Sept. 9, 1969 J. J. MILLY 3,465,986

SATELLITE DESPIN DEVICE

Filed June 7, 1967 4 Sheets-Sheet 1

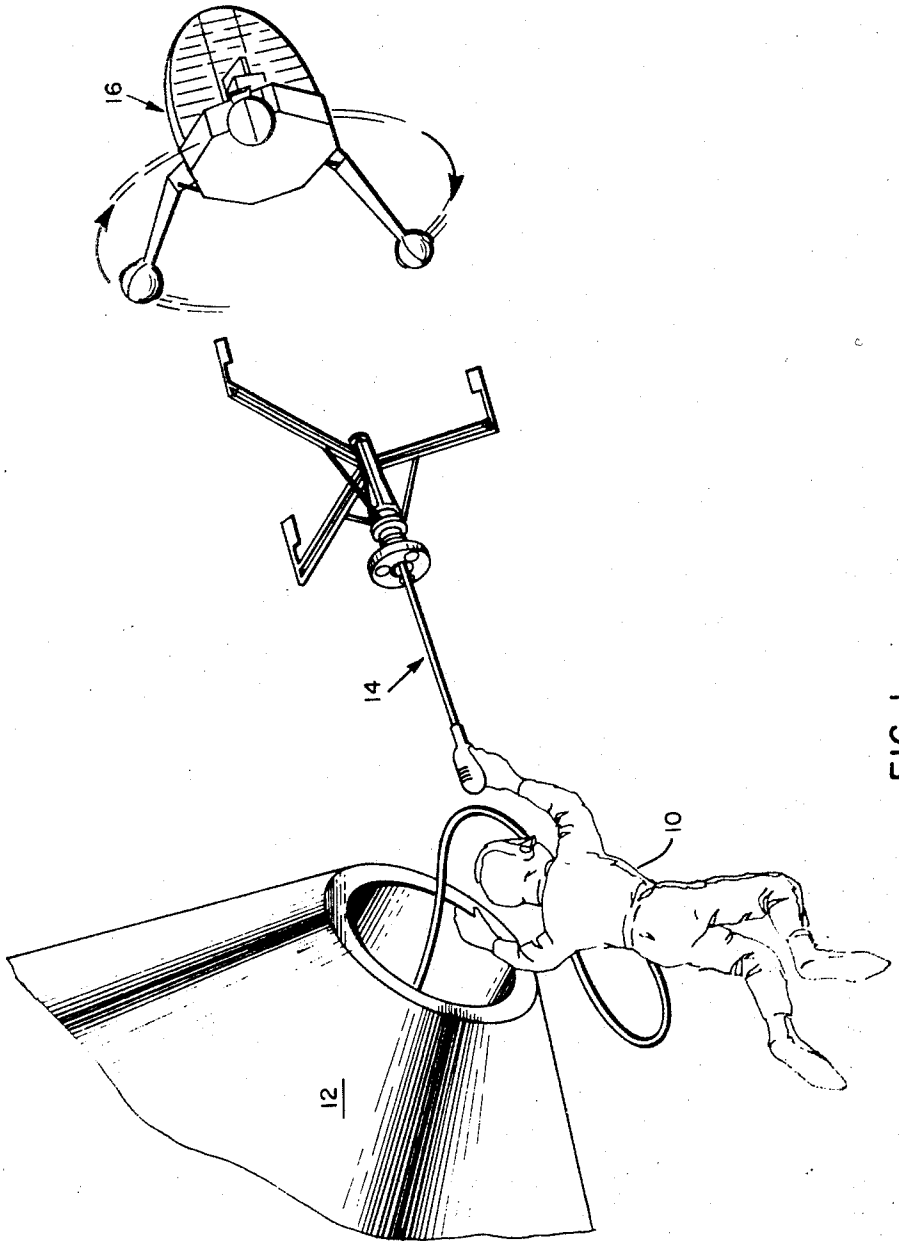


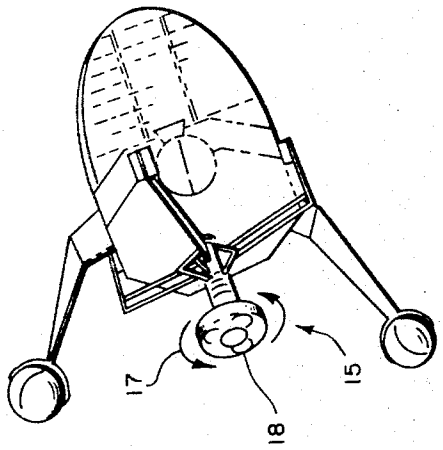
FIG. 1

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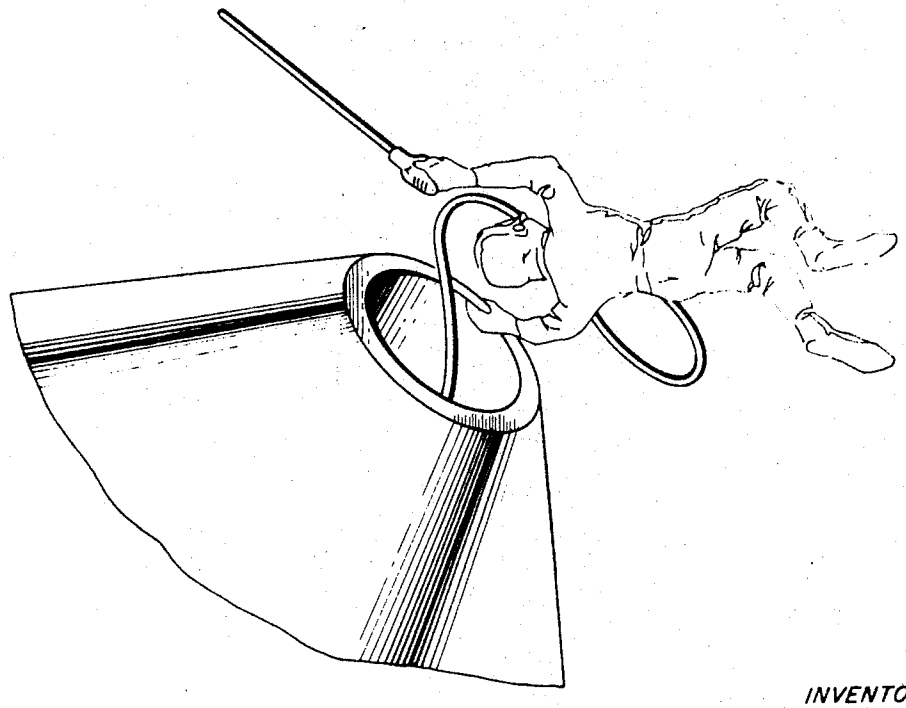


FIG. 2

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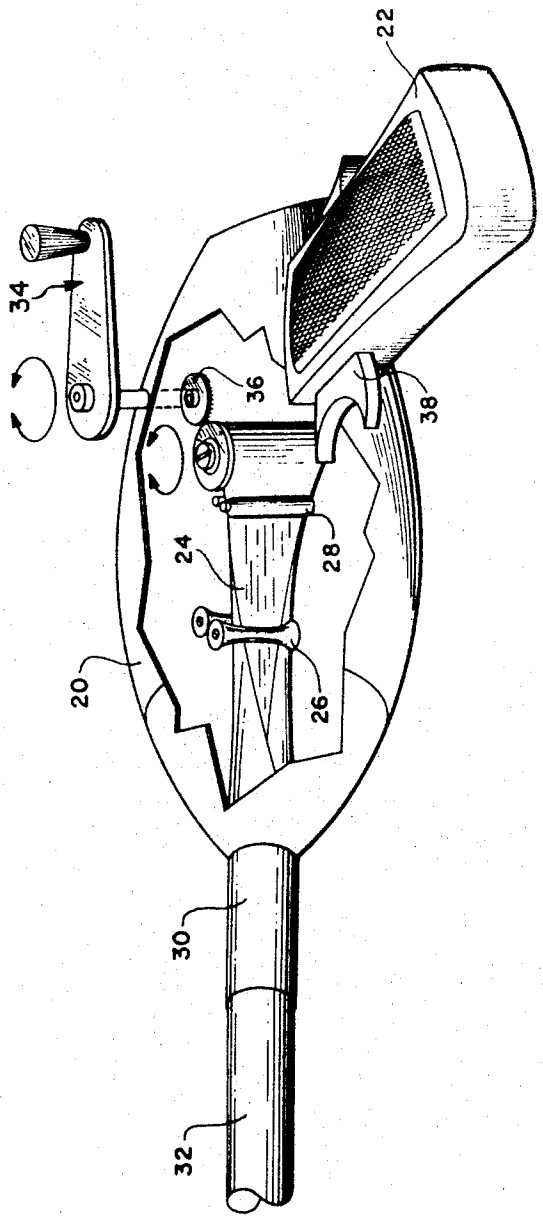


FIG. 3

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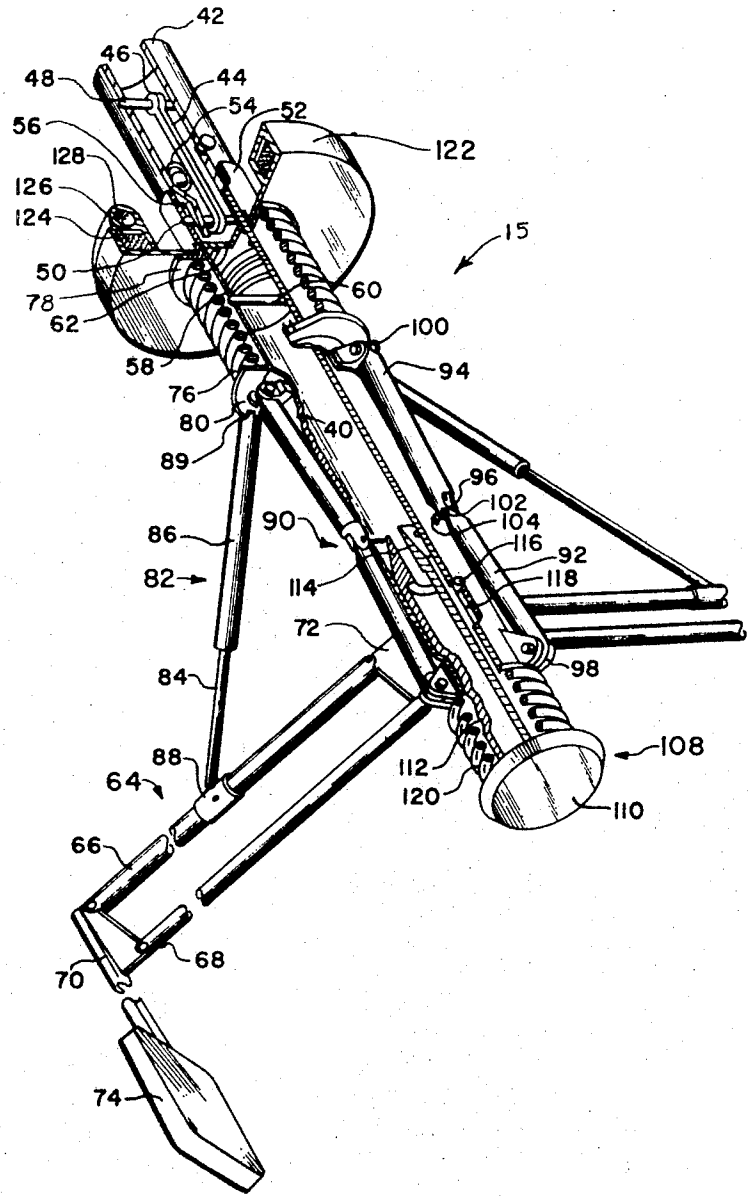


FIG. 4

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SATELLITE DESPIN DEVICE

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Filed June 7, 1967, Ser. No. 645,563
Int. Cl. B64g 9/00
U.S. Cl. 244—1 4 Claims

ABSTRACT OF THE DISCLOSURE

A grasping device comprising an extensible boom device connected to a powerhead having a plurality of pivotally mounted arms positioned thereon which are actuated by a spring driven linkage. The arms and linkage can be cocked and then released by a trigger included in the powerhead to cause the arms to move to a grasping position. The powerhead includes a rotary rocket motor for generating thrust which tends to contra-rotate the powerhead and stop the rotation of a grasped object. The powerhead is releasably connected to the extensible boom that is formed from a roll of thin metallic tape stored on a spool in a hand held deployment device. The metal tape assumes the form of a tube when unfurled.

BACKGROUND OF THE INVENTION

The invention described herein was made by an employee of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

During the past several years, the United States and other countries have placed a great many satellites and other objects into orbit about the earth in carrying out their numerous research programs. Some of the objects placed into space were satellites that were spin stabilized to enable performances of their intended function. Many of the spinning or rotating satellites have completed their intended missions and have long since ceased to function. Most are now maintaining useless orbits about the earth occupying space, but providing no further research data.

Recently, interest in these vehicles has increased because of the possibility of their being given inflight maintenance or retrieved for study of such things as causes of failure, life expectancy of components and the effect of an outer space environment. Information that is obtained can be applied to future space vehicles. Thus, the need exists for a device to retrieve objects from outer space and particularly, there exists a need for a tool capable of stopping the rotation of a satellite so as to permit an astronaut to work on or retrieve the satellite without danger of bodily injury. It is readily apparent that the consequences of an astronaut grasping a rotating satellite would be disastrous.

SUMMARY OF THE INVENTION

The invention described herein comprises an extensible boom device connected to a powerhead for grasping and stopping the rotation of a satellite in space. The extensible boom device is utilized to position the powerhead in the vicinity of the satellite to be stopped and it is composed of a length of thin metal tape which is wound upon a spool or storage drum mounted in a container of a convenient size to be held in the hand of an astronaut. The characteristics of the metal tape is such that when unwound from the storage spool it will assume the form of a tube to which the powerhead can be attached. The tape is wound or unwound by means of a hand crank or other suitable means connected through appropriate gearing to the storage spool. The powerhead includes a cylindrical body having three arms pivotally mounted to one end thereof. The arms have grasping pads attached to the extremities thereof and the arms actuated by means of a spring powered linkage. The linkage can be placed in a cocked position and a trigger mechanism is included that is actuated by contact with a satellite to unlock the linkage and permit the arms to grasp the satellite. A quick disconnect coupling is provided between the extensible boom and the powerhead. Also, a rotary rocket motor is provided on the powerhead which provides the force necessary to stop the rotation of a satellite that has been grasped.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a pictorial view of an astronaut in the process of using a despin tool constructed in accordance with this invention.

FIGURE 2 is a view similar to FIGURE 1 except that the powerhead has been attached to the satellite and disconnected from the extensible boom.

FIGURE 3 is a pictorial view, partially broken away, showing the details of the extensible boom device.

FIGURE 4 is a pictorial view, partially in section and broken away, showing the details of the powerhead.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Refer now to FIGURE 1 of the drawings which illustrates how a despin device constructed in accordance with this invention will be used by an astronaut in space. An astronaut **10** has exited from his spacecraft **12** and has deployed a despin device **14** towards a rotating satellite **16**. In FIGURE 2, powerhead **15** of the despin device has been attached to the rotating spacecraft and a rotary rocket motor **18** has been ignited which will generate sufficient thrust in a direction indicated by arrows **17** in FIGURE 2 to stop the rotation of the satellite.

Referring now to FIGURE 3 of the drawings, the extensible boom device for placing the satellite despin device in the vicinity of a satellite will be described. The extensible boom device consists of an outer housing **20** having a handle **22** attached to one end thereof. Housing **20** has a storage drum or spool rotatably mounted therein on which a thin metal tape **24** is stored. The metal tape passes from the storage spool across two sets of guide rollers **26** and **28** suitably mounted in the housing **20** out through guide tube **30** attached to one end of housing **20**. The characteristic of the metal tape is such that after it has passed through roller set **26**, it then assumes the form of a tube to effectively form a boom or tube **32** to which a powerhead or despin device described hereinafter can be attached. The guide rollers **28** function to flatten out the tape when it is being rewound. The storage spool upon which the metal tape is stored is suitably journaled within housing **20** and can be rotated either by a hand crank **34** and drive pinion **36** or the hand crank can be replaced if desired with a suitable battery driven electric motor (not shown).

A trigger mechanism **38** is mounted in handle **22** that engages the storage spool to prevent rotation thereof until released. The connection between the trigger mechanism and the spool is not shown in detail herein since any suitable mechanism can be provided to lock the storage spool in place and prevent rotation thereof until the trigger is released. The metal tape can be made of any suitable material, thin stainless steel for example, which will have sufficient strength to extend and retract the despin device in space. Due to the weightless conditions that exist in an outer space environment, the strength of the tube formed by the thin metallic tape will not be a significant factor and the boom can be formed from very lightweight tape.

Referring now to FIGURE 4 of the drawings, power-

head 15 consists of a tubular body 40 adapted to have end 42 of the extensible boom inserted into one end thereof. There is a quick disconnect connection between the extensible boom and tubular body 40 made up of a handle release hook 44 which has an eye 46 formed on one end thereof that is mounted on a transverse pin 48 mounted in end 42 of the extensible boom. The other end of the handle release hook is in the form of a hook which fits over a second transverse pin 50 mounted in housing 40. An unlocking spring 54 is attached to end 42 of the extensible boom and is positioned so that it exerts a bias against the handle release hook that tends to move the handle release hook to an unlocked position. The extensible boom has a slot 56 formed in end 42 thereof that when fitted over pin 50 prevents relative rotation of the extensible boom with respect to the powerhead. A disengage spring 58 is positioned within tube 40 so as to abut a retainer pin 60. Compressed spring 58 exerts a force which acts upon a guide disc 62 positioned between the spring 58 and end 42 of the extensible boom.

The force exerted by the spring is such that when the handle release hook has been unlocked from pin 50, the force exerted by the spring will cause separation of the extensible boom and powerhead. Unlocking of the handle release hook is accomplished by pushing end 42 of the extensible boom into the end of tubular body 40 sufficiently far to permit the hooked end of the handle release spring to clear pin 50. The unlocking spring will then displace the hook far enough to clear pin 50 when the extensible boom is separated from the powerhead.

The powerhead has three arm members 64 pivotally mounted thereon which function to grasp an object. The arm members and linkage associated with each are identical and therefore only one arm member will be described herein. Each arm member 64 includes two parallel links 66 and 68 that are connected at their extremities by brackets 70 and 72. Each of the links are pivotally mounted to bracket 70 and 72 so that grasping pad 74 connected to brackets 70 will maintain a proper position for grasping a satellite while the arm members are moved.

A mechanism for moving the arm members to a grasping position includes a ram power spring 76 disposed around tubular body 40. One end of the ram power spring abuts against a flange member 78 attached to the tubular body 40 and the other end of the spring abuts a collar 80 that is slideably mounted on tubular body 40. Ram link 82 is composed of a small rod 84 slidably mounted within tube 86. The purpose of the telescoping construction is to permit links 66 and 68 to fold forward for easy stowage. During use of the device, rod 84 is immobilized in tube 86 by a suitable locking means (not shown). Shaft 84 is connected to link 66 by means of a collar 88, and tube 86 is mounted to a bracket 89 on collar 80. The grasping arms are retained in a cocked position with the coil spring 76 compressed by means of a detent assembly 90 associated with each grasping arm.

Each detent assembly comprises a pair of links 92 and 94 that are joined together at one of their ends to form a pivotal joint 96. The other ends of links 92 and 94 are pivotally connected to brackets 98 and 100. Bracket 98 is fixed to tubular housing 40 and does not move whereas bracket 100 is attached to collar 80 which slides with respect to tubular housing 40. It will be noted that one end of link 92 has a pin 102 formed on the end thereof which connects to link 94 and this pin extends into the interior of housing 40 through an opening 104 formed therein. The function of pin 102 is believed readily apparent and will be discussed further hereafter. It will be noted that FIGURE 4 illustrates the grasping arms in a cocked position and the links 92 and 94 of the detent assembly have been bent through their longitudinal axis so that the force exerted thereon by the ram spring 76 tends to drive the pivotal connection 96 and pin 102 into housing 40.

A trigger assembly 108 is slidably mounted in a tubular housing 40, but projects therefrom for engagement with the object to be grasped. The end of the trigger assembly which projects from tubular housing 40 includes a contact button 110 for contact with the object to be grasped and a tubular extension 112 that extends into the tubular housing. Extension 112 terminates in a conical camming surface 114 that engages pins 102 when the trigger assembly is pushed into housing 40 to cam pins 102 outwardly and thus bend links 92 and 94 through their longitudinal axis and releases collar 80 so that it can be moved toward the grasping arms by spring 76. The trigger assembly is secured in housing 40 by a pin 116 attached to housing 40 and slidable in a slot 118 formed in the tubular extension. The trigger assembly is biased by a trigger spring 120 to a position wherein the camming surfaces 114 are not normally in engagement with pins 102 of the detent assemblies.

The rotary rocket motor is mounted to a disc shaped member 122 attached to flange 78. The motor includes a motor casing 124, a circular solid propellant grain 126 of a suitable type, and a plurality of rocket nozzles 128 (normally three) mounted on the motor casing. The nozzles are of course in communication with the interior of the motor casing. An ignition device (not shown) is included with the motor assembly for ignition of the propellant grain after separation of the extensible boom and powerhead.

The operation of the despin device is as follows: An astronaut by means of the extensible boom deploys the device toward a satellite to be retrieved and presses the trigger assembly of the powerhead against the satellite being retrieved at its center of rotation. This causes the camming surfaces 114 of the trigger assembly to cam the pins 102 outwardly such that the detent assemblies are bent through their longitudinal axis to permit the ram power spring to continue bending of the linkage. When the linkage is bending the ram power spring also exerts pressure on the ram link which in turn transfers pressure to the parallel links of the grasping arms. The three grasping arms then rotate forward and inwardly, causing the three grasping pads to engage the satellite as shown in FIGURE 2.

While the above action is taking place, end 42 of the extensible boom has been pushed into tube 40 against the action of spring 58 to release the hooked end of handle hook to a position wherein the hook will not catch pin 50 as the extensible boom is retracted or ejected from the tubular housing during separation of the extensible boom and the powerhead. The rocket motor will then be ignited (by either a delayed fusing, radio ignition or any suitable means) after separation of the boom and powerhead to generate a thrust for stopping the rotation of the satellite. The size and thrust of the rocket motor will be calculated prior to use, taking into account the mass and rotational speed of the satellite being retrieved. A remote radio operated release (not shown) can be provided that will free rocket motor disc 122 from housing 40 when satellite rotation stops.

What is claimed is:

1. A satellite retrieval and despin device for use by an astronaut to retrieve a satellite, said device compising in combination:

a powerhead for grasping a rotating satellite in space; and

an extensible boom means releasably connected to said powerhead for moving said powerhead from a remote position relative to the satellite to a position adjacent the satellite;

said powerhead including:

a tubular body and a plurality of grasping arms pivotally mounted adjacent one end of said tubular body, each grasping arm comprising two parallel links pivotally connected at one of their ends to a first bracket mounted on said

tubular body and pivotally connected at their other ends to a second bracket, and a grasping pad connected to said second bracket;

actuating means mounted on said tubular body and connected to said grasping arms for holding said grasping arms in a cocked position and moving said grasping arms to a position of engagement with the satellite when released from a cocked position;

trigger means slidably mounted in said one end of said tubular body and in sliding engagement with said actuating means for releasing said actuating means from a cocked position when said trigger means contacts a satellite to be grasped; and

a rocket motor mounted on the other end of said tubular body for rotating said powerhead about the longitudinal axis of said tubular body;

said extensible means including:

a hand held mechanism comprising a spool of thin metal tape that forms itself into a tube-like boom when unrolled and drive means for rolling and unrolling said metal tape to vary the length of the boom and thus the position of said powerhead.

2. The satellite retrieval and despin device recited in claim **1** wherein said actuating means includes:

a coil spring mounted on said tubular body in a position so that one end thereof abuts said rocket motor and the other end engages a collar slidably mounted on said tubular body;

linkage means connected to said collar, the tubular body and said grasping arms, said linkage means being in a cocked position when the spring is compressed; and

said trigger means being mounted in said one end of said tubular body in proximity to said linkage whereby operation of said trigger means will release said linkage and permit movement of said grasping arms.

3. The satellite retrieval and despin device recited in claim **2** where in said rocket motor mounted on the other end of said tubular body has an annular propellant grain.

4. The satellite retrieval and despin device recited in claim **2** wherein said hand held mechanism includes a manually operated crank means for rolling and unrolling said tape.

References Cited

UNITED STATES PATENTS

406,546	7/1889	Taber	294—110
2,736,600	2/1956	Carlson	214—658 X
3,041,102	6/1962	Day	294—110
3,268,091	8/1966	Melton	214—1
3,362,656	1/1968	Wyatt	244—1

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U.S. Cl. X.R.

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