PN-ABE-699 65316

AGENCY FOR INTERNATIONAL DEVELOPMENT
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1. Project/Subproject Number: 936-5428

2. Contract/Grant Number: DAN-5428-A-00-3047-00

3. Publication Date: Jan. 1986

4. Document Title/Translated Title: Technology Assessment: The Ram-Type Manual Oil Press

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6. Contributing Organization(s): Appropriate Technology Intenational

7. Pagination: 15p.

8. Report Number:

9. Sponsoring A.I.D. Office: Bureau for Science and Technology

10. Abstract (optional - 250 word limit)

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11. Subject Keywords (optional)
1. oil processing
2. oil press
3.
5.
6.

12. Supplementary Notes

13. Submitting Official: Arleen Richman

14. Telephone Number: 202-879-2903

15. Today's Date: May 10, 1988

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16. DOCID

17. Document Disposition: DOCRD [] INV [] DUPLICATE []

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A. T. International

Staff Member: Bielenberg

Date: January 24, 1986

TECHNOLOGY ASSESSMENT

THE RAM-TYPE MANUAL OIL PRESS

The ram press is a compact manually-operated expeller for extracting oil from small oilseeds. It was developed by ATI's Farm Equipment Specialist during two visits to Tanzania in June and November, 1985, in order to provide a low cost alternative to batch presses being promoted under an ATI project for village oil processing. The ram press has been tested using various qualities of black sunflower seed, both decorticated and undecorticated, and has given consistent outputs of 2.5 to 3.0 liters of unrefined oil per hour at yields of 16 liters per 50 kg bag of undecorticated seed. The ram press has not been tested using material other than sunflower seed, but may work satisfactorily with groundnut, copra, cottonseed, etc, assuming that suitable pretreatment procedures can be found. Minor modifications to the press itself may also be necessary.

A. Operation of the Ram Press

The operation of the ram press is illustrated in figure 1. When the handle is in the vertical position the piston retracts from the cylinder, exposing the opening to the hopper and allowing a fresh charge of seed to enter the cylinder. 'Bumping' the handle against its upper stop vibrates the press sufficiently to prevent bridging of seed in the hopper under normal conditions. When the handle is subsequently pulled down to the horizontal position, the piston moves down into the cylinder, closing the hopper port and compressing the new charge of seed. Spent cake is expelled from the opposite end of the cage as the handle moves from about the 45° to the 30° position. Experience gained during testing of the device has shown that most of the oil extraction occurs as the handle is pressed downward from a 30° angle to the horizontal position. If this is done slowly, little or no cake will be discharged during this portion of the stroke, and the maximum oil yield will be

obtained. The cone at the cake outlet should be adjusted to provide the maximum pressure that the operator can comfortably develop on a sustained basis. A single moderately strong adult or two small adults or children are needed to develop the correct pressure for efficient oil extraction. Three strokes per minute is a comfortable cadence which will result in an output of 2.5 to 3 liters per hour.

In comparison to the hydraulic and screw-type batch presses, the output and yield of the ram press are relatively insensitive to the manner in which the seed is treated prior to pressing. When using high quality (high yielding) seed, which should be easily punctured by pinching with a fingernail, there is no need to decorticate or crush the seed. Such treatment has been found essential to efficient pressing in the batch presses. When using low yielding hard shelled seed, decortication of the seed and the removal by winnowing of most of the shells do result in improved performance of the press. In either case, and with both the ram and batch presses, it is necessary to heat the seed to a temperature of between 60°and 80°C to facilitate the removal of oil during pressing. This may be accomplished by spreading the seed in the sun, on days when the sun is bright and the humidity low, or, lacking these conditions, by briefly heating the seed on a pan or sheet of steel over a stove or open fire. Efficient oil extraction has been found to be much more difficult with both the batch presses and ram press under humid atmospheric conditions, and it is very important that the seed be hot and dry upon entering the press under such conditions.

An empty ram press is started by operating the handle through about twenty strokes with the adjustable cone screwed in far enough to prevent the escape of seed from the cage outlet. When resistance begins to be encountered on the downstroke of the handle, and oil starts to drip from the cage, the cone should be opened sufficiently to allow enough seed to escape to prevent the pressure from becoming excessive. The press is somewhat more difficult to operate during the initial few minutes when oil laden seed is being expelled from the press, and the cone may have to be fully opened to expell this 'wet' cake. The 'wet' cake can be

crumbled and returned to the hopper to extract its oil. As the cake becomes dry, the cone should be readjusted to increase the pressure if necessary. Once properly set, it should not be necessary to further adjust the cone unless the condition (temperature or moisture content) of the incoming seed changes.

B. The Market for the Ram Press

The ram press was designed as a relatively inexpensive alternative to manually operated batch presses for village processing of small oilseeds. The batch press, which consists of a cage containing from five to forty liters of seed typically, and a hydraulic or mechanical jack capable of exerting from 20 to 100 tons, has provided the principal alternative to motorized expellers for rural oil processing. The expellers themselves give very high oil yields, extracting over 90% of the available oil, but with high initial and operating costs. The smallest expellers extract about 10 to 15 liters of oil per hour, but with a power consumption of about 3 kw, and the frequent replacement of expensive internal components. Since these units cost about $4000, exclusive of import duties and installation costs, require electricity or a diesel engine, costing an additional $1000 to $3000 respectively, and need ready access to imported spare parts to be maintained in efficient operating condition, they are clearly unsuited to use in remote rural areas. It is even doubtful that expellers represent the best technology choice for urban applications in those countries which have serious foreign exchange shortages and acute underemployment. The batch presses overcome many of the deficiencies of the oil expellers: they can be locally manufactured (except for the hydraulic jacks which are most economically obtained as lorry jacks from commercial manufacturers), they are intrinsically more reliable since they have no parts subject to acute abrasion, and they can be manually operated. However, the efficient processing of sunflower in these presses requires that the seed first be decorticated, winnowed, and crushed. The high cost of the presses themselves, plus the cost of the ancillary equipment raise the total cost of equipping a village oil plant to between $6000 and $10,000 (U.S.). Oil processing plants of this type are promoted by the Royal Dutch Tropical Institute, Amsterdam, and

the Institute for Production Innovation, Dar Es Salaam, Tanzania. The high investment cost and the complexity of these systems, in terms of the number of necessary components and operations, will probably remain a deterent to their adoption on a large scale by small farmers and the urban informal sector.

The high cost of edible oil, when compared with the market value of the oil content of unprocessed seed, can make village oil processing a very lucrative activity. In the Arusha region of Tanzania, the cost of oilseed needed to produce a liter of oil that sells for 120 Tsh ($6.67) is 36 Tsh ($2.00). In addition to the revenue from oil, the presscake is sold as poultry feed. Whereas this is an extreme case, it indicates the degree to which a shortage of processing capacity and poor transport infrastructure can create profitable conditions for village level oil processing. Conversely, the availability of an efficient inexpensive oil press can significantly reduce consumer prices for edible oil in rural areas where oilseeds are produced, but oil is likely to be most expensive.

The ram press can significantly reduce the cost and complexity of village oil extraction capability. The cost of producing the device in Tanzania has been estimated at 8150 Tsh ($453.00), including the financing and depreciation of workshop equipment, but excluding profits or marketing and administrative costs. This figure does not include the cost of a decorticator, scorcher, or oil purifier (see section D) which are not essential, but can be helpful under certain conditions. As previously mentioned, the decorticator is useful for processing low-grade (hard shelle sunflower, whereas the scorcher and purifier are useful for improving the yield and quality of oil extracted. The latter can, however, be improvised by village artisans. The cost of producing the press in Zimbabwe, for example, may be significantly lower than the above figure since steel costs in Zimbabwe ($.45 U.S./kg) are $33.75 per machine, compared with $112.50 per machine in Tanzania. The difference in steel prices for these two countries indicates that there may be differences in other factor prices, enabling cost reductions beyond the difference in raw material costs. If a complete pressing unit can be produced for $600.00, including scorcher and purifier, the unit could be repaid in 150 days of operation at a daily output of 15 liters of oil, with $.30 per liter

retained for equipment financing. However, since the machine has not been tested in long use, a useful life of no more than 400 days (2000 hrs. should probably be assumed. Extended use will enable the detection of those components which limit the useful life, allowing the durability to be greatly improved. Larger scale production could also realize reductions in the production costs which have been assessed for very small scale production (100 machines/year).

Other advantages of the ram press for village oil processing include:

i. its portability and ease of transport facilitate demonstration and eventual distribution of the technology, as well as transport to repair facilities,

ii. its output is compatable with the level of village demand for edible oil, so full capacity utilization is easily achieved,

iii. its low price enables village oil processors to purchase multiple units, improving their security against mechanical problems,

iv. it appears to be superior, in terms of return on investment, to any of the more expensive alternatives, and

v. its manufacture can be easily undertaken by small machine shops using mild steel bar of the kind commonly found in the markets of developing countries.

C. Technical Description of the Ram Press

The ram press is able to extract oil at high yields from undecorticated seed because it is able to achieve pressures as high as the 30 to 100 ton batch presses, but does so in a cylinder of much smaller diameter. Since the cage of the ram press has a diameter of approximately two inches at the piston end, the oil in the center of the cage needs to flow only one inch in order to escape from the cage. Since the flow path for the oil is very short, the pressure gradient along this flow path is very large, and the oil will more readily flow through the seed shells and tissue that obstruct its pathway out of the press.

The cage of the ram press increases in diameter toward the cake discharge end in order to reduce the friction of the seed mass against the walls of the cage (cage bars). Since sunflower shells are highly abrasive, such friction would result in rapid wear of the cage bars as well as a rapid loss of pressure along the length of the cage. The

cake moves through the diverging cage very freely, enabling the pressure developed at the piston end to be transmitted efficiently to the discharge end, with loss of pressure thereby limited to the effect of increasing cage diameter (cross-sectional area). It is important to minimize the pressure gradient in the direction of the cage axis in order to discourage oil flow in this direction, that is toward the cake discharge end. We have not yet experimented with reductions in the cage divergence which could further decrease the axial pres[illegible] loss by optimizing the trade-off between wall friction and excessive cage outlet diameter. Despite the satisfactory performance of the present design, optimizing the cage geometry to maximize a 'performance' function of oil yield and output would be justified prior to large-scale manufacture.

Back pressure is developed at the outlet end of the press by the combined effects of a choke ring and adjustable cone. The effect of the choke ring is to multiply the back pressure applied by the adjustable cone, so that the cone may be tightened (or loosened) without opposing the full pressure of the cake. The machines being produced in Tanzania are equipped with a choke ring that restricts the outlet diameter of the cage from 80 mm to 75 mm. Restricting the outlet diameter more than 5 mm has been found to cause blockage of the cage under certain conditions. In order to facilitate cleaning of the cage, or replacement of the choke ring, the latter fits into a recess in the press cage and is removed by simply removing the two nuts that secure the cage to the frame of the machine.

The compression cylinder of the press, because it is necessarily parallel walled, and is subjected to the highest pressures developed by the ram, is susceptible to rapid wear. Consequently, this component is both reversible and cheaply replaceable. It is fabricated from a 150 mm (six inch) long piece of two inch diameter galvanised water pipe, having a rectangular cut or punched hole midway between its two ends. Removal or reversal of the cylinder is accomplished by removing the two tie rods from the wrist pin of the r m (see detailed plan), pulling the ram out of the cylinder, and removing the bolts that secure the cylinder retainer cap. Since wear is confined to the end of the cylinder in which the seed is compressed, reversing the cylinder will double its effective life.

D. How to Build the Manual Ram Press

This section does not provide a complete, step-by-step set of instructions for building the ram press, but will concentrate on the production of those components of the press which a small shop might find difficult. Production of the press requires, at a minimum, a lathe having at least an eight-inch swing, a drill press, an arc welder, a power hacksaw, bench grinder, taps and dies, and ordinary hand tools. A raw material list accompanies the plans.

1. The Press Cage

The press cage is probably the most complicated component of the press to produce, particularly because of its tapered form. The construction of a tapered cage necessitates machining tapered cage bars, which can be done by milling or turning. Because small workshops are more likely to have a lathe than a milling machine, the method described here applies to the lathe.

A turning fixture is illustrated in the accompanying plans. It consists of two mild steel discs mounted on a common shaft, one removeably, and having square section grooves to precisely retain the ends of the bars to be machined. This fixture can be made as large as the capacity of the lathe will allow in order that the maximum number of cage bars can be simultaneously tapered. Unless the available lathe is equipped with a taper attachment, it is necessary that the diameter of the groove in one of the discs be 8mm larger than the diameter of the other, so that an axial cut will cause a 4 mm taper. The fixture is loaded with its axis in the vertical position and the larger of its two discs sitting on the bench. When it is full of cage bars, the upper disc is installed and lightly tightened down. Since variations in the exact length of the bars will prevent the majority from being held rigidly in place, it is necessary to incorporate threaded holes in the end discs through which wedge bolts can be screwed in. Such bolts, of hardened steel and having tapered ends, should pass between adjacent cage bars, and force the bars against each other and the outside surfaces of the grooves in the end discs. Proper selection of the diameter of the discs and the position of the wedge bolts

will enable a single 8mm bolt in the smaller disc and 4 to 8 bolts in the larger disc (depending on its diameter) to take up the 'slack' between the cage bars.

Once assembled and fully tightened, the cage bars are turned down until their exposed surface has been machined. The fixture is then dissassembled, and the remaining unmachined portion of the bars is ground off to extend the taper to the ends of the bars.

The welding of the cage requires a jig that, in conjunction with the external cage rings, holds the bars in place during welding. The welding jig is also illustrated in the plan. It is set on the bench with its big end down, and the tapered bars installed by placing them against the jig with the machined surface of every bar adjacent to the unmachined surface of its neighbor. When all of the bars are in position, the cage rings are set around the bars, and the .25 mm separation of the bars is established with a shim or shims. It may be necessary to grind or machine one of the bars in every cage in order to obtain the correct separation of the bars. While .25 mm seems optimal, gaps varying in the range of .1 to .5 mm are acceptable. Note that the inside diameter of the small end of the cage should be 62 mm.

When completely welded, the large end of the cage is faced off and recessed for the choke ring by turning the cage between centers with its small end in the chuck. A steel plug, center drilled and having the same taper as the cage and a maximum diameter of 78 mm, is inserted into the cage and used to support it on the tailstock center.

2. The Frame

In order to ensure that the fram is square, the welding should be done on a bench having a clean 10 mm or thicker steel plate for its surface. If the table top is accurately leveled and the table is rigid and securely anchored, the squareness of the frame components can be accurately determined with a small level. The frame components should be 'tacked' together prior to doing any heavy welding. A piece of shafting inserted through the handle pivot holes in the sideframes permits the welder to verify that the axis of the handle pivot is square with respect to the frame in both the horizontal and vertical plane.

The side plates of the frame should be bored before welding the frame

since a large number of these can be bored simultaneously if stacked. If the workshop does not contain a drill press of sufficiently large capacity to bore these holes, this work can be done in the lathe, either by attaching the piece to the faceplate or, if it is to large for the swing of the lathe, by clamping the piece on the carriage cross slide in a vice adapted to replace the compound slide. Bored holes of diameters different from the size of available drill bits can be made using an adjustable boring bar having a shank that will fit the tapered bore of the spindle.

3. The Handle Pivot Piece

The handle pivot piece is the part into which the 2" handle pipe fits and which carries both the handle pivot and crank pin. The pivot piece is constructed of 60 x 20 mm (2.5 x .75") material both to withstand the large bending forces it receives and also to provide large bearing surfaces for the pivot and crank pins. The pivot piece should be entirely welded before through boring the pivot and crank pin holes. This can be done in a vice mounted on the cross slide of the lathe if a large drill press is not available. By advancing the cross slide, both holes can be accurately parallel bored, since the work need not be released from the vice. Oiling holes should be drilled in the pivot piece both to suggest and facilitate lubrication of the crank and pivot pins. Sunflower oil appears satisfactory for this purpose. The pivot pin should be constrained as shown to prevent it from rotating in and wearing out the holes in the frame.

The handle itself is a five foot length of 2" diameter pipe welded to a 1.25" diameter (1.5" o.d.) section of pipe, 18" long, forming a 'T'. The latter should be covered with a soft but durable material that protects the hands from the steel pipe. The lower end of the main tube should be reinforced where it enters the pivot piece with four 4" long pieces of 8 mm round rod, also preventing rotation of the handle.

4. The Ram and Cylinder

The ram can be turned from 60mm diameter mild steel bar, or a 60 mm grey iron casting. The same applies to the adjustable cone. The ram may be bored for the 36 or 40 mm draw pin in a fixture mounted to the face plate of the lathe, in the carriage mounted vice, or in a large capacity

drill press. The ram should have approximately 1mm free play, and the replaceable ram head have .25mm free play, but these clearances are not critical.

The compression cylinder is fabricated from 2" (54mm i.d. x 60mm o.d.) water pipe, faced off or accurately square cut to 6 inches of length, and having a rectangular opening midway along its length. The rectangular opening may be made by sawing the two transverse cuts, and by making the two lengthwise cuts with a chisel, following a series of small hoes drilled closely together. If a large number of the cylinder pipes are to be made, the rectangular hole could be punched out with a suitable pair of dies, or the transverse cuts sawn, and the lengthwise cuts punched with a manual impact punch.

The compression cylinder is attached to the cage via a snug fitting collar, which also serves to reinforce the compression cylinder and the intake end of the press cage. This collar is bored and welded to the cage after grinding or turning the small end of the cage to be flat and perpendicular to the cage axis. The opposite end of the compression cylinder is supported by a similar collar which, however, is bored .25 mm oversize to facilitate removal of the cylinder. A set screw entering a drilled or punched indentation in the cylinder holds it in position. The head of this screw should tighten firmly against the collar to prevent deformation of the cylinder resulting from overtightening.

The crank pin and ram draw pin are linked by two tie rods on either side of the press. The best attachment of these rods to the pins is obtained by grinding flats on the pins, upon which the tie rod bushings and nuts can firmly seat. Otherwise, the rods will tend to bend, where they enter the pins, as a consequence of friction between the pins and their bearing surfaces. Spacer tubes, cut from 1.5" water pipe, are used to keep the tie rods at an equal distance from the centerline of the press.

The use of a very deep hopper in the original prototype indicated that bridging of seed in the neck of the hopper will occur if the hopper is more than about 25 cm deep. Consequently, a wide mouthed shallow hopper of the dimensions shown on the plan is recommended. This design has the further advantage of preventing seed from falling into the oil collection tray during filling. Further insurance against seed and other impurities falling into the oil, and a degree of prefiltering, is obtained

by draping a piece of clean cloth over the oil recipient.

The oil press may be mounted either by utilizing anchor bolts cast into a concrete base, or by using a steel stand, shown in the plans. The latter has been preferred because it simplifies installation and enables the machine to be moved from one location to another for the purpose of demonstration. However, the stand contributes approximately fifty dollars of the 453.00 dollar cost of producing the machine in Tanzania.

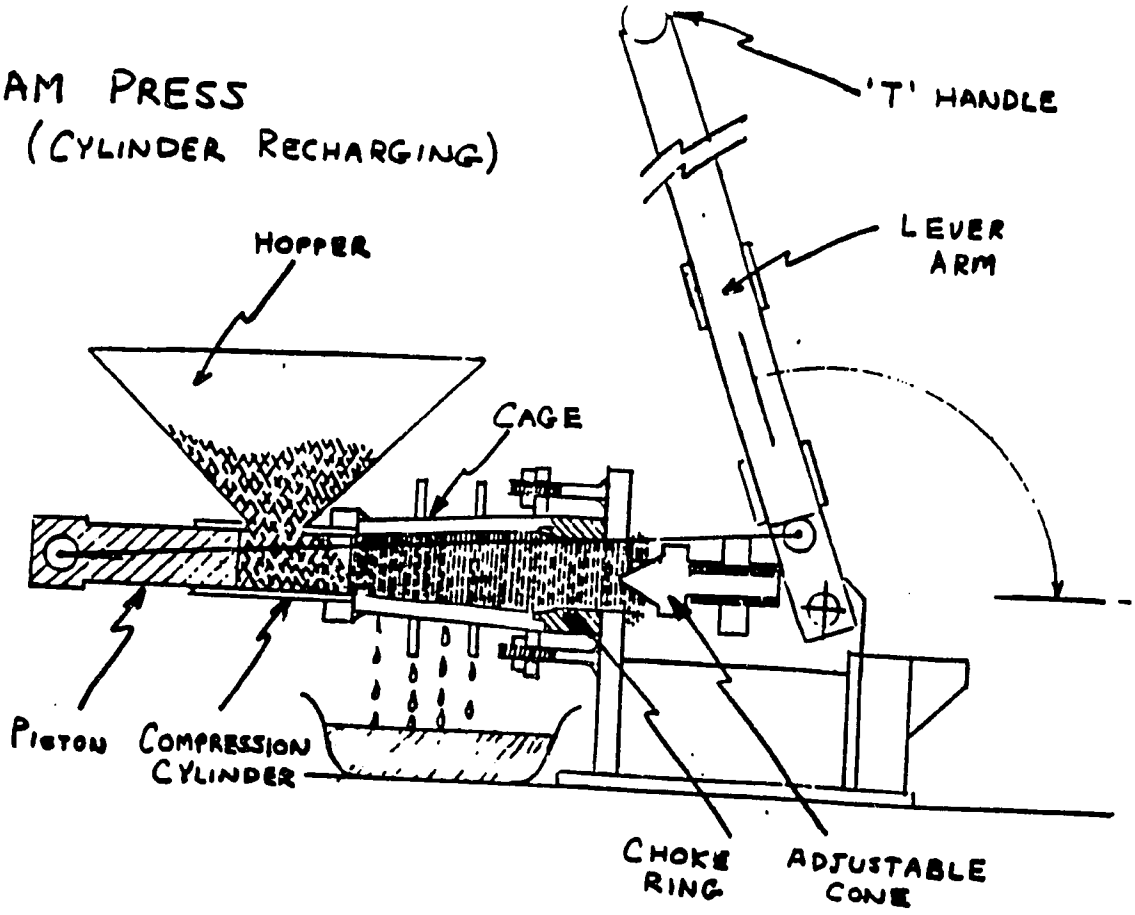
RAW MATERIAL LIST

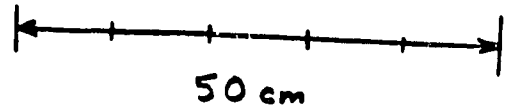
Description	Quantity Required Per Machine
12 mm or 0.5" square bar	4.5 meters
100 mm x 10 mm or 4" x .375" flat bar	1.3 m
* 100 mm x 20 mm or 4" x .75" flat bar	0.53 m
140 mm x 6 mm or 5" x .375" flat bar (or 8 mm plate)	0.60 m (or 800cm^2)
* 60 mm x 20 mm or 2.5" x .75" flat bar	0.90 m
60 mm x 10 mm or 2.5" x .375" flat bar	0.80 m
16 mm Ø or 6.25" Ø round bar	1.52 m
40 mm Ø or 1.5" Ø round cold rolled (or hot rolled if c.r. unavailable)	0.54 m
60 mm Ø or 2.5" Ø round bar (or use grey iron if capability exists)	0.34 m
54 mm i.d. x 60 mm o.d. or 2" pipe	1.7 m
32 mm i.d. x 38 mm o.d. or 1 1/4" pipe	0.5 m
38 mm i.d. x 44 mm o.d. or 1 1/2" pipe	0.1 m

miscellaneous nuts and bolts, electrodes, etc.

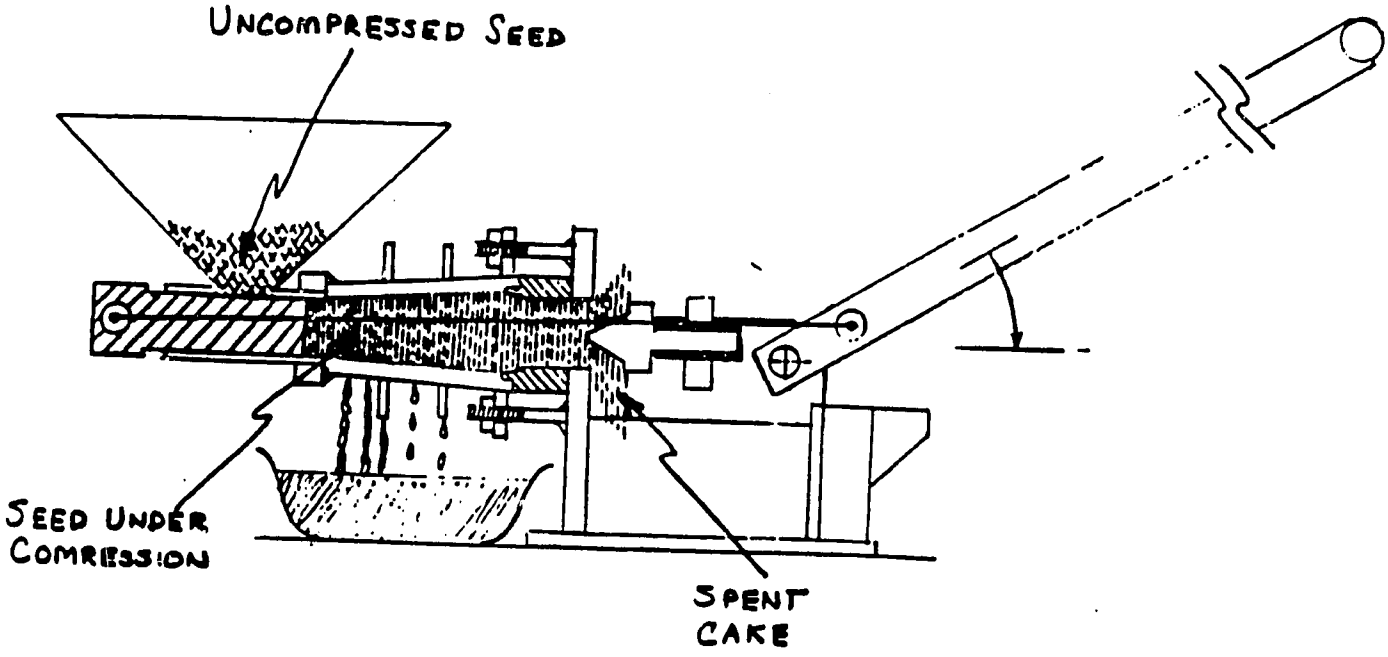
* If unavailable, substitute with two pieces of 10 mm thick stock, peripherally welded (laminated) together.

RAM PRESS
(CYLINDER RECHARGING)



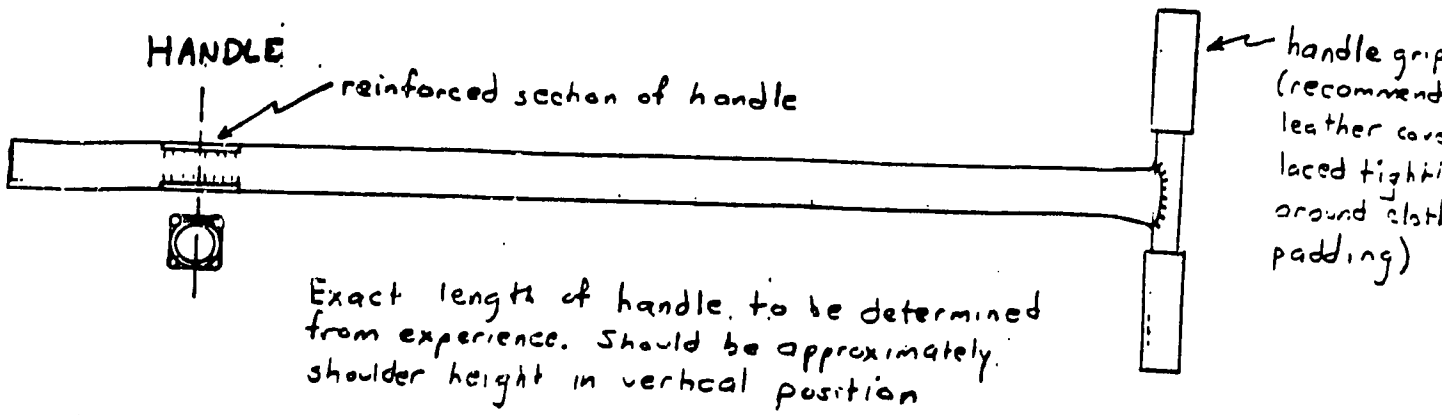


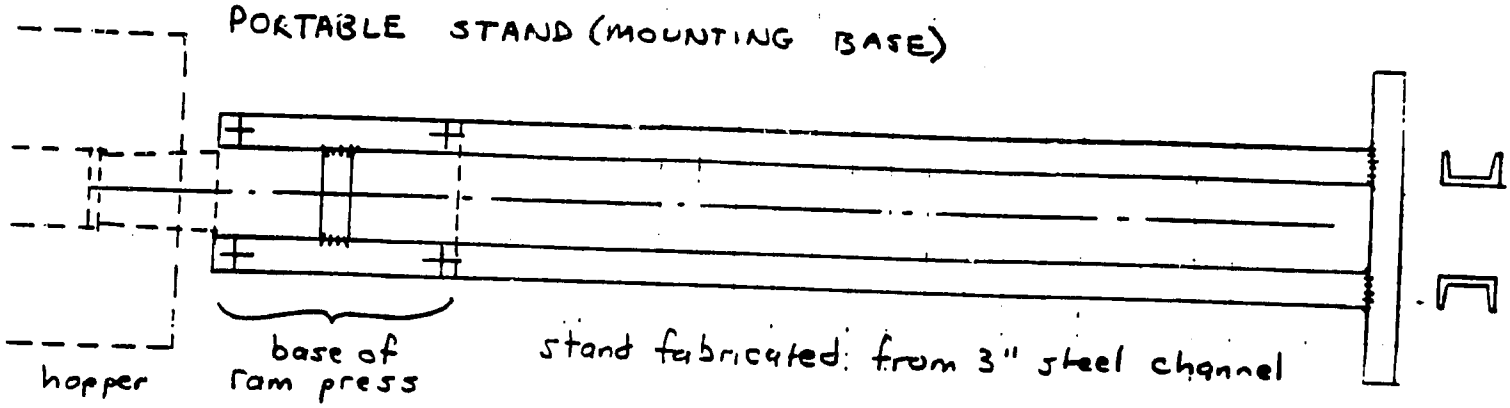
RAM PRESS
(CYLINDER COMPRESSING)

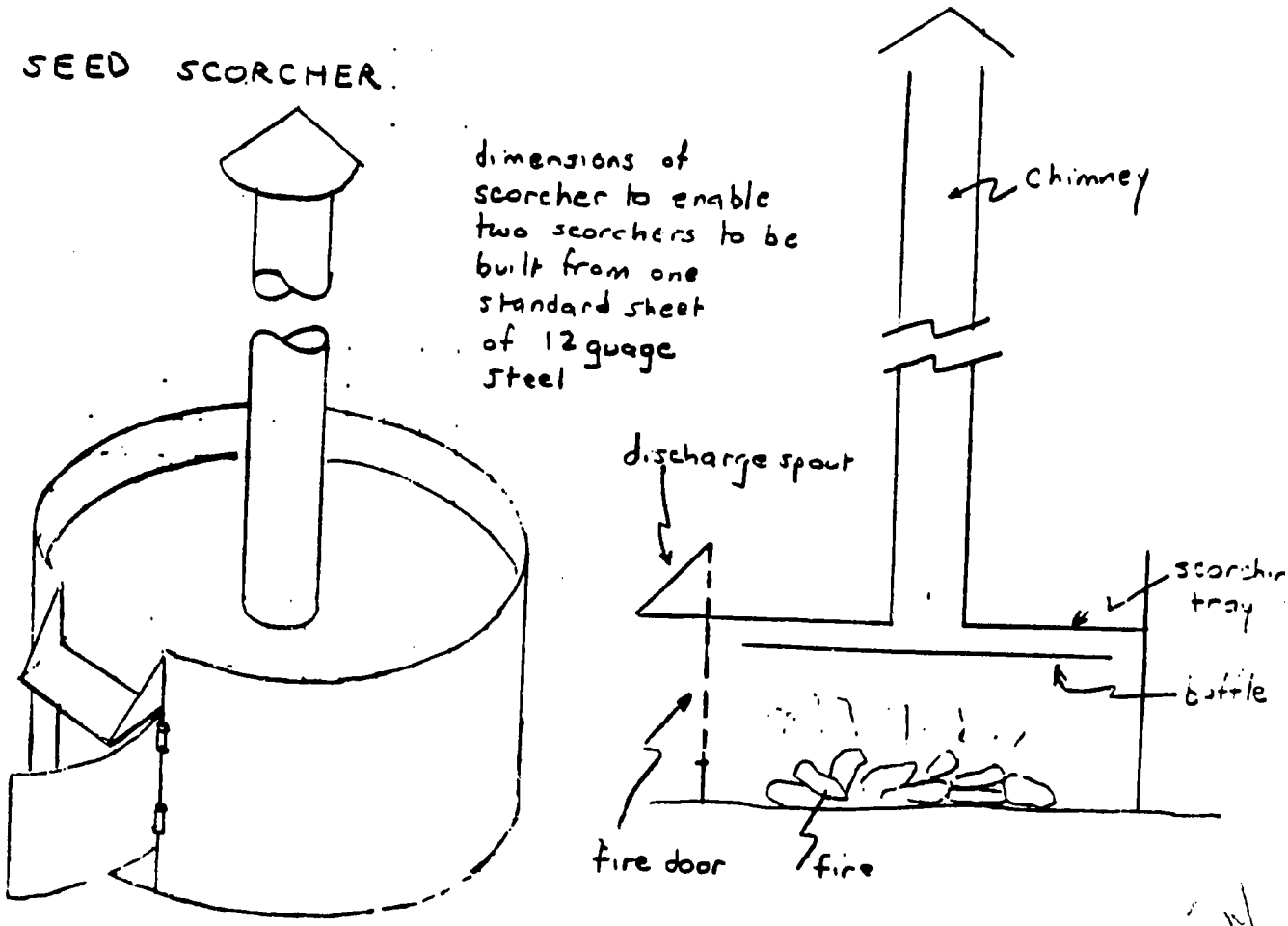


C. BIELENBERG
A.T. INTERNATIONAL
WASHINGTON D.C.
DECEMBER 4, 1985

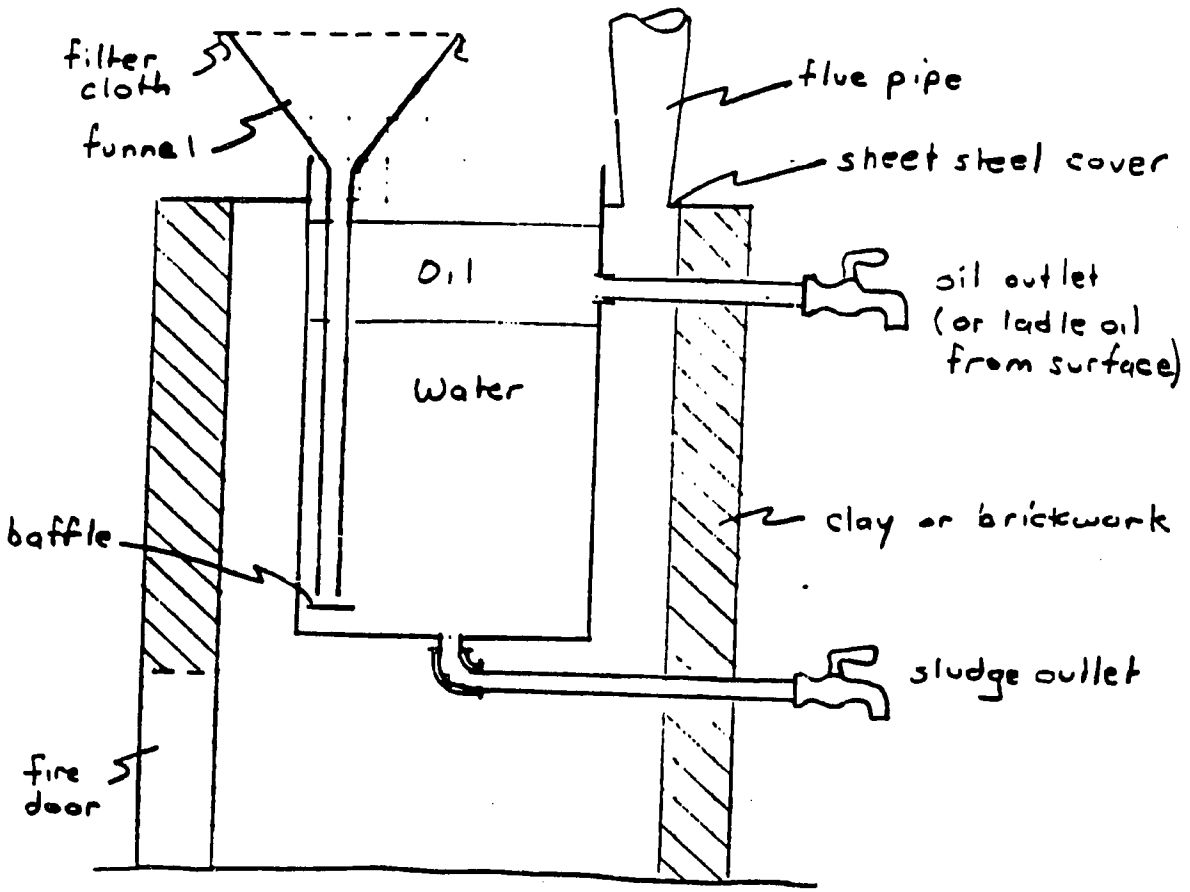
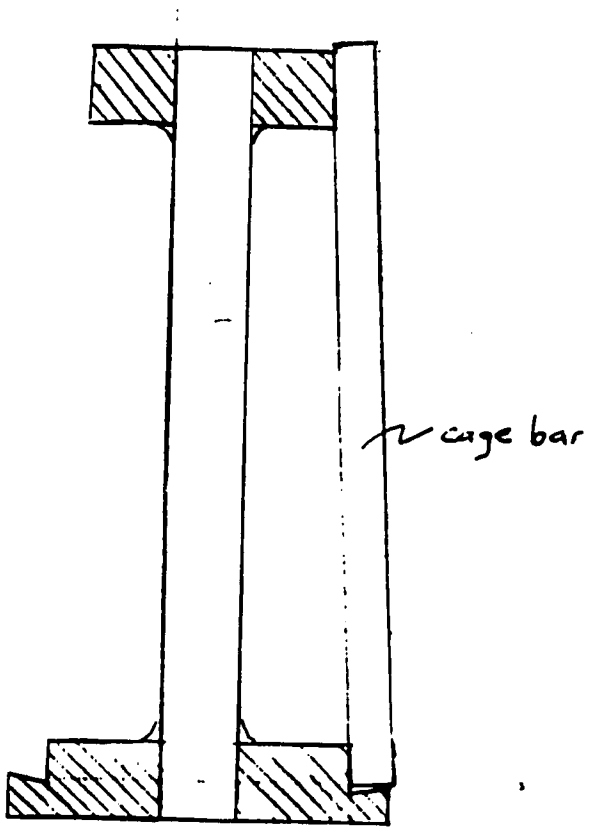
PISTON PUMPED EXPELLER, MISCELLANEOUS COMPONENTS, 1/10 SCALE







. OIL PURIFIER (1/10 SCALE): Untested design, subject to revision



PRESS CAGE ASSEMBLY JIG (1/2 SCALE)