limiting rotation
 thereof.

 22. The apparatus of claim 21, in which the member
10 has an integral ear extending from the juncture and the stop
 means limits rotation of the ear.

 23. The apparatus of claim 18, in which the legs
 diverge at an angle of approximately 90 degrees.
15

 24. The apparatus of claim 18, in which the output of
 the member vibrates about a neutral position, the apparatus
 additionally comprising a tool stop mounted on the carrier
 to prevent the tool from moving to the neutral position of
20 the output of the member.

 25. The apparatus of claim 18, in which the output of
 the member has an enlarged thickness forming a hammer.

25 26. The apparatus of claim 18, in which the ripping
 tool has a shank on which a centrally located vertical
 leading edge is formed.

30

35

-19-

- 1 27. Apparatus for performing work on an earthen
medium comprising:
- 5 a ripping tool movable in backward and forward
directions along a work path below the earth's surface to
engage the medium;
- a sonic oscillator producing a reciprocating
force having at least a component parallel to the work path;
 means for transmitting the reciprocating force
from the oscillator to the tool, the transmitting means
10 having an output that reciprocates in forward and backward
directions about a neutral position responsive to the
oscillator, the output having smaller lateral dimensions
than the ripping tool and being located near the cutting
surface of the ripping tool below the earth's surface, a
15 changing gap being formed between the tool and the output
as the output reciprocates, the gap tending to close and
strike the tool as the output reciprocates in a forward
direction and tending to open as the output reciprocates
in a backward direction;
- 20 means for applying to the output of the transmitting
means a continuous unidirectional force in the forward
direction to advance the tool intermittently along the work
path responsive to the unidirectional force and the
reciprocating force; and
- 25 a tool stop for maintaining a minimum protective
gap between the neutral position of the output and the tool
when the tool is unable to advance responsive to the
unidirectional force and the reciprocating force.

30

35



-20-

1 28. A force delivery system having a resonant force
transmitting member with an output and an input, means for
supporting the resonant member, and a source of vibrations
coupled to the input of the resonant member at or near
5 the resonant frequency thereof, characterized in that the
resonant member is bent, and configured to exhibit a
single central node when restrained at such node at the
frequency of the vibrations and the supporting means supports
the resonant beam at the single node.

10

29. The system of claim 28, in which the resonant
member comprises first and second straight integral divergent
legs that meet at a juncture.

15 30. The system of claim 29, in which the legs diverge
at an angle of approximately 90 degrees.

31. The system of claim 30, in which the resonant
member has an integral ear extending from the juncture.

20

32. The system of claim 31, in which the supporting
means comprises means for pivotably supporting the
resonant member at the single node and stop means for
limiting rotation of the ear.

25

33. The system of claim 32, additionally comprising
shims disposed between stop means and the ear to adjust the
position of the output of the resonant member.

30 34. The system of claim 32, in which the ear extends
along a plane that bisects the angle formed by the
divergent legs.

35



-21-

1 35. A material working machine having a work tool,
a force transmitting beam having an output coupled to the
work tool and an input, means for supporting the beam, and
means for coupling vibrations to the input of the beams so
5 as to drive the work tool through vibration of the output
of the beam, characterized in that the force transmitting
beam has two straight divergent legs that meet at a juncture
and form an angle of approximately 90 degrees and the
coupling means vibrates the input of the beam transverse
10 to the one leg, the output of the beam transverse to the
other leg.

36. The machine of claim 35, in which the legs are
integral.

15

37. The machine of claim 35, in which the legs are
equal in length.

38. The machine of claim 35, in which the output of the
20 beam has an enlarged thickness.

39. The machine of claim 35, in which the supporting
means restrains the juncture from vibrating.

25 40. The machine of claim 35, in which the vibrations
are at or near the resonant frequency of the beam.

41. The machine of claim 40, in which the supporting
means restrains the juncture from vibrating.

30

42. The machine of claim 41, in which the beam has
an integral ear extending from the juncture between the legs
and the supporting means comprises means for rotatably
supporting the beam at the juncture and stop means for
35 abutting the ear to position the output of the beam.



-22-

1 43. A material working machine having a tool holder, a
tool movably attached to the tool holder and adapted to move
forward and backward relative to the tool holder along a work
path, a resonant member supported by the tool holder, the
5 resonant member having an output backwardly spaced from the
tool and an input means for applying an oscillatory,
resonance causing force to the input of the resonant member
for a given period of time to cause the output to oscillate
forward and backward relative to the tool holder about a
10 neutral position and to strike the tool on forward oscillations,
and means for applying a unidirectional force to the tool
holder for the given period of time to advance the tool
intermittently along the work path as the resonant member
resonates, wherein the improvement comprises means for stopping
15 the backward movement of the tool before the tool reaches
the neutral position of the output of the resonant member
when the tool encounters an immovable object during the
given period of time.

20 44. The material working machine of claim 43, in which
the stopping means comprises a stationary bar supported by
the tool holder between the output of the resonant member
and the tool.

25 45. The machine of claim 44, in which the bar is so
located that the spacing between the bar and the neutral
position of the output of the resonant member is approxi-
mately 1/8 of the total peak-to-peak amplitude of the
oscillations of the output of the resonant member.

30 46. The machine of claim 45, additionally comprising
a plurality of shims mounted on the bar facing toward the
tool.

35



-23-

- 1 47. The machine of claim 46, additionally comprising
a plurality of shims mounted on the bar facing toward the
tool.
- 5 48. Apparatus for performing work on a medium comprising:
a tool movable in backward and forward directions
along a work path to engage the medium;
a sonic oscillator producing a reciprocating force
having at least a component parallel to the work path;
10 means for transmitting the reciprocating force from
the oscillator to the tool, the transmitting means having an
output that reciprocates in forward and backward directions
about a neutral position responsive to the oscillator, a
changing gap being formed between the tool and the output as
15 the output reciprocates, the gap tending to close and strike
the tool as the output reciprocates in a forward direction
and tending to open as the output reciprocates in a backward
direction;
means for applying to the output of the transmitting
20 means a continuous unidirectional force in the forward
direction to advance the tool intermittently along the work
path responsive to the unidirectional force and the
reciprocating force; and
a tool stop for maintaining a minimum protective
25 gap between the neutral position of the output and the tool
when the tool is unable to advance responsive to the
unidirectional force and the reciprocating force.
49. The apparatus of claim 48, in which the transmitting
30 means comprises a resonating beam.
50. The apparatus of claim 49, additionally comprising
a tool carrier that supports the tool and the force trans-
mitting means, the applying means applying the continuous
35 unidirectional force to the tool carrier.



-24-

1 51. The apparatus of claim 50, in which the tool stop
is fixed to the tool carrier between the tool and the output
of the force transmitting means.

5 52. The apparatus of claim 51, additionally comprising
shims mounted on the tool stop such that the tool abuts the
shims when the tool is unable to advance responsive to the
unidirectional force and the reciprocating force.

10

15

20

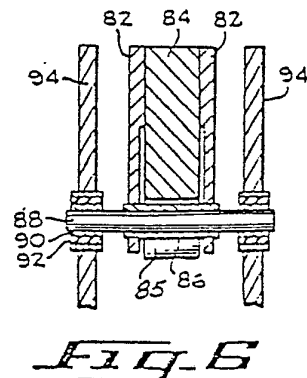
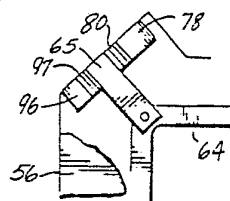
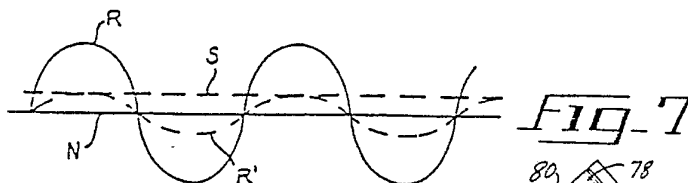
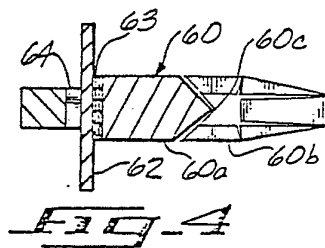
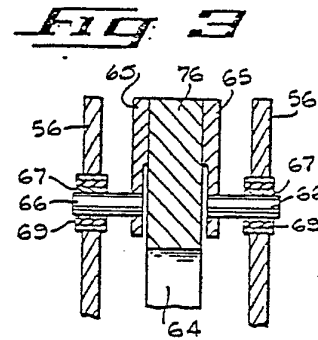
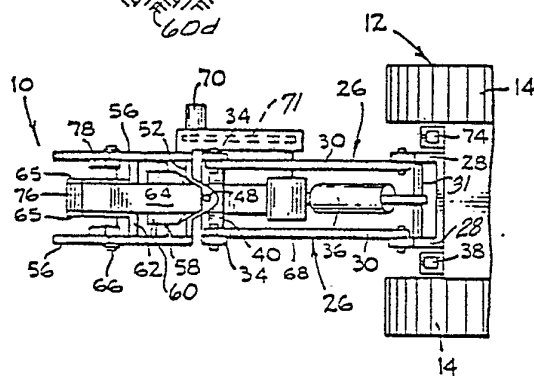
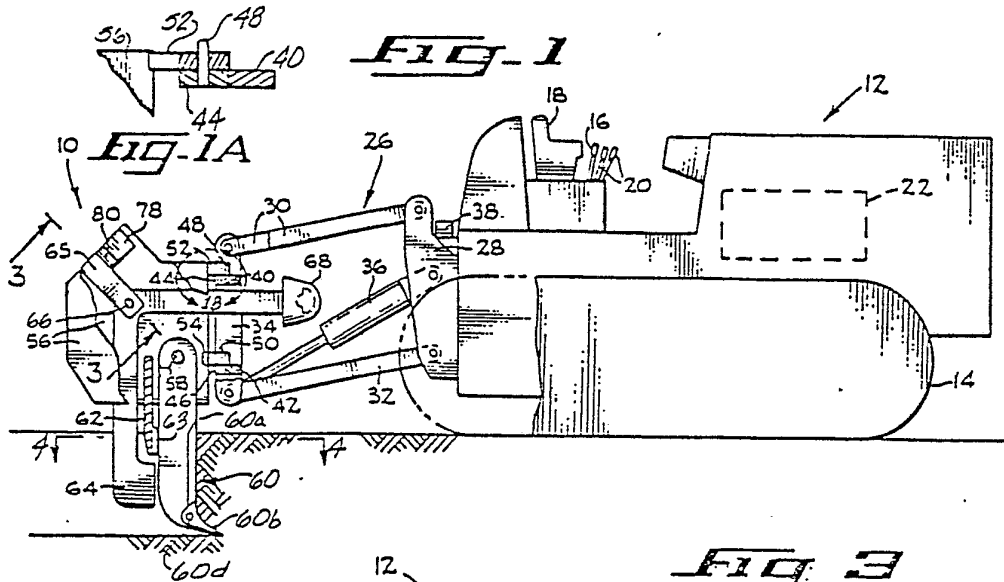
25

30

35



1



INTERNATIONAL SEARCH REPORT

International Application No PCT/US79/00306

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) ³

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl. A01B 35/00; E01C 23/06

U.S. Cl. 299/37, 172/40

II. FIELDS SEARCHED

Minimum Documentation Searched ⁴

Classification System	Classification Symbols		
U.S.	299/14.37	404/90.91	30/272R, 272A, 277
	172/40	173/49	169-172
	37/Dig. 18	15/93R	

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in the Fields Searched ⁵

III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴

Category [*]	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
X	US, A, 3,437,381, Published 08 April 1969 Bodine	1-5, 7-26, 28-42
X	US. A. 3,770,322, Published 06 November 1973 Cobb Et Al	6, 14, ; 5, 21, 22, 24, 27, 32, 33, 34, 42-52
X	US, A, 3,897,975, 'Published 05 August' 1975 Cobb et al	6, 14, 15, 21, 22, 24, 27, 32, 33, 34, 42-52
X	US, A, 3,695,365, Published 03 October 1972 Schadlich	33, 47
A	US, A, 3,633,683, Published 11 January 1972 Shatto	1-52
A	US, A, 4,003,603, Published 18 January 1977 Stemler et al	1-52
A	US, A, 3,857,609, Published 31 December 1974 Felix	41-52
A	US, A, 3,922,017, Published 25 November 1975 Cobb	51-52

^{*} Special categories of cited documents: ¹⁵

"A" document defining the general state of the art

"E" earlier document but published on or after the international filing date

"L" document cited for special reason other than those referred to in the other categories

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search ²

14 August 1979

Date of Mailing of this International Search Report ²

05 OCT 1979

International Searching Authority ¹

ISA/US

Signature of Authorized Officer ²⁰

