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ON ORBIT SURFACING OF THERMAL CONTROL SURFACES

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MONTHLY PROGRESS REPORT #7

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PREPARED FOR

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SUBMITTED BY

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MONTHLY PROGRESS REPORT

ON ORBIT SURFACING OF THERMAL CONTROL SURFACES

A. Program Objective

The objective of this program is to support future long term space missions by developing and testing on orbit surfacing methods for thermal control surfaces.

This program is to:

(1) Determine the performance requirements for on orbit surfacing of thermal control and other optical surfaces.

(2) Define methods of on orbit surfacing of thermal control and optical surfaces and select promising methods for laboratory facility studies.

(3) Perform a feasibility study of selected surfacing methods for final selection of a particular method or methods for full development of the process and instrumentation.

B. Work Perfromed during this period

Substrates to be contaminated and contamination source were prepared. Additional information on paint spray method apparatus was obtained. Status of program was reviewed on site with contractor representative.

Paint Spray Apparatus

Last month, a patent application for a paint spray apparatus to be used by a free flying astronaut was briefly described. The inventors of this device have been contacted and additional information obtained.

The apparatus was developed at Johnson Space Center and was originally designed for use in repairing shuttle tiles for reentry. Formal report on the device, except for the patent application, was not completed because increased confidence in shuttle tile reliability caused termination of the program. However, astronauts were trained to use it and testing in vacuum and also in ballistic trajectory aircraft was performed, and a patent is pending and expected to be issued in the near future. The inventors are J. F. Kuninecz and M. F. Lausten.
Although it has not actually been used in orbit, the device was designed so the astronaut could use it either attached or unattached to the vehicle being sprayed. Patent application sketch and description is in appendex A.

Capacity of the gun is about 0.5 liter. It took 4 guns to cover 25 square feet. This is about 50 ft^2/gallon. This is substantially below the standard paint spray efficiency. The low efficiency was apparently partly the result of the rough surface being sprayed and partly becuase additional carrier was required for the vacuum application.

However, it is estimated that the evaporation rate effect cause only a doubling of the carrier needed in air. Thus a smooth surface would result in a higher coverage efficiency.

The paint used in the shuttle application was basically silicon carbide in alcohol carrier plus a dispersant to prevent the silicon carbide from sticking together in globs as a result of storage. Only 1 to 2% binder was used because the material stuck quite well to the rough surface being sprayed.

An open urethane foam acted as spray shield and filter. There was some difficulty with this because the shield was designed to conform to typical spacecraft shapes but the urethane foam loses flexibility when cold. It tends to become cold in operation because of evaporation cooling by the carrier. It becomes brittle and is subject to breaking. One of the inventors (J.K.) indicates he would solve this polyimide foam in any future model.

There was no difficulty with the nozzle or filter clogging during operation, though there would be after a number of uses. Leaks in the various passages did cause clogging because of evaporation of carrier near the leak. Careful production and assembly is needed. The inventors are not aware of any other similar effort.

Experimental

S 13 GLO paint samples and silver teflon second surface mirror samples have been mounted, photographed under microscope and the α_s measured to establish baseline data on particular samples to be contaminated and then cleaned. Also a contamination source oven with urethane contaminant has been prepared. These will be used for cleaning studies after compeltion of vacuum system improvements being accomplished without contract support. Additional TQCM measurements previously referred to will also be accomplished at that time.

Last month it was also mentioned that removal of acryllic adhesive residue after removal of thermal control tapes per strip/replace renewal method would be difficult. This was confirmed by a short test which showed that, in the lab, it took several minutes to clean off a residue spot about one inch square using either isopropyl alcohol or acetone. Additionally it is difficult to keep the adhesive of the removal tool which redeposits it. It must be noted that it may not be necessary to remove the residue.

Contractor Review

Roger Linton of MSFC visited Valley Forge for on site review of the program to date and discussion of future work. The advantages and disadvantages of various systems of cleaning as identified to date were reviewed. The atomic oxygen discharge source and photo dissociation source which have been used were described and examined.

It was noted that consideration of atomic oxygen cleaning and spray painting refurbishment is encouraging. Electrostatic powder and plasma spray coating systems appear to have serious drawbacks. Other systems, such as sputtering, heat or laser cleaning, strippable/replaceable coatings and abrasive cleaning have some disadvantages but require more study. Future direction and the goal of proceeding to more developed systems were also reviewed.

C. Plans For Next Period

During the next month, study of the various cleaning processes will continue. Atomic oxygen cleaning experiments will be resumed upon completion of G.E. funded vacuum system improvements.

D. Performance, program schedule and/or cost are not being impeded by any current problems.

E. Cumulative costs as of May 20 are $29,728. Estimate of physical completion of contract is 52%. Physical completion is on schedule relative to comulative costs.

A P P E N D I X A

PATENT APPLICATION

DESCRIPTION OF

SPRAY GUN FOR SPACE

USE

(M S C - 18852 Ser.# 392,094)

(JUNE 25, 1982)

DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates a cross-sectional view of the invention.

Fig. 2 shows a detailed cross-sectional view of the trigger activated value of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to Fig. 1, the mumeral 11 generally indicates the self-contained spray applicator as herein described. The spray applicator 11 includes a accumulator 12, a spray gun 13, and a spray shield 14. Turning now to the accumularor 12, the major components thereof include a rigid outer shell or canister 15, which contains inner flexible bladder 16 and a head 26. The liquid coating material 17 is contained within the bladder 16. A pressurized propellant 18 may be injected into the outer shell 12 so as to apply a constructive force on the bladder 16, thereby inducing the liquid coating material 17 to exit the bladder through an outlet passageway 19 located in head 26 at one end of the outer shell and bladder. The pressurized propellant may be injected into the rigid outer shell through an adapter assembly 20 threaded within the accumulator at the end opposite the outlet passageway 19. The adapter assembly 20 inches a valve 21 for controlled injection of the propellant, a conventional O-ring 22 annuarly mounted with respect to the adapter assembly so as to rpovide an effective seal with respect to the pressurized propellant contained within the accumulator, and a removable adapter plug 23 threaded above the exposed end of the valve 21 and an additional O-ring 24.

The accumulator 12 will further include one or more weighted balls 25, the motion which within the bladder assure agitation and uniform distribution of the liquid coating material 17 contained therein, which may tend to stratify and separate during prolonged periods of storage and inactivity. Further, head 26 includes a plurality of orifices 2 7 of sufficient diameter and location so as to assure uninterrupted flow of the liquid coating material 17 despite any interference from the mixing balls or coagulated material of any individual orifice. The accumulator 12 will further include a suitable insulation layer 28, whereby the contents thereof are protected from the temperature conditions in the ambient environment during operation of the spray applicator, and in addition the temperature thereof may be controlled during periods of storage prior to use. This insulation layer 28 is applied in a nearly continuous envelope of material over the outer surface of the outer shell 15.

The escaping coating material 17 is channeled through a passageway 19 in value assembly 31 connecting the accumulating 12 and the spray gun assembly 13. A shut off plug assembly 30 and external handle 32 in valve assembly 31 may be manually placed in an open position during periods of extended operation and conversely placed in a closed position during periods of inactivity, so as to effectively reduce the possibility of seepage or leakage of the liquid

coating material under pressure during storage. Further, the valve assembly 31 will include a removable filter 34, whereby unacceptably large droplets or coagulated masses of coating material are prevented from entering the spray gun assembly. The filter 34 is accessible from the outside through an opening 37 in the valve assembly 31. The opening 37 is sealed by a hex plug 35 and a conventional O-ring 36, both of which may be removed for extraction and cleaning of the filter 34 as necessary.

As previously mentioned, the valve assembly 31 connects the accumulator 12 to the spray gun 13. The spray gun 13 includes handle 39. A handle support assembly 41 connects the handle 39 to the accumulator 12 to provide support and strength to the overall assembly. The handle support assembly 41 includes a bracket 42 fixed at one end to the handle 39 and mounted on the other end on the outer shell 15 of the accumulator 12. The bracket 42 is mounted in encircling engagement with the outer shell 15 through the use of a hose clamp 43. The shell 15 is insulated from bracket 42 and hose clamp 43 by means of a felt 45. The handle support assembly 41 will further include a tether ring 46, whereby a convenient means is provided to secure the spray applicator to the space craft or the operator.

The spray gun 13 further includes a trigger means 47, which in the preferred embodiment of the invention includes a lever 48 pivotally mounted to the spray gun handle 39 at one end thereof and in a closed position is substantially parallel to the handle 39; and when the lever 48 is rotated manually towards the handle 39, it assumes an open position. The significance of the open and closed positions of the lever 48 will be explained more fully at a later time. A self-locking trigger lock 49 is further provided to prevent inadvertent operation of the spray applicator. A lock spindle 50 is mounted in the spray gun handle 39. A lock spring 52 is concentrically mounted on the lock spindle 50 so as to prevent the lock 49 from rotating into an indentation

79 in the body of the trigger lever 48. However, the lock spring 52 exerts a torsional force on the asymmetrical lock 49 so as to prevent it from assuming the orientation suitable for engagement and insertion into the identation 79. Thus, movement of the trigger lever 48 towards the handle 39 and therefore into an open position, is prevented until the torsional force exerted by the trigger spring 52 is manually overcome and the lock 49 is rotated so as to be inserted into the identation 79. Also included is a spring stop 54, for a second spring 77, which is concentrically arranged behind the lock spindle 50 and may be adjustably positioned inside the handle 39 and locked thereon by means of a conventional set screws or the like 55. The spring load for sealing valve set 65 by shut off needle 64 is adjusted by insertion and rotation of a hex head wrench into stop 54 through a hole 78 to increase or decrease the load on spring 77.

The action of the trigger means 47 actuates a valve 56 controlling the outflow of liquid coating material 17 into passageway 80. Positioning the trigger means 47 in an open position correspondingly opens the valve 56 allowing the liquid coating material 17 to escape through a nozzle 57 to the ambient environment in the form of a pressurized spray. Concentrically mounted with respect to the nozzle 57, is a spray shield assembly 14, previously mentioned. The spray shield assembly 14 is so constructed as to allow the venting of any associated gases from the emitting spray of liquid coating material, while simultaneously entraping coagulated particles deviating from the desired path of the emitting spray, or bouncing back from the surface being coated.

The spray shield assembly is comprised of an inner shield layer 53 and an outer shield layer 59, both layers concentrically arranged and adjacent one another. The inner shield 53 and the outer shield 59 are both constructed of an open cell flexible urethane foam material, with

the inner shield having a core shell structure and the outer shield 59 having a fine cell structure. Specifically, the inner shield will have a composition of approximately 35 pores per inch, whereas the outer shield will have a composition of approximately 65 pores per inch. Thus, in operation, the larger particles of material deviating from the emitting spray, as well as splashback from the surface being coated, will be entrapped by the core cell structure of the inner shield 58 and finer particles will penetrate the inner shield but will be prevented from leaving the spray shield assembly by the fine cell structure of the outer shield 59, while still allowing the venting of gas from the vacuum evaporated coating fluid. Attachment of the spray shield assembly to the spray applicator will be accomplished by an annular flange 60, which will be mechanically attached by a screw 61.

Fig. 2 shows in detail the structure of the valve 56, including an inlet body 62 defining passageways 53 and 50 connecting at one end the valve assembly 31 and at the other end, through passageway 80, the nozzle 57. The flow of liquid coating material 17 through the passageway 80 is controlled through the positioning of a shut off needle 64 concentrically located along the center axis of the passageway 50. The shut off needle has a first end which is connected to the trigger means 47, whereby when the trigger means is in a closed position, the shut off needle is forcibly engaged with a plastic valve seat 65 so as to seal off the nozzle 57 from the coating in passageway 50. When the trigger means 47 is in an open position, the shut off needle 64 is retracted and no longer engages the valve seat 65 nor obstructs the flow of liquid coating material 17 through the passageway 80.

The shut off needle 64 is allowed to slide in and out of the inlet body 62, yet be sealed to the passageway 50 so as to prevent the unwanted emittance of liquid coating material 17, except through the nozzle 57, by a series of

sealing materials shown in Fig. 2. Concentrically arranged around the shut off needle 64 is a shaft seal 75 which includes spring loaded Teflon. O-ring 66 is suitably concentrically arranged with respect to the shaft seal and shut off needle 64. The shut off needle 64 also has suitable threads within the inlet body 62 so as to compress the shaft seal 75 against a packing stop 68, whereby an effective seal is maintained with respect to the inlet body 62 and passageway 50.

In operation, the trigger means 47 is placed in an open position, thus retracting the shut off need le 64 from the valve seat 65 allowing the emittance of liquid coating material 17 through the passageway 80 and the nozzle 57. The nozzle 57 includes a nozzle tip 69 designed to properly atomize the coating in the cacuum environment. Nozzle 57 necks down to an orifice 70 and then conically widens to a funnel like area 71 which shapes and guides the emitting spray of liquid coating material. Under the conditions of zero gravity and vacuum in the ambient environment, it has been observed that an orfice of .020 inches in diameter offers the optimum control of the emitting spray when used in conjunction with a funnel with an angular cross-section of 90°.

SPRAY APPLICATOR FOR SPRAYING COATINGS AND OTHER FLUIDS IN SPACE

ABSTRACT

The object of the invention is to provide a self-contained spray applicator for one handed operation in a zero gravity vacuum environment by a free-flying astronaut not attached to any spacecraft while avoiding contamination of the operator by back spray.

Said applicator includes a rigid accumulator (12) for containment of a fluid (17) within a flexible bladder (16), the fluid being urged out of the accumulator under pressure through a spray gun (13). The spray gun includes a spring loaded lockable trigger (47) which controls a valve (56). When in an open position, the fluid passes through the valve into the ambient environment in the form of a spray. A spray shield (14) is provided which directs the flow of the spray from the applicator by trapping errant particles of spray yet allowing the passage of escaping gases through its material. This reduces the reactive force exerted by the escaping spray on the operator of the applicator. The spray shield consists of two concentric layers of open celled urethane foam with the inner layer consisting of a coarser grain than the outer, thereby trapping progressively finer particles of spray.

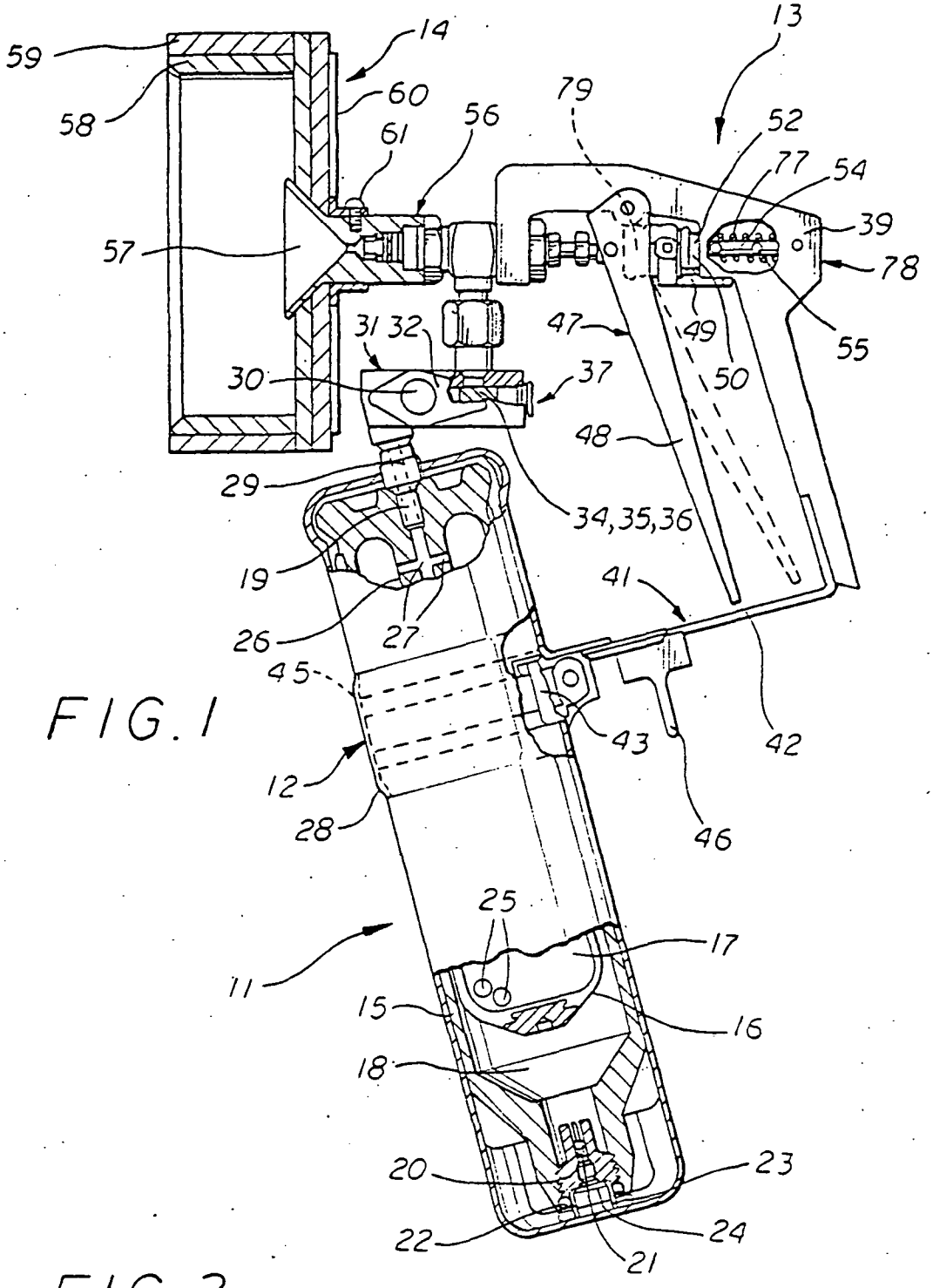
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FIG. 1

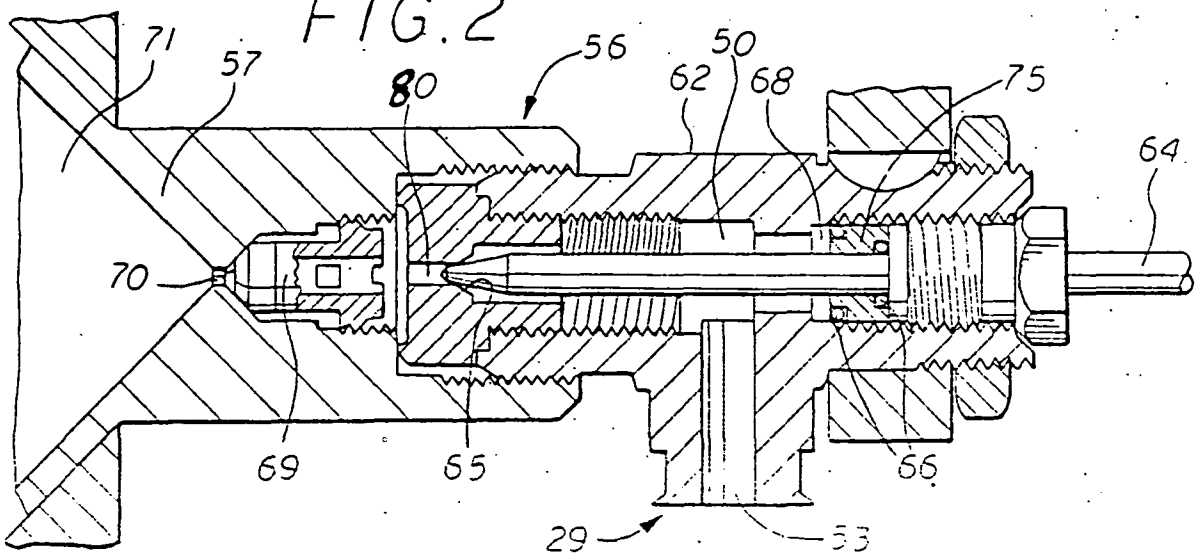
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FIG. 2