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71 IRC 76 - 1.1

COMUNIDAD AGROPECUARIA MONCLOVA, S.A.
Apartado 121 Depto. de Ventas Tel-633
Monclova, Coah.

"MOLINOS DE VIENTO"

VI. 1.1
71
IRC 76
International Rept
for Community Water Sup

Lista de precios No. 1

10. de Abril de 1967

MODELO (Diámetro de aspas)	MOLINO (Mecanismo, Aspas y Timón) Escala	TORRE Tamaño Precio	PESO Aproximado	PRECIO TOTAL.
2.45 Mts (8')	\$ 5,000.00	Tipo "C" 33' \$2,200.00	660Kg.	\$ 8,000.00
3.05 Mts (10')	7,750.00	Tipo "A" 33' 2,750.00	840Kg.	10,500.00
3.65 Mts. (12')	11,500.00	Tipo "B" 40' 6,000.00	1,450Kg.	17,500.00
4.25 Mts. (14')	15,300.00	Tipo "B" 40' 6,000.00	1,510Kg.	21,300.00
4.25 Mts. (14')	15,300.00	Tipo "B" 50' 8,700.00	1,675Kg.	24,000.00

NOTA:- Los precios son LAB-muestra planta Monclova y no incluyen el impuesto sobre Ingresos Mercantiles.

PARA DETERMINAR LAS CAPACIDADES DE BOMBEO DE LOS MOLINOS DE VIENTO "MONCLOVA" VER EL FOLLETO ILUSTRATIVO.

CONSTRUCCIONES MECANICAS MONCLOVA, S.A.
 Apartado No. 121 Depto. de Ventas, Tel.-655
 Monclova, Coah.

ACCESORIOS DE MOLINOS DE VIENTO.

Lista de Precios No. 1

10. de Mayo de 1967.

CILINDROS DE BRONCE (BOMBA)

LAE-Nuestra Planta
 Precio c/u.

51 X 407 mm. (2" X 16" para tubo de 1-1/4" 1 1/2")	\$	510.00
64 X 407 mm. (2 1/2" X 16" para tubo de 1-1/4" y 1 1/2")	"	650.00
76 X 407 mm. (3" X 16" para tubo de 1-1/2" X 2")	"	700.00
89 X 407 mm. (3 1/2" X 16" para tubo de 1-1/2" X 2")	"	880.00
102 X 407 mm. (4" X 16" para tubo de 2" y 2 1/2")	"	960.00
127 X 457 mm. (5" X 18" para tubo de 2-1/2 y 3")	"	1,260.00

VALVULAS DE PIE

32 mm. (1-1/4")	"	34.00
38 mm. (1-1/2")	"	43.00
51 mm. (2")	"	60.00
64 mm. (2-1/2")	"	76.00
76 mm. (3")	"	120.00

VARILLA GALVANIZADA (Roladas en Frío en 3 metros de largo)

11 mm. (7/16")	"	33.60
13 mm. (1/2")	"	40.60
16 mm. (5/8")	"	60.20

Nota: Se suministran con sus respectivos coples.

COPLES PARA VARILLA

11 mm. (7/16")	"	3.10
13 mm. (1/2")	"	3.80
16 mm. (5/8")	"	4.90

REDUCCIONES

De 13 a 11 mm. (De 1/2" a 7/16")	"	4.90
De 16 a 13 mm. (De 5/8" a 1/2")	"	7.50
De 16 a 11 mm. (De 5/8" a 7/16")	"	7.50

GRAPATAPAS,

152 mm. X 25.32 y 58 mm. (6" X 1" 1-1/4" y 1 1/2")	"	75.00
173 mm. X 32.38 y 51 mm. (8" X 1-1/4" 1 1/2" y 2")	"	86.00
254 mm. X 32 y 38 mm. (10" X 1-1/4" y 1 1/2")	"	103.00
254 mm. X 51 y 64 mm. (10" X 2" y 2 1/2")	"	110.00
305 mm. X 52 y 58 mm. (12" X 1-1/4" X 1 1/2")	"	131.00
305 mm. X 51 X 64 mm. (12" X 2" y 2 1/2")	"	157.00

Nota: Los precios son LAE-Nuestra planta Monclova y no incluyen el impuesto sobre los Ingresos Mercantiles.



MOLINOS DE VIENTO, S. A.

CALLE 53 No. 1
APDO. POST. 724

CHIHUAHUA, CHIH.

TELS. { 2-86-72
2-50-64
2-32-57
2-26-77

FABRICANTES DE:

Molinos de Viento

Guimbaletes

Cilindros

BOMBAS

Tipo Turbina

Elevadoras

Centrifugas

Autocebantes

Moto-Bombas

Portátiles

Estacionarias

Caseras

Aspersoras

Fumigadoras

SERVICIOS:

Galvanizado

FUNDICIONES:

Aceros Especiales

Fierro Gris

Cobre — Bronce

y

Aluminio

EQUIPO INDUSTRIAL
Y MINERO

GUIMBALETES "MOVISA" (Pumping Jacks)

LISTA DE PRECIOS EFECTIVA AL 10. DE ENERO DE 1971.°

	MODELO	PRECIO PUBLICO.
	13 M 9	\$ 3,750.00 ✓
	+ 19 M 7	5,975.00
	19 M 12	6,300.00
	+ 25 M 9	9,500.00
	25 M 12	9,950.00 ✓
	50 M 12	12,150.00
	+ 50 M 18	12,500.00
	100 M 18	18,700.00
	+100 M 24	18,975.00

+ Se surten sobre pedido a 30 días aproximadamente.

Precios sujetos a fluctuaciones sin previo aviso.

Esta lista no incluye contra-pesos ni motor.

L.A.B. Chihuahua, Chih.

" M O V I S A "

NOTA: Esta lista cancela nuestras anteriores.

Registro Patrimonio Nacional 28891

lg'





MOLINOS DE VIENTO, S. A.

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CHIHUAHUA, CHIH.

TELS. { 2-86-72
2-50-64
2-32-57
2-26-77

FABRICANTES DE:

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Centrífugas

Autocebantes

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Aluminio

EQUIPO INDUSTRIAL
Y MINERO

CONTRA-PESOS PARA GUIMBALETES.

LISTA DE PRECIOS EFECTIVA AL 1o. DE ENERO 1971.

	MODELO	CONTRA-PESOS DE:	PRECIO UNITARIO.
	13-M-9	Viga	\$ 75.00
	19-M-12	Viga	75.00
	25-M-12	Viga	160.00
	25-M-12	Maestro (curvo)	115.00
	25-M-12	Segmento (biela)	80.00
	50-M-12-18	Viga	160.00
	50-M-12-18	Maestro (curvo)	160.00
	50-M-12-18	Segmento (biela)	90.00
	100-M-18-24	Viga	160.00
	100-M-18-24	Maestro (curvo)	225.00
	100-M-18-24	Segmento (biela)	150.00

JUEGOS DE CABLES COMPLETOS PARA GUIMBALETES.

	MODELO	CARRERA	PRECIO
	13 y 19	9-12	\$ 250.00
	25	9-12	310.00
	50	12-18	360.00
	100	18-24	410.00

SUJETA A FLUCTUACIONES SIN PREVIO AVISO.

L.A.B. Chihuahua, Chih.,

"M O V I S A "

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MOLINOS DE VIENTO, S. A.

CALLE 53 No. 1
APDO. POST. 724

CHIHUAHUA, CHIH.

TELS. { 2-86-72
2-50-64
2-32-57
2-28-77

FABRICANTES DE:

Molinos de Viento

Guimbaletes

Cilindros

BOMBAS

Tipo Turbina

Elevadoras

Centrifugas

Autocebantes

Moto-Bombas

Portátiles

Estacionarias

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SERVICIOS:

Galvanizado

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Aceros Especiales

Fierro Gris

Cobre — Bronce

y

Aluminio

EQUIPO INDUSTRIAL
Y MINERO

CILINDROS DE BRONCE .

LISTA DE PRECIOS EFECTIV. AL 10. DE ENERO 1971.

TIPO: Profundo, 4 empaques; doble bola de bronce o cromada.

HISTORIA: Válvula check, con cono en la tuerca inferior.

DIAMETRO mm.	CARRERA	PRECIO PUBLICO.
48 1-7/8	21 x 33	1,550.00
48 "	24 x 36	1,625.00
+ 48 "	30 x 42	1,850.00
57 2-1/4	21 x 33	2,200.00
57 "	24 x 36	2,350.00
+ 57 "	30 x 42	2,700.00
70 2-3/4	17 x 33	2,850.00
70 "	20 x 36	3,120.00
+ 70 "	26 x 42	3,350.00
95 3-3/4	18 x 36	5,250.00
+ 95 "	24 x 42	5,700.00
+ 95 "	30 x 48	6,200.00

+ SE FABRICAN SOBRE PEDIDO, 45 DIAS
DE ANTES DE ENTREGA.

REGLA Y MEDIDAS SIGUEN LAS NORMAS Nacionales.

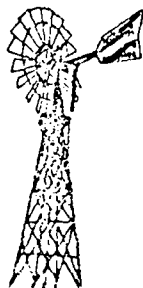
L. S. Chihuahua, Chih.

NOTA: Esta lista cancela nuestras anteriores.

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Registro Patrimonio Nacional 26891.

13'





MOLINOS DE VIENTO, S. A.

CALLE 53 No. 1
APDO. POST. 724

CHIHUAHUA. CHIH.

TELS. { 2-86-72
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2-26-77

FABRICANTES DE:

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Fierro Gris

Cobre — Bronce

y

Aluminio

EQUIPO INDUSTRIAL
Y MINERO.

COLADORES.

PARA LOS CILINDROS DE BRONCE "MOVISA"

LISTA DE PRECIOS EFECTIVA AL 10. DE ENERO 1971.

Diám. de la rosca del colador	M/M	Para Cilindro de:	Precio al Público.
1-1/4	32	1-7/8	\$ 80.00
2	51	2-1/4	115.00
2-1/2	64	2-3/4	150.00
3	76	3-3/4	225.00

P U N T A S C. R. S.

PARA VARILLA HUECA (FLECHA DE TRASMISION)

Para soldarse en tubo de:	M/M	Diam. de la rosca, en jue gode puntas. (espiga)	Precio al público. Jgo. hembra y macho.
3/8	10	1/2	\$120.00
1/2	12.5	5/8	135.00
3/4	19	7/8	150.00

SUJETA A FLUCTUACIONES SIN PREVIO AVISO.

L.A.B. Chihuahua, Chih.

"M O V I S A "

Registro Patrimonio Nacional 28891
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MOLINOS DE VIENTO, S. A.

CALLE 53 No. 1
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CHIHUAHUA, CHIH.

TELS. { 2-86-72
2-50-64
2-32-57
2-26-77

FABRICANTES DE:

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FUNDICIONES:

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Fierro Gris

Cobre — Bronce

y

Aluminio

EQUIPO INDUSTRIAL
Y MINERO

REPUESTOS.

VAQUETA PARA CILINDRO DE BRONCE "MOVISA"

LISTA DE PRECIOS EFECTIVA AL 10. DE ENERO 1971.

PARA CILINDRO DE:

1-7/8

2-1/4

2-3/4

3-3/4

PRECIO AL PUBLICO.

\$ 17.50

23.75

29.50

51.50

PRECIO UNITARIO

SUJETA A FLUCTUACIONES SIN PREVIO AVISO.

L.A.B. Chihuahua, Chih.

"MOVISA"

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MOLINOS DE VIENTO, S. A.

CALLE 53 No. 1
APDO. POST. 724

CHIHUAHUA, CHIH.

TELS. { 2-86-72
2-50-84
2-32-57
2-26-77

FABRICANTES DE:

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Guimbaletes

Cilindros

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Aluminio

EQUIPO INDUSTRIAL
Y MINERO

V A R I O S .

LISTA DE PRECIOS EFECTIVA AL 1o. DE ENERO DE 1971.

VARILLA SOLIDA "ALTO CARBON" de 1/2 x 20'	\$ 120.00
VARILLA SOLIDA "ALTO CARBON" de 1/2 x 10'	75.00
VARILLA SOLIDA "ALTO CARBON" de 5/8 x 20'	190.00
VARILLA SOLIDA "ALTO CARBON" de 5/8 x 10'	105.00
(tramo completo, totalmente galvanizado, incluye acoplador).	

ESTOPERO DE BRONCE de 2"	\$ 475.00
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ESTOPERO DE BRONCE DE 2-1/2"	525.00
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ESTOPERO DE BRONCE DE 3"	690.00
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(entrada de la varilla variable, desde 3/8 hasta 3/4, se surten a solicitud sin cargo extra)

FLECHA DE ALCANCE DE 1/2 x 2 Mts.	180.00
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FLECHA DE ALCANCE DE 5/8 x 2 Mts.	250.00
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FLECHA DE ALCANCE DE 3/4 x 2 Mts.	290.00
(de cold-rolled 1045 pulidas y rectificadas)	

PRECIOS UNITARIOS.

SUJETA A FLUCTUACIONES SIN PREVIO AVISO.

L. A. B. Chihuahua, Chih.,

" M O V I S A "

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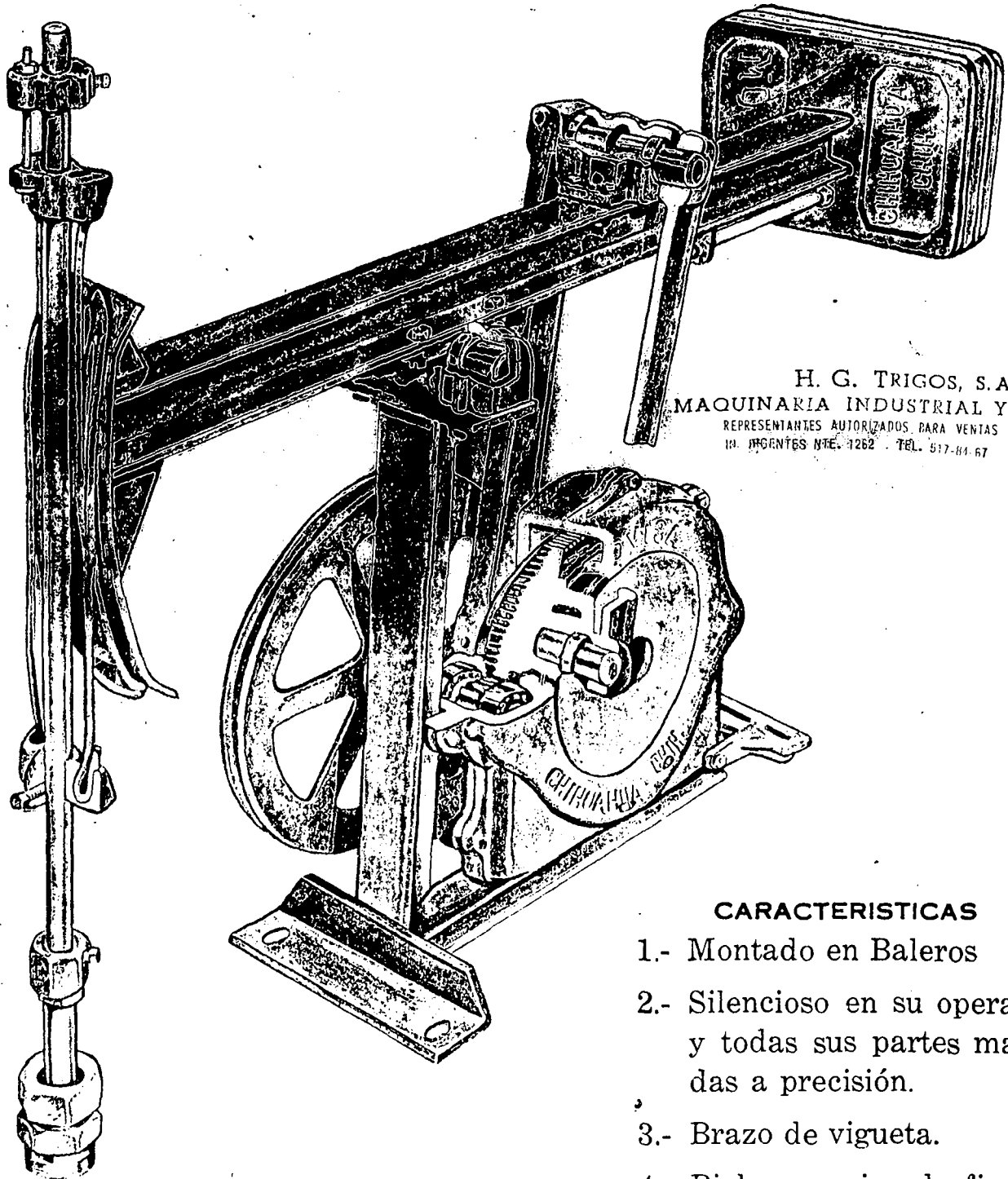
Registro Patrimonio Nacional 28891

lg'



GUIMBALETES

"MOVISA"



H. G. TRIGOS, S.A.
MAQUINARIA INDUSTRIAL Y AGRICOLA
REPRESENTANTES AUTORIZADOS PARA VENTAS AL GOBIERNO
IN. ARGENTES NTEL. 3262 TEL. 517-84-67 MEXICO D.F.

CARACTERISTICAS

- 1.- Montado en Baleros
- 2.- Silencioso en su operación y todas sus partes maquinadas a precisión.
- 3.- Brazo de vigueta.
- 4.- Bielas y cajas de fierro vaciado gris de alta calidad.
- 5.- Engranajes cortados a precisión.
- 6.- Partes intercambiables en varios modelos.

FABRICADO POR:

MOLINOS DE VIENTO, S. A.

CALLE 53 NO. 1 TELS. 2-26-92 Y 2-50-64

CHIHUAHUA, CHIH.

Ilustración Número	Descripción	Número Pieza	Número de Piezas	Peso de cada Pieza en Kilos	Matefial de Construcción
1	Tapa de Caja "D"	101	1	7.625	Fierro Vaciado
1	Tapa de Caja "T"	101	1	8.500	Fierro Vaciado
11	Perno Biela	111	2	0.700	Fierro Vaciado
13	Retén del Brazo	113	1	1.200	Comercial
20	Contra Peso	120		7.500	Fierro Vaciado
23	Retén del Poste	123	2	0.450	Comercial
23 U	Abrazadera Tipo U	123 U	2	0.250	Fierro Comercial
31	Polea Tipo "V"	131	1	5.000	Fierro Vaciado
32	Cuña de la Polea	132	1	0.050	Fierro Comercial
36	Biela	136	2	3.000	Fierro Vaciado
39	Tornillo Ténzor	139	1	0.200	Fierro Comercial
44	Cabeza Cable (Cama)	144-9	1	9.000	Fierro Comercial
51	Engrane Mayor	151	1	11.000	Fierro Vaciado
52	Piñón	152	1	0.600	Fierro Dulce
58	Balancín	158	1	0.825	Fierro Vaciado
60	Base (Marco)	160	1	6.250	Est. Comercial
60 S	Soporte Motor	160 S	1	0.650	Est. Comercial
65 B	Balero Abierto	165 B	1	0.115	Comercial
65 P	Balero Sellado Lado Polea	165 P	1	0.115	Comercial
66	Prensa Cable Interior	166-9	1	0.430	Fierro Vaciado
70	Prensa Varilla Inferior	170	1	0.650	Fierro Vaciado
76	Retén del Balancín	176	6	0.115	Comercial
94	Cable	194	1	0.115	Comercial
95	Prensa Varilla Superior	195	1	0.250	Fierro Vaciado
96	Tensor Prensa Superior	196	1	0.115	Fierro Vaciado
97	Prensa Superior	197-9	1	0.500	Comercial
98	Cable sin Prensa	198-9	1	0.115	Comercial
99	Tapón Nivel Aceite	199	1	0.075	Comercial
100	Tapón Entrada Aceite	200	1	0.075	Comercial

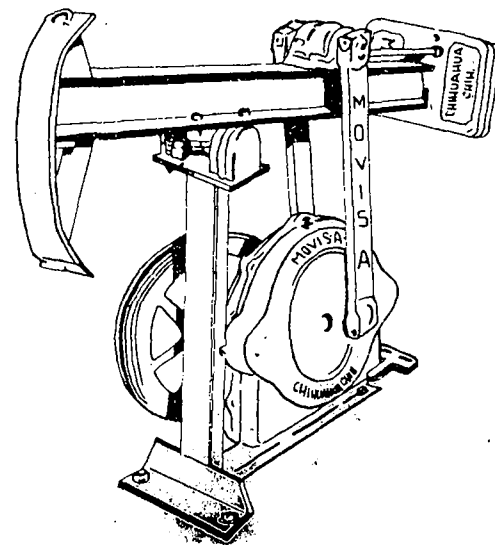
NOTA: Los datos de este catálogo son válidos para el modelo de motor de 10 HP. Para otros modelos consulte el manual de instrucciones.

COMPAÑÍA DE MOTORES Y MAQUINARIA S.A.
Calle 53 No. 1 - P.O. Box 1000 - 1000
TELÉFONO 1000

GUIN

H. G. TRIGOS, S.A.
 MAQUINARIA INDUSTRIAL Y AGRICOLA
 REPRESENTANTES AUTORIZADOS PARA VENTAS AL GORRIERO
 INDEPENDENTES NIE. 1262 TEL. 517-41-67 MEXICO D.F.

MODELO 13-M-9

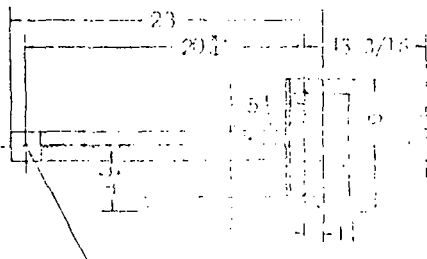


CARACTERISTICAS

Carrera 229 mm. (9)
 Golpes por Minuto 40
 Descarga Libre
 Líquido a Bombear Agua Limpia
 Diámetro de la Polea 337 mm. (13 1/4)
 Sección Banda "V" 1 A
 Relación Engranes 8.4:1
 Capacidad Aceite 1/2 Lt.
 Peso Aprox del Guimbalet
 (sin accesorios) 54.900
 Contrapesos 7.500 Kls. c/u

Medida del Cilindro		Tubería de Descarga		Rendimientos			MOTOR DE 1/4 H. P.				MOTOR DE 1/3 H. P.			
							Descarga Libre				Descarga Libre			
							PROP. MAX. DEL CILINDRO		CONTRA PESO		PROP. MAX. DEL CILINDRO		CONTRA PESO	
mm.	pg.	mm.	pg.	GPH	LPH	GPH	Pies	Mts.	Kls.	Lbs.	Pies	Mts.	Kls.	Lbs.
29	1 1/8	32	1 1/4	93	352	1.6	365	111.2	104.3	230				
35	1 3/8	38	1 1/2	140	529	2.3	300	91.4	104.3	230				
38	1 1/2	51	2	210	793	3.5	230	70.10	97.2	215	250	76	104.3	230
48	1 7/8	51	2	260	982	4.3	190	57.9	88.2	195	220	67	104.3	230
51	2	64	2 1/2	295	1116	4.9	165	50.2	83.8	185	205	62.3	104.3	230
57	2 1/4	64	2 1/2	415	1570	6.9	115	35	77	170	155	47.2	102	225
64	2 1/2	76	3	460	1741	7.7	105	32	72.5	160	140	42.6	95.1	210
70	2 3/4	76	3	607	2297	10.1	80	24.4	68	150	105	32	90.72	200

Núm. de Pesas	Carga		Núm. de Pesas	Carga		Núm. de Pesas	Carga	
	Kilos	Libras		Kilos	Libras		Kilos	Libras
1	15.85	35	5	58.8	130	9	95.1	210
2	24.9	55	6	70.1	155	10	104.3	230
3	36.2	80	7	77	170			
4	47.5	105	8	86	190			



H. G. TRIGOS, S.A.
MAQUINARIA INDUSTRIAL Y AGRICOLA
 REPRESENTANTES AUTORIZADOS PARA VENTAS AL GOBIERNO
 GENTES NTE. 1262 TEL. 511-04-57 MEXICO F.

LISTA DE PARTES

Ilustración Número	Descripción	Pieza Número	Número de Piezas	Peso Unitario en Kilos	Material de Construcción
I	Tapa de Caja "D"	101	1	11.300	Fierro Vaciado
1	Tapa de Caja "I"	102	1	15.250	Fierro Vaciado
11	Perno Biela	111	2	.600	Fierro Vaciado
13	Retén del Brazo	113	1	1.200	Fierro Vaciado
20	Contra Peso	120		7.500	Fierro Vaciado
23	Retén del Poste	123	2	.450	Fierro Vaciado
23 U	Abrazadera tipo U	123 U	2	.250	Fierro Comercial
31	Polea tipo "V"	131	1	5.000	Fierro Vaciado
32	Cuña de la Polea	132	1	.050	C.R.S.
36	Biela	136	2	2.300	Fierro Vaciado
39	Tornillo Tensor	139	1	.200	Fierro Comercial
44	Cabeza Cable (Cama)	144 - 12	1	11.100	Fierro Comercial
51	Engrane Mayor	151	1	16.700	Fierro Vaciado
52	Piñón	152	1	.750	C.R.S.
58	Balancín	158	1	.750	Fierro Vaciado
60	Base (Marco)	160	1	11.500	Est. Comercial
60 S	Soporte Motor	160 S	1	.900	Fierro Vaciado
65 B	Balero Abierto	165 B	1	.115	Comercial
65 P	Balero Sellado lado Polea	165 P	1	.115	Comercial
66	Juego cable prensa inferior	166 - 12	1	.430	Fierro Vaciado
70	Prensa Varilla Inferior	170	1	.650	Fierro Vaciado
76	Retén del Balancín	176	6	.115	Comercial
94	Cable	194	1	.115	Comercial
95	Prensa Varilla Superior	195	1	.575	Fierro Vaciado
96	Tensor Prensa Superior	196	1	.115	Fierro Vaciado
97	Prensa Superior (juego)	197 - 12	1	.500	Comercial
98	Cable sin Prensa	198 - 12	1	.115	Comercial
99	Tapón Nivel Aceite	199	1	.075	Comercial
100	Tapón Entrada Aceite	200	1	.075	Comercial

FABRICADO POR:

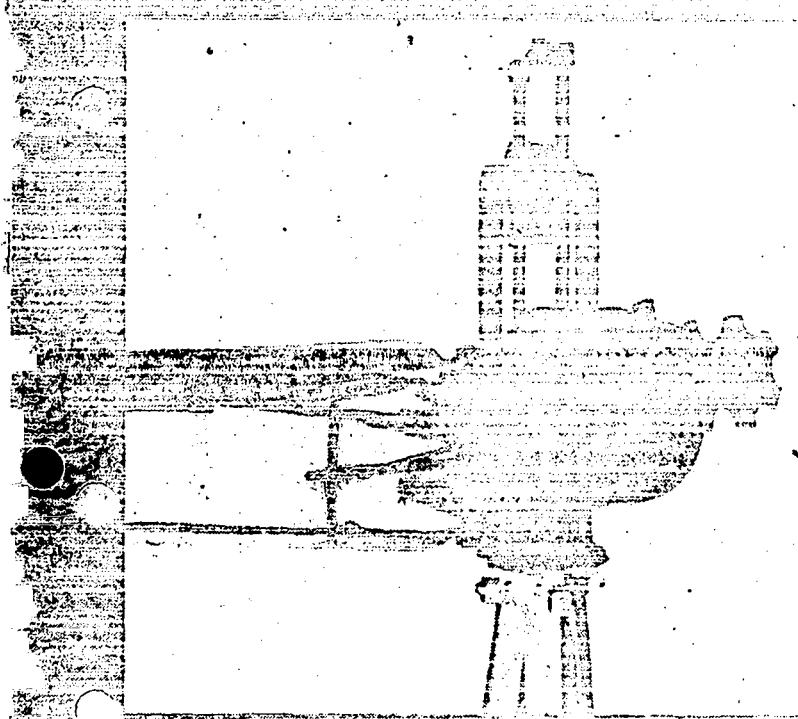
Molinos de Vientos, S. A.

Calle 53 N° 1 — Tels. 2-26-92 y 2-50-64

CHIHUAHUA CHIH

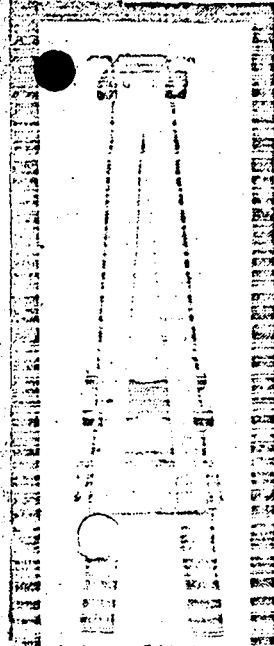
Monclova en
con torres en p

TAMANOS 2.45 y 3.05 m.



Fabricados para capacidad media de bombeo.
Equipados con insuperable mecanismo antifricción,
autolubricado.

Para montarse en la TORRE TIPO "A"



Ligera, resistente, y de sencilla erección. Totalmente en acero galvanizado. Rigidez asegurada por tirantes de alambre torcido autoajustables a los cambios de temperatura.
Se suministra en alturas de: 5.20, 6.70, 8.50, 10.00, 11.80 y 13.40 metros.

PESO DE EMBARQUE

Altura Torre A	1 Molino 2.45 m.	Molino 3.05 m.
5.2 m.	405 k.	435 k.
6.7 m.	465 k.	495 k.
8.5 m.	515 k.	545 k.
10.0 m.	570 k.	600 k.
11.8 m.	620 k.	660 k.
13.4 m.	670 k.	720 k.

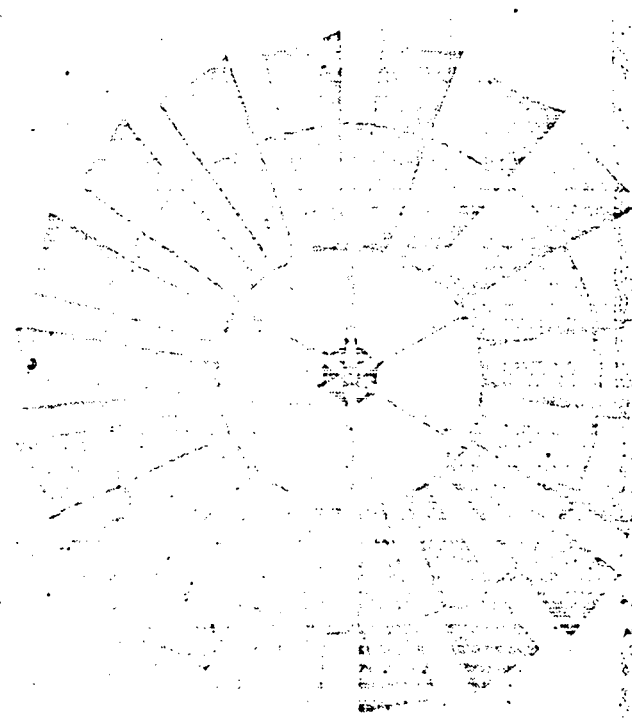
CAPACIDADES DE BOMBEO DE 1

Tamaño del cilindro de viento —		2.45 m.	3.05 m.	
Carrera —		190 mm.	8'-6"	
DIAMETRO DEL CILINDRO		Espesa metros	Ciños por hora	E m
48 mm.	1 1/4"	52	1655	1
51 mm.	2"	41	735	1
57 mm.	2 1/4"	33	935	1
63 mm.	2 1/2"	27	1150	1
70 mm.	2 3/4"	23	1400	1
76 mm.	3"	20	1665	1
83 mm.	3 1/4"	18	2140	1
89 mm.	3 1/2"	15	2270	1
95 mm.	3 3/4"	13	2605	1
102 mm.	4"	11	2950	1
108 mm.	4 1/4"	10	3245	1
114 mm.	4 1/2"	9	3745	1
121 mm.	4 3/4"	8	4160	1
127 mm.	5"	7	4620	1

Capacidades determinadas con la carrera máxima
kilómetros por hora para los tamaños 2.45 y 3.05 m
y 4.25 metros. Reduciendo la carrera del pistón, la

En cada Molino de Viento Monclova se obsequia n
instalación.

Para mayor información dirijase al distribuidor de



**Los tamaños
de las aletas**

TAMAÑO DE LA ALETA
TAMAÑO DE LA ALETA
TAMAÑO DE LA ALETA
TAMAÑO DE LA ALETA

MOLINOS DE VIENTO "MOLINO"

Altura m.	3.65 m.		4.25 m.	
	10'-0"	12'-0"	14'-0"	
Velocidad m/s	3.06	3.06	3.06	3.06
Litros por hora	Espesor metros	Litros por hora	Espesor metros	Litros por hora
680	118	680	176	600
755	92	780	138	665
795	73	985	109	840
1 210	61	1 220	91	1 045
1 435	53	1 475	79	1 265
1 740	45	1 750	67	1 500
2 080	38	2 060	57	1 760
2 420	33	2 385	49	2 044
2 740	29	2 740	43	2 345
3 105	25	3 110	38	2 670
3 480	22	3 520	33	3 010
3 785	20	3 935	30	3 375
4 235	18	4 390	27	3 760
4 730	16	4 805	24	4 085

El pistón y asumiendo vientos con velocidad de 24 y 31 kilómetros por hora para los tamaños 3.65 y 4.25 metros, la capacidad decrece proporcionalmente.

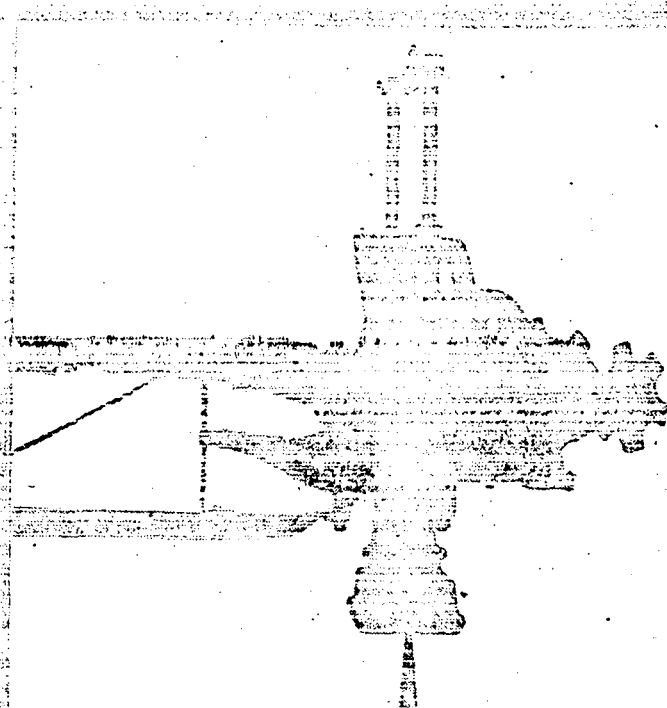
Se incluye manual de montaje para facilitar aún más su instalación o bien a nuestra planta en Monclova, Coah.

Inmejorable conjunto de rueda de aspas.

Ligera, fuerte y sensible a los más leves vientos, resistente a los más severos.

Aspas de acero de alta calidad, galvanizadas, perfectamente diseñadas, con arreglo de conjunto y balanceo correcto que evitan interferencia entre ellas aun cuando ocurren vientos de altas velocidades. El diámetro de la rueda de aspas determina la potencia de bombeo y por lo tanto el tamaño del Molino de Viento.

TAMAÑOS 3.65 y 4.25 m.



Para gran capacidad de bombeo, dotados de vida ilimitada por sus óptimas cualidades mecánicas y su eficiente sistema de rodamientos.

Equipados con la TORRE TIPO "B"

Fuerte y estable, fabricada en acero galvanizado, de fácil instalación. Contravientos eficientes con resistentes tirantes de alambre forjados, tensionados con granelas excéntricas.

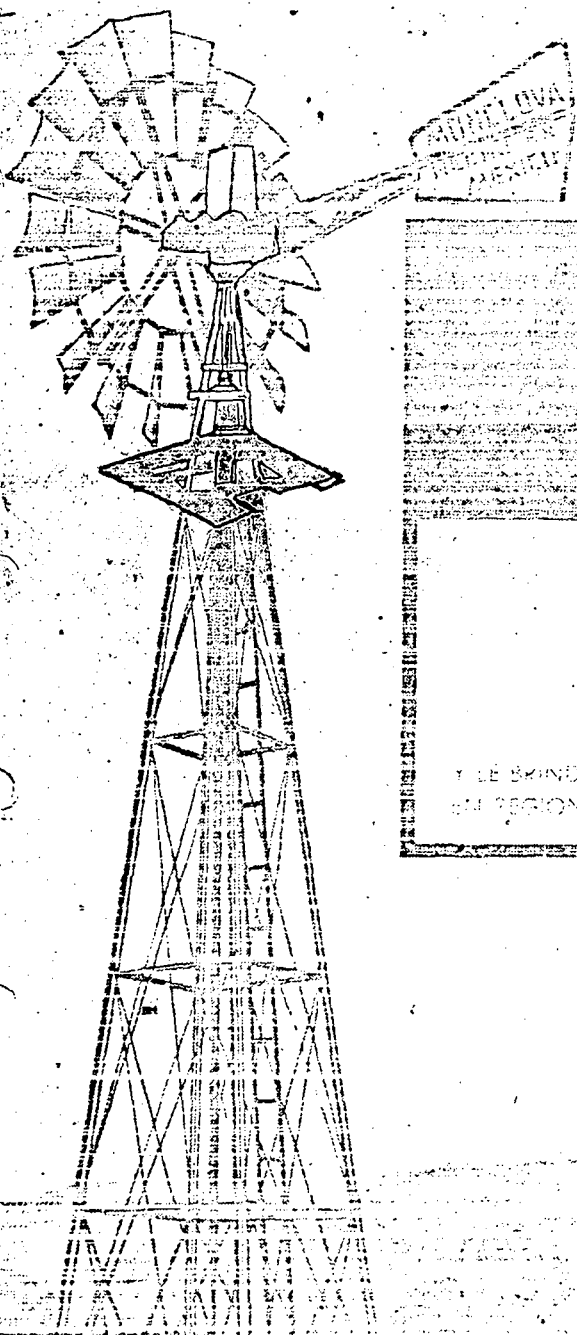
Se suministra en alturas de: 6.10, 9.15, 12.20 y 15.25 metros.

PESO DE EMBAQUE

Altura Torre B	Molino 3.65 m.	Molino 4.25 m.
6.10 m.	765 k.	810 k.
9.15 m.	855 k.	900 k.
12.20 m.	970 k.	1015 k.
15.25 m.	1070 k.	1135 k.

Alturas mayores pueden suministrarse a solicitud.

Fuente: **Verdate**



es LO MEJOR PARA

MOLINOS DE VIENTO

6

CARACTERISTICAS INSUPERABLES QUE LOS DISTINGUEN

Y LE BRINDAN RESPUESTA PARA BOMBLEAR EN FORMA CONTINUA Y CONFIABLE, AUN EN REGIONES APARTADAS DONDE SE CARECE DE ELECTRICIDAD Y COMBUSTIBLES.

FACIL LUBRICACION ANUAL

La valvula de control de aceite cada año para que el mecanismo opere con absoluta seguridad. Igualmente el accionamiento externo de la valvula de bombeo, mantiene suficiente grasa en el alojamiento para durar todo un año, y pueda ser reabastecida fácilmente por medio de la graseira de control.

OPTIMO SISTEMA GIRATORIO

La rotación sobre el eje de la torre se facilita al permitir el acercamiento de los ventos más ligeros, haciendo este sistema de mesa giratoria está diseñado para mayor facilidad en el manejo del mecanismo en la torre.

FUNCIONAMIENTO INSUPERABLE

Los ejes tienen buena los hace trabajar y con más durables porque se han diseñado cuidadosamente para que sus partes con movimiento actúen sin esfuerzo, por ello prestan servicio a más largo plazo que cualquier otro sistema, siempre que se mantenga.

SEGURA PROTECCION DEL MECANISMO

Una cubierta de aluminio de acero galvanizado, protege el mecanismo de la intemperie, para evitar que los elementos se dañen por la humedad, viento, polvo, etc., y a su vez evita el ruido que produce el funcionamiento.

MATERIALES DE ALTA CALIDAD

Todos los ejes y partes están fabricados con acero roto en frío de alta calidad, para asegurar una larga duración. Los pivotes fundidos, son fabricados en hierro gris con granitismo por resquebrajamiento, para evitar el resquebrajamiento de los ejes.

EFICAZ DISPOSITIVO AMORTIGUADOR

El Molino de Viento tiene un eficaz dispositivo amortiguador, que reduce los efectos de las ráfagas de viento, para la protección del mecanismo, evitando el resquebrajamiento de los ejes y partes.



who international reference centre for community water supply

postal address: p.o. box 140, leidschendam, the netherlands
office address: nw havenstraat 6, voorburg (the hague)
telephone: 070 - 69 42 51, teleg.: worldwater the hague, telex: 33604

to:

date July 10th, 1976
our reference
our reference
subject International Workshop on Hand Pumps

Dear Mr.

Welcome to the Netherlands. I would like to wish you a pleasant stay and I trust you have found your accomodation satisfactory.

This file contains documents for reference use at the Workshop, in conjunction with the draft "Guidelines on Hand Pumps" you have received earlier.

The opening session of the workshop will be held on Monday, July 12th, at 10:00 a.m., in the Conference Room on the second floor of Damsigt Building, where the IRC has its offices. Monday morning, July 12th, the coach for delegate's use will be leaving from the gate of the Royal Garden at the rear of the hotel at 8:45 a.m. As from Tuesday on, the sessions will commence at 9:00 a.m. and the coach will be at the Garden gate at 8:00 a.m.

Further information has been included in the file, together with tourist brochures on The Hague and several forms which I should like to request you to complete and return to the Secretariat. You will also find an invitation for cocktails on Monday at 5:00 p.m.

Should you have any queries or wish to have any assistance, please do not hesitate to contact Mr. Hofkes, who has prepared the meeting, Miss Keijzer, the meeting secretary, or any other member of the Secretariat.

Sincerely yours,

Drs. J.M.G. van Damme
Manager

On the occasion of
the International Workshop on Hand Pumps

the Director of the
National Institute for Water Supply

requests the pleasure of the company of

at cocktails
on July 12th, 1976 from 17:00 to 18:30
Damsigt Building (second floor)
Nw. Havenstraat 6, Voorburg (The Hague)

who international reference centre for community water supply

post: 11000, p.o. box 100, IJdoornham, the netherlands
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telephone: 070-104251, telex: 33604

INTERNATIONAL WORKSHOP ON HAND PUMPS

The Hague, 12-16 July 1976

"DUTCH TREAT DINNER"

The undersigned wishes to participate in the "Dutch Treat Dinner"
(cost of dinner, including wine and coffee, is Dfl. 39,=) at the
Restaurant "In 't Gemeste Schaap", Raamstraat 9, on Thursday, 15th
of July, 1976 at 20:30 p.m.

Name: _____

Vegetarian menu requested:

YES/NO

the international reference centre for community water supply

Postbus 100, P.O. Box 100, 1000 Amsterdam, the Netherlands
tel. 020-674-1111, telex 1000000 (the Hague)
tel. 020-674-1111, telex 1000000 (the Hague), telex: 33514

INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

QUESTIONNAIRE

SURNAME : _____

INITIALS, TITLE(S) : _____

FIRST NAME : _____

OFFICIAL POSITION : _____

INSTITUTE : _____

ADDRESS : _____

P.O. BOX : _____

TELEPHONE : _____

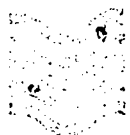
TELEPRINTER : _____

CABLE : _____

PERMANENT ADDRESS : _____

ADDITIONAL
INFORMATION : _____

Please complete this form and return to the Secretariat



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

List of Participants

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Ghana

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* participant will be attending certain sessions of the workshop

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KEIJZER, Miss Peggy

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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

List of Participants

ABROBAH-CUDJOE, Dr. A.	Faculty of Engineering University of Science and Technology Kumasi <u>Ghana</u>
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DRAFT AGENDA

1. Opening Session
2. Nomination of Chairman and Adoption of Agenda
3. Objectives of the Workshop
4. Technical Handbook on Hand Pumps
 - introduction by Dr. F.E. McJunkin
 - presentation by participants
5. Plenary Meeting
 - presentation by Mr. J. Shawcross
 - formation of Working Groups
6. Working Group Sessions (detailed review of Handbook)
 - installation, operation and maintenance
 - technology, research and development
 - manufacture, local materials and production
7. Visit to Amsterdam Water Works
8. Plenary Meeting
 - discussion of Working Group Reports
 - presentation by participants
9. Task Group Sessions
 - recommendations for follow-up activities
10. Plenary Meeting
 - discussion of Task Group Reports
11. Adoption of Final Recommendations
12. Closing Session



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

ANNOTATED AGENDA

Sunday, 11 July

16:00

Registration at the Park Hotel, The Hague
Issue of conference documents

Monday, 12 July

10:00 - 11:00

1. Opening Session
 - 1.1 Welcome by Dr. G.W. Putto, Deputy Director
National Institute for Water Supply, The Hague
 - 1.2 Opening by Professor O. Kranendonk,
Royal Tropical Institute, Amsterdam
 - 1.3 Rural Water Supply Support Programmes
Drs. J.M.G. van Damme, Manager, IRC
 - 1.4 Objectives of UNEP and WHO in supporting the
preparation of the Technical Handbook on
Hand Pumps
Dr. R.C. Ballance, WHO, Geneva

11:00 - 11:20

COFFEE BREAK

11:20 - 11:45

2. Organizational Matters
 - 2.1 Nomination chairman and rapporteurs
 - 2.2 Adoption of agenda
 - 2.3 Presentation of participants
 - 2.4 Announcements

11:45 - 12:30

3. Objectives of the Workshop
 - 3.1 Introduction on the objectives of the Workshop
Mr. E.H.A. Hofkes, IRC
 - 3.2 Discussion on objectives and adoption

- 12:30 - 14:00 LUNCH
(will be held at Ministry of Public Health and Environmental Hygiene, Building B, top floor lunchroom)
- 14:00 - 14:30 4. Technical Handbook on Hand Pumps
4.1 Presentation of draft handbook
Dr. F.E. McJunkin, consultant IRC
- 14:30 - 15:00 4.2 Presentations by participants *
- 15:00 - 15:20 TEA BREAK
- 15:20 - 16:00 4.3 Presentations by participants * (continued)
- 16:00 - 16:55 4.4 General discussion
- 16:55 - 17:00 4.5 Summary of main issues by the Chairman
- 17:00 - 18:30 RECEPTION
at the National Institute for Water Supply

Tuesday, 13 July

- 9:00 - 10:00 5. Plenary
5.1 Introduction on choices associated with hand pump tubewell programmes and hand pump design (with reference to the Bangladesh Rural Water Supply Programme)
Mr. J. Shawcross, UNICEF, Dacca
- 5.2 General discussion
- 5.3 Formation of Working Groups;
terms of reference:
I. Installation, operation, maintenance
II. Technology, research and development
iii. Manufacture, local materials and production
- 10:00 - 12:30 6. Working Group Sessions
6.1 Detailed review of draft Handbook
- 12:30 - 14:00 LUNCH

* Names of participants who are requested to briefly introduce principal comments on draft Handbook, including written contributions as submitted, will be shown subsequently

- | | | |
|---------------|-----|--|
| 14:00 - 17:00 | 6.2 | Detailed review of draft Handbook |
| 17:00 - 17:30 | 6.3 | General plenary discussion (if required) |

Wednesday, 14 July

- | | | |
|---------------|-----|---|
| 9:00 - 9:30 | 7. | <u>Plenary</u>
Information from and further guidance to Working Groups |
| 9:30 - 12:30 | 8. | <u>Working Group Sessions</u> (continued)
Finalization detailed review draft Handbook;
drafting reports for processing by secretariat |
| 12:30 - 13:30 | | LUNCH |
| | 9. | Visit to Amsterdam Water Works
catchment area and purification plant in dunes |
| 13:35 | 9.1 | bus leaves Damsigt Building, Voorburg |
| 17:30 | 9.2 | return to Park Hotel, The Hague |

Thursday, 15 July

- | | | |
|---------------|------|---|
| | 10. | <u>Plenary Discussion on Working Group Reports</u> |
| 9:00 - 9:45 | 10.1 | Working Group report I |
| 9:45 - 10:30 | 10.2 | Working Group report II |
| 10:30 - 10:45 | | COFFEE BREAK |
| 10:45 - 11:30 | 10.3 | Working Group report III |
| 11:30 - 12:00 | 11. | General discussion on lay-out, editing, publication
of Technical Handbook on Hand Pumps |
| 12:00 - 12:30 | 12. | Presentation on Shinyanga Shallow Wells Project
Mr. C.J. Bonnier
Netherlands Agency for Development Cooperation |
| 12:30 - 14:00 | | LUNCH |

14:00 - 14:30 13. Plenary
Presentation on the integration of the use of
materials and equipment, administrative and
technical skills, for the development of rural
areas
Mr. S.B. Watt, ITDG

14:30 - 15:00 14. General discussion on additional studies, pro-
grammes and activities
Formation of Task Group; terms of reference

15:00 - 17:30 15. Task Group Sessions
Drafting of recommendations additional studies,
programmes and activities

Friday, 16 July

 16. Plenary Discussion on Task Group Reports

9:00 - 10:30 16.1 Recommendations regarding additional studies,
programmes and activities

10:30 - 11:00 COFFEE BREAK

 16.2 Recommendations regarding further extension,
editing, publication, distribution and up-
dating of Technical Handbook and subsequent
guideline

11:00 - 12:30 16.3 Miscellaneous items
International specification for hand pumps
Standard procedure for testing and evaluation, etc.

12:30 - 13:00 LUNCH

13:00 - 14:30 16.4 Conclusions and adoption of final recommendations
regarding additional studies, programmes and ac-
tivities, including priority allocation and assign-
ment of responsibilities for implementation

14:30 - 14:35 17. Closing Session

until 15:00 18. Drinks.

who international reference centre for community water supply

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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

ANNOTATED AGENDA

Sunday, 11 July

16:00

Registration at the Park Hotel, The Hague
Issue of conference documents

Monday, 12 July

10:00 - 11:00

1. Opening Session

- 1.1 Welcome by Dr. G.W. Putto, Deputy Director
National Institute for Water Supply, The Hague
- 1.2 Opening by Professor O. Kranendonk,
Royal Tropical Institute, Amsterdam
- 1.3 Rural Water Supply Support Programmes
Drs. J.M.G. van Damme, Manager, IRC
- 1.4 Objectives of UNEP and WHO in supporting the
preparation of the Technical Handbook on
Hand Pumps
Dr. R.C. Ballance, WHO, Geneva

11:00 - 11:20

COFFEE BREAK

11:20 - 11:45

2. Organizational Matters

- 2.1 Nomination chairman and rapporteurs
- 2.2 Adoption of agenda
- 2.3 Presentation of participants
- 2.4 Announcements

- 11:45 - 12:30 3. Objectives of the Workshop
- 3.1 Introduction on the objectives of the Workshop,
 including summary of comments received
 Mr. E.H.A. Hofkes
- 3.2 Discussion on objectives and adoption
- 12:30 - 14:00 LUNCH
- (will be held at Ministry of Public Health and
 Environmental Hygiene, Building B, top floor
 lunchroom)
- 14:00 - 15:00 4. Technical Handbook on Hand Pumps
- 4.1 Presentation of draft handbook
 Dr. F.E. McJunkin, consultant IRC
- 15:00 - 15:20 TEA BREAK
- 15:20 - 16:50 4.2 General Discussion
- 4.3 Summary of main issues by the Chairman
- 17:00 - 18:00 RECEPTION
- at the National Institute for Water Supply

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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

ANNOTATED AGENDA

- | | |
|-------------------------|---|
| <u>Tuesday, 13 July</u> | 5. <u>Plenary</u> |
| 9:00 - 10:00 | 5.1 Daily report - Monday |
| | 5.2 Presentation by Mr. W.K. Journey
"A Hand Pump and Well for Rural Areas in
Developing Countries" |
| | 5.3 Presentation by Mr. V.J. Emmanuel and
Mr. A. Chakravarty
"Experiences and Technical Aspects of Several
Hand Pump Projects" |
| | 5.4 Presentation by Mr. R.D. Fannon
"Battelle's Involvement in Hand Pump Programmes" |
| 10:00 - 10:30 | 5.5 Formation of Working Groups;
terms of reference:
I. Installation, operation and maintenance
II. Technology, research and development
III. Manufacture, local materials and production |
| 10:30 - 12:30 | 6. <u>Working Group Sessions</u> |
| | 6.1 Detailed review of draft Handbook |
| 12:30 - 14:00 | LUNCH

during lunch the film "Piped Water for Villagers"
will be presented (29 min.) |
| 14:00 - 17:00 | 6.2 Detailed review of draft Handbook (continued) |
| 17:00 - 17:30 | 6.3 General plenary discussion (if required) |

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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

ANNOTATED AGENDA

Wednesday, 14 July

- | | |
|---------------|---|
| 9:00 - 9:30 | 7. <u>Plenary</u> |
| | 7.1 Daily report Tuesday |
| | 7.2 Information from and further guidance to Working Groups |
| 9:30 - 12:00 | 8. Working Group Session (continued)
Finalization detailed review draft Handbook.
Preparation additional recommendations as to the development of a technical guideline |
| 12:00 - 12:30 | 9. <u>Plenary</u>
Review activities working groups |
| 12:30 - 13:30 | LUNCH |
| | 10. Visit to Amsterdam Water Works
catchment area and purification plant in dunes |
| 13:30 | 10.1 bus leaves Damsigt Building, Voorburg |
| 17:30 | 10.2 return to Park Hotel, The Hague |



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INTERNATIONAL WORKSHOP ON HANDPUMPS

The Hague, 12-16 July, 1976

ANNOTATED AGENDA

Thursday, 15 July

- | | | |
|---------------|------|---|
| | 10. | <u>Plenary Discussion on Working Group Reports</u> |
| 9.00 - 9.45 | 10.1 | Working Group Report I |
| 9.45 - 10.30 | 10.2 | Working Group Report II |
| 10.30 - 10.45 | | COFFEE BREAK |
| 10.45 - 11.30 | 10.3 | Working Group Report III |
| 11.30 - 12.30 | 11. | <u>Presentation by Mr. J. Shawcross, UNICEF, Dacca</u>
Introduction on choices associated with hand pump
tubewell programmes and hand pump design (with
reference to the Bangladesh Rural Water Supply Programme). |
| 12.30 - 13.30 | | LUNCH |
| 13.30 - 14.00 | 12. | <u>Presentation by Mr. C.J. Bonnier, Netherlands Agency</u>
for Development Cooperation, on Shinyanga Shallow
Wells Project. |
| 14.00 - 14.30 | 13. | <u>Planning Task Groups</u> |
| | 13.1 | General discussion |
| | 13.2 | Formation of Task Group |
| | 13.3 | Terms of Reference Task Groups |
| 14.30 - 17.00 | 14. | <u>Task Group Sessions</u> |
| | 14.1 | Inventory predominating problems and constraints ex-
perienced in carrying out hand pump projects and
related to planning, technology, implementation and
management. |
| | 14.2 | Sub-group discussions on possible solutions for specific
and important elements of the inventory of problems
and constraints. |
| | 14.3 | Drafting of recommendations for additional studies,
programmes and activities. |
| 17.00 - 17.30 | 15. | <u>Plenary</u>
Review activities of Task Groups |
| 20.30 | | DUTCH TREAT DINNER

Restaurant "'t Gemeste Schaap"
Raamstraat 9
The Hague |



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

ANNOTATED AGENDA

Friday, 16 July

9:00 - 10:30

15. Plenary Discussion on Task Group Activities

15.1 Review of Task Group recommendations regarding additional studies, programmes and activities

10:30 - 11:00

COFFEE BREAK

11:00 - 12:30

15.2 Adoption of final recommendations

15.3 Allocation of priorities

15.4 Assignment of responsibilities for implementation

12:30 - 14:00

LUNCH

13:00

Presentation of film: "Water Supply, A Global Care"

Conference Room

14:00 - 14:30

16. Recommendations regarding further extension, editing, publication, distribution and updating of Technical Handbook and subsequent guideline

14:30 - 15:00

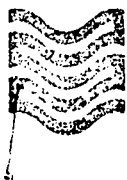
17. Presentations

15:00 - 15:15

18. Closing Session

until 16:00

Drinks



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

INTRODUCTION ON OBJECTIVES OF THE WORKSHOP

By E. H. A. HOFKES

OUTLINE

I should like to place before you some introductory remarks on the objectives of this meeting:

Holding an International Workshop with handpumps as the subject may seem to contain an element of bringing together two worlds that are supposedly very different. Indeed, one of our many correspondents observed, with a streak of gentle humor, "It is very encouraging to see the subject of the humble handpump 'rising to such level of prominence'".

However, there can be no denying that a need exists for better exchange of experiences with handpumps, design ideas and test results; between countries, development agencies and international organizations, worldwide. Involved are all who are concerned with rural water supply programmes. Better access to the body of knowledge should prove useful to many people working in this field.

The Workshop, then, is intended to serve a dual purpose:

Firstly, we owe it to all who can benefit from comprehensive information on handpumps, that the draft Technical Handbook on Handpumps will be thoroughly reviewed. I have pleasure in saying that the document, even in the present interim stage, did receive a favourable reception and appreciation from many quarters. On the other hand, there can be no doubt that further improvement is both desirable and possible. I am pleased to know that all present are willing to take on this task and surely the joint effort of this meeting will bring out a document, strengthened by review and incorporating all changes and additions deemed necessary.

Secondly, participants in the Workshop will want to consider how the Handbook - once it has been finalized - can be made use of to best advantage, and what related follow-up activities should be embarked upon. This will mean, in fact, considering what else can be done, on the international level, to promote handpumps fulfilling their important role in rural water supply programmes, especially in developing countries. By indicating and formulating recommended demonstration, training, studies and further publications, the meeting would provide for the effective use of the Technical Handbook and other results of the workshop.

Please allow me to speak first about the review of the Handbook. After that, I shall be keen to return to the point of follow-up activities.

REVIEW OF DRAFT TECHNICAL HANDBOOK ON HANDPUMPS

You will have noted from the agenda, that the work of reviewing the Handbook in detail, is to be carried out during the first three days of the meeting, with the actual hard work planned for Tuesday and Wednesday morning. One might say this is not too much time and I would tend to agree.

However, the wealth of expert knowledge and experience you are bringing to this meeting, from some 20 countries in almost all parts of the world, leaves hardly anything to be desired. It should enable the review effort to be both intensive and effective.

We received a number of valuable comments on the draft Handbook. Some have been included in your documentation field for easy reference. In addition, I should like to pass on to you remarks that were received through correspondence and other communications. I would think it is best to let them speak for themselves and will not burden you with numerous references indicating where they originated.

1. GENERAL COMMENTS

"This document", Mr. Martin Beyer of UNICEF said, "represents an excellent effort, especially considering the short time at the disposal of Dr. McJunkin, and will constitute a very helpful document for anybody concerned with rural water supply. In principle, the disposition of the contents is well balanced. One section that would be worthwhile to stress and detail even further, is that of installations, operation and maintenance of handpumps. One detail that might be helpful, would be tabulation with a list of all different types of handpumps with brief indications of their construction, place of manufacture, measurement, depth, range, potential yield, price range and possibly, even indicating restraints or other evaluative features."

Several times the Handbook was called "a timely and comprehensive document". It was expressed that the document should prove very helpful in making recommendations on critical aspects of manufacture, type of materials, maintenance etc. After verification of facts, the document could serve

quite well as a reference manual on handpumps.

There were very favourable comments such as "The report on handpumps fills the urgent necessity of developing countries and will be a good aid to the personnel who is working in rural water supply programmes" or "The Handbook goes a long way in bringing handpump technology from an art to a science. It certainly seems comprehensive." The following remarks ring a more critical note, should equally have your attention.

It was commented that the report should not be called "Guidelines" but, for instance, a Review of Handpump Technology and Problems. The opinion was given that: "A document of this nature need only be a glossary of authentic information brought up-to-date, so that the user of these different kinds of pumps in different countries can refer to it and make their own improvements from time to time." And further, "It would perhaps be in the fitness of things for the appropriate authorities concerned within the countries to develop their own 'Guidelines' for operation and maintenance to suit their local conditions fully utilizing the information in the Handbook. It is also desirable and necessary that the developments that would be made from time to time in any country using handpumps on a large scale are brought to the notice of an 'expert committee' or similar body that may be set-up, to up-date and re-write the handbook so that it remains as a constant source of information and reference for the future."

In this respect, I should not fail to bring to your notice the following rather basic comment on the draft Handbook and related future action required: "Limited distribution might be preferable to a more universal one. So many models and ideas are discussed that it might confuse someone not fully involved with handpump technology. Much of the applied work at field level has only been done in the past 4 - 5 years. Much of the results of this work are only now finding extensive application. A guideline is intended to guide. But the present draft presents many options, but few conclusions. Publication of a formal guide might wait until the options have been field tested extensively enough to warrant some firm conclusions. Some of the work is in a rather unconsolidated form. Perhaps, within 2 - 3 years, a great deal of work will have reached a more advanced state. It might be worth considering issuing this Guidelines as a interim report, with the full guidelines to be published in a few years."

I think this valuable comment should be taken fully into account during the workshop discussions. Taken the matter one step further, I wonder whether the meeting would consider it useful if ultimately not only the Handbook were published, but also shortened version for field engineering staff and perhaps even some kind of an abstract for the use of each caretaker with a handpump. The latter should then include information on the operation of the pump as well as general health education material.

2. INSTALLATION, OPERATION AND MAINTENANCE

Principal Comments

i. Community involvement

Principal comments on the sections of the Handbook discussing installation, operation and maintenance of handpumps all pointed out that it is impossible to maintain a reliable water supply without community participation. Attention should be given to the role a tubewell fitted with a handpump should play in the community. It has been suggested to even involve the community in the sinking of the well so that the handpumped water supply would then be accepted more easily and better taken care of. In this respect, we received advice expressing the correspondent's confidence "that the participants at the IRC Handpump Seminar in Holland shall be persons with long-standing experience from rural water supply programmes, who will be quite aware of the need of promoting community motivation."

ii. Selection of sites and the set-up of installation programmes

Several requests were made that following versions of the Handbook be expanded to provide technical information on:

- a. The selection of sites and how to install a handpump.
- b. How to prepare, implement and evaluate programmes for installation and maintenance of handpumps.

There can be no doubt that special mention of these subjects in the Handbook would materially widen its scope.

iii. Maintenance

Not all reviewers were impressed with the report suggesting that the more expensive the pump the less maintenance problems it will have. An inexpensive pump that is easy to maintain may cost much less. Central maintenance systems were considered too expensive where large numbers of pumps are installed. It was stressed that, basically, the pump must be maintained by the villagers and the pump should be designed with this objective in mind. If the villagers can maintain bicycles, motorcycles and small irrigation pumps, they also can maintain handpumps, provided there are made easy to repair.

In general it was suggested that the section of the Handbook dealing with installation, operation and maintenance be further elaborated and expanded to cover the subjects more completely

3. TECHNOLOGY, RESEARCH AND DEVELOPMENT

Principal Comments

i. Shallow Well versus Deepwell Handpumps

The draft Handbook does contain a note about the depth ranges for handpumps. However, a number of reviewers advocated that the subject be dealt with more specifically. Reference was made to the fact that deepwell handpumps become rather inefficient at greater depth and the wear is such that some manufacturers do not recommend their pumps for depths below 150 feet and some even would not recommend to go far below 100 feet. It was suggested to elaborate the subject in more detail in order to avoid that exaggerated expectations are attached to the capabilities of deepwell handpumps.

ii. Uniform design

It will perhaps not be correct to attempt for an uniform design for adapted use both for a shallow well pump and a deep well pump. Whilst it is true that engineering principles remain very much the same, there are limitations in expertise, materials, finance, etc. in a country and besides that, chemical qualities of water, systems of maintenance

and administration, water use habits etc. will vary considerably from country to country.

iii. Closed versus open top cylinders

Many experts suggest the use of open top cylinders which are very expensive as compared with closed top cylinders. The open top cylinders, of course, are supposed to have the advantage that the piston can be pulled out and the pump leather can be renewed without too much difficulty, whereas closed top cylinders would have to be extracted entirely which may present difficulties. It would be of interest to find out whether there is, in fact, a considerable advantage in open top cylinders justifying the substantially higher cost.

Comments indicate that the draft Handbook is not completely clear on this issue.

iv. Multiple pump leathers

It has been recommended to provide pump cylinders with three or even more pump leathers. Others say there is no particular advantage in having more than one pump leather. For instance, three pump leathers seem to give no longer life than a single one, and would be an unnecessary expenditure. Maybe something on the subject should be included in the Handbook.

v. Small diameter pump cylinders

We were informed by UNICEF that they continue to receive requests for pump cylinders of 1 7/8" and 1 13/16" internal diameter. These small pump cylinders result in very low water output especially at greater depth. It would be useful if something on the subject could be said in the Handbook.

vi. Miscellaneous

The following general aspects of commercial handpumps were mentioned for more detailed elucidation in the Handbook:

- a. smoothness of the interior of the pump cylinder, machining or brass lining etc.
- b. cups of different materials.

4. MANUFACTURE, LOCAL MATERIALS AND PRODUCTION

Use of PVC

A subject many times raised by reviewers is that of using PVC-pipe as well casing and pump cylinder. Perhaps the issue is brought out best in the following statement:

"The greater part of the report is on cast iron pumps which is reasonable since most of the pumps have been made of this material. However, cast iron is constantly increasing in cost and to modify it to get a better piston surface and to improve bearing and other problem points will make this type of pump too costly for mass utilization."

"The use of PVC-pipe as a well casing and pump cylinder can completely change our approach to pump design. PVC is still much lower in cost than cast iron and is available as pipe in almost all developing countries. Its surface is smoother than brass and a whole order of magnitude smoother than cast iron, no matter how carefully this may be machined. PVC pipe used as a cylinder has not shown appreciable wear in tests in Germany, Bangladesh and Thailand. If the pump handle is supported on a separate post, PVC pipe acting as a pump stand would take little stress and, if necessary, could be protected by a surrounding pier of brick, wood, or concrete pipe. If the well casing is PVC and this becomes the cylinder, the pump rod and piston can be easily removed by villagers for repair."

"So use the newer and better technology now available. At this stage the need is to draw up specifications for a PVC pump, based on present information. We can then have some fabricated in several countries and installed where they can be closely observed. After a field trial of six months or a year, we can review the experience, modify the specification,

if necessary, and install a new model pump for field tests. After this has been done a few times, we should have a good specification and design that can be recommended to all countries."

Requests that the Handbook should deal in more detail with the use of plastics, were also received in respect of:

- a. parts such as cups, cupseals, etc.
- b. use of plastic lining or inserts, or for coating (epoxy resins).

We were advised that the matter is also under consideration at the World Bank and I am pleased to quote to you the following statement from them:

" We have recently been concerned with the development of a simple handpump, based on the use of PVC casing and are somewhat disappointed that the potential of such a development seems to have been rather lightly dismissed in the draft report. Hopefully, it may be possible to expand the section of the report dealing with the use of plastics and the simplified designs (i.e. using the upper well casing as the cylinder), since, in our opinion this proposal has passed the feasibility or prototype stage and should now definitely be evaluated in full scale field trials."

Miscellaneous

Further points brought forward were:

- information on the use of fiber glass in screens and pipes.
- the belief that as much as possible each country should manufacture their own equipment, determine adequate well locations, make proper installations and set-up their own maintenance programmes.
- would there be merit in having an internationally standardized specification for handpumps?
- is there a case for an agreed upon protocol for testing and evaluation of handpumps?

This meeting will want to consider these and similar questions and I trust you will not hesitate to bring them forward.

Recommendations regarding changes, extensions and additions of the contents of the Technical Handbook on Handpumps, are to be drafted in working group

sessions for approval by the meeting in plenary, through consensus action. It will be Dr. McJunkin's responsibility to assist in incorporating these recommendations in his report. The responsibility of implementing recommendations concerning publications and distribution of the Handbook will rest with the IRC and will be decided upon in consultation with WHO and UNEP.

Recommended follow-up activities

I now should turn briefly to follow-up activities, that is the best way the Handbook - once it has been finalized - may be utilized, as well as related programmes. The experience and expert knowledge gathered here, makes it only natural for the IRC to seek your advice and recommendations, as well as your cooperation in further work.

When we circulated the draft Handbook, we did not explicitly pose these questions, but a number of reviewers sat down and pondered what action they would like to see undertaken in conjunction with or more indirectly related to the eventual publication of the Technical Handbook on Handpumps.

Here are a few suggestions, that are certainly worth mentioning:

- maintain an active file of technical information on handpumps.
- establish clearing-house function for dissemination of handpump test results.
- draw-up a maintenance chart containing a schedule of (preventive) maintenance work together with the organizational arrangements required for carrying out this work.
- make an inventory of ongoing projects, field trials and programmes as well as the agencies and organizations involved.
- direct to selected persons questionnaire asking for detailed information on
 - . local use of handpumps
 - . local manufacturing capacity
 - . costs of pumps commercially available
 - . maintenance system employed.

Time has been set aside for consideration of these and other proposed follow-up activities, on Thursday and Friday of this week. The point of

who is to accept project agency responsibility will no doubt we raised and I have pleasure in stating that the IRC is prepared to take on its fair share.

CONCLUSION

In conclusion, I am glad to be able to say that the whole concept of compiling information on handpumps for subsequent development into guidelines, did stir up considerable interest. One international organization did not lose time in ordering 60 copies of the Handbook to be published. Numerous other requests, if more modest, have already been received.

I have pleasure in submitting the draft objectives of the meeting, which you have found amongst your conference documentation files, for your consideration. I trust you realize, as I do, that the double task assigned to the Workshop, results in a somewhat tight schedule. Perhaps they will turn out to be the understatement of the week!

THANK YOU.



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

GENERAL OBJECTIVES

1. To review, discuss and supplement the draft Technical Handbook on Hand Pumps, as prepared by the IRC consultant, as well as additional background information.
2. To give recommendations on further studies and activities in planning, technology and management aspects and to advise on the preparation of an integrated guideline for the development of hand pump projects.
3. To identify and formulate both technical and organizational recommendations for programmes and activities and to agree upon priorities and initial arrangements for the implementation of specific activities.

GUIDANCE WORKING GROUPS

I. Introduction

The ultimate goal of the handpump-programme as started with this meeting is to arrive at an overall guideline (or series of guidelines) on handpumps to the benefit of planners and executive engineers in developing countries, responsible for handpump schemes. This would include: (1) programme development and planning; (2) technology and installation; and (3) management (operation and maintenance). These 3 elements could be dealt with in 3 separate documents, or alternatively, be integrated in one volume.

An interim step in order to arrive at this guideline (or series of guidelines) is the preparation of interim guidelines/handbooks/study results on these three elements as related to handpumps (the first and last elements could cover more than handpumps).

We now have a draft handbook on technology, which covers broadly 3 technical items:

- installation and maintenance (chapter 4)
- research and development (chapters 3 and 5)
- manufacture and local production (chapter 6).

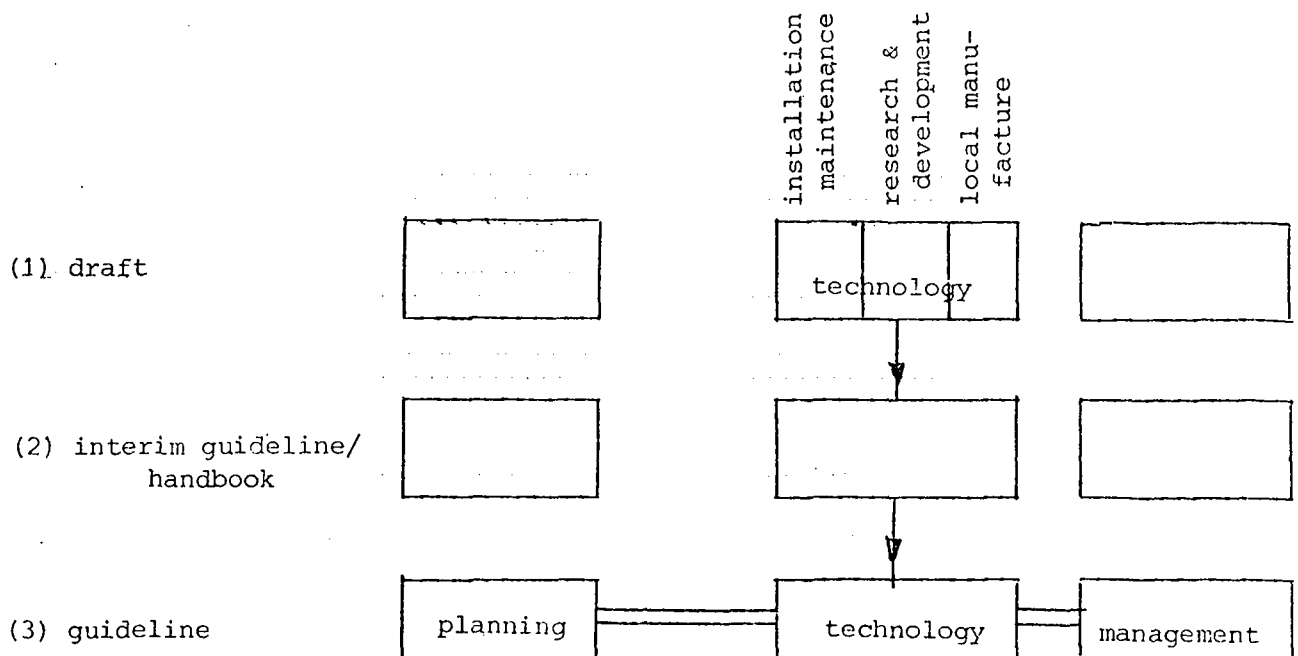
Schematically:

Levels:

Planning

Technology

Management



The working groups are asked

1. to bring the technology part (the present document) from level (1) to level (2)
2. to consider what should be done to bring it to level (3) (e.g. evaluations?)
3. to consider what should be done on the planning side and the management side (e.g. studies?) in order to arrive at an ultimate guideline (or series of guidelines) covering the three mentioned elements.

II. Terms of Reference of Working Groups

- 1) - to thoroughly and critically review the relevant chapter(s) of the draft handbook;
 - to comment on and supplement the chapters relevant to your group;
 - to make their modification in ONE WORKING DOCUMENT (an extra copy especially for this purpose will be made available per group) which will be used for the assemblance of the final document;
- 2) - to consider extension of the handbook into a technical guideline and to report on the conclusions;
 - to note down elements of planning, management and other non-technical aspects that may come up, and that may be discussed in more detail, during the last two days of the week.

INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

DAILY REPORT ON MONDAY, JULY 12

Dr. G.W. Putto, Deputy Director of the National Institute for Water Supply, The Hague, welcomed the participants to the International Workshop on Hand Pumps. Following this, the session was opened by Professor O. Kranendonk, Royal Tropical Institute, Amsterdam. He spoke about the public health aspects of water supply, which must be seen in both a "quantative and qualitative" light. He then mentioned that the access to and proper use of ample water supply by the rural population would give them a new quality of life. He added that engineers and health professionals should consider the social acceptability and the primary or basic services of the rural population. He mentioned that the education of the rural population in health and maintenance would be the means of solving many problems.

Drs. J.M.G. van Damme, Manager, IRC, expressed his ideas on the Hand Pump: it is a simple technology but in need of development. This should be rapid, in order to ensure the successful work-integration. One of the most important things is to build up the infra-structure of water supply and sanitation by such means as training programmes, health education and demonstrations. He concluded that every programme should be self-reliant, well coordinated and make more efficient use of its finances.

Dr. R.C. Ballance, WHO, Geneva mentioned the objectives of UNEP and WHO in supporting the preparation of the Technical Handbook on Hand Pumps. He observed that the project is one of the most useful in rural water and sanitation, as it could increase the percentage of the rural population having access to water supply up to 25% - as mentioned in the Global Target for the end of 1980.

Following the nomination of the Chairman, Mr. Bennell, and the rapporteurs, Mr. Lert and Mr. Henry, Mr. Hofkes of the IRC reviewed the major points raised by organizations that had been invited to comment on the Handbook prepared by Mr. McJunkin. Mr. Hofkes commented that the objective was to improve the handbook, and that the major points raised by organizations which had submitted comments were:

1. the need to develop more effective community participation
2. the need to evaluate, on a systematic basis, hand pumps that were currently in use
3. the need to examine alternative materials, such as PVC which appeared to have considerable potential

Dr. McJunkin, in opening the discussion of his paper, stated that the hand pump situation at this stage posed more questions than answers, but that it was generally considered that the experience with hand pumps in rural water programmes was poor. Dr. McJunkin emphasized that he considered this to be an interim report, to which he expected the comments and contributions of people in the field.

After Dr. McJunkin reviewed his report, a number of participants commented, highlighting the following points:

- A. the failure rate of existing handpumps in some countries was as high as 80%
- B. There is a need:
 1. for a uniform terminology
 2. to explore the application of alternative materials
 3. to develop a technology which combines the factors of minimum cost and complexity with maximum reliability
 4. to examine the social and institutional problems associated with the technological aspects of hand pumps
 5. to explore the relationship of research in the hand pump field to manufacturing technology
 6. to develop a uniform methodology for the research, development and field testing of a new hand pump technology, in order to enable information to be compiled and disseminated on a systematic basis

In order to clarify the terminology for the meeting, Mr. Journey, at the request of the chairman, listed the following terms:

Tubewell

1. screen
2. lower well casing
3. upper well casing

Pump

1. pump stand
2. column (drop) pipe
3. pump rod
4. pump cylinder

The chairman, in summarizing the discussion, observed it was apparent that we would need to develop basic technical options which could be applied to varying sets of situations, and that a document which analyzed the financial, technical and social aspects of rural water technology was needed.

INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

DAILY REPORT ON TUESDAY, JULY 13

Mr. Journey described the pumping concept he was proposing: it utilizes PVC pipe and a piston and check valve which could be manufactured locally.

He mentioned that this concept was already being used in Ghana and Thailand, where it had been developed independently.

It was generally considered that the concept had considerable potential and warranted further field testing and development.

Mr. Emmanuel described the development of the Bangalore pump in India, the details of which are contained in Dr. McJunkin's report.

Mr. Chakravarty, in describing the steps that were taken to develop the pump, emphasized that they associated a manufacturer with the project from the outset. This ensured that the research was conducted in an atmosphere relevant to the conditions which would prevail in a manufacturing process.

The pump will be fieldtested during the next few months.

Mr. Kumar, referring to cost data in a WHO report on the Bangalore pump, mentioned that the prices quoted were considerably below the current prices being quoted by the manufacturer. This raises some basic questions which remain to be answered. He emphasized that there was still considerable work to be done before the pump could be produced on a large scale.

Mr. Abrobah-Cudjoe questioned Mr. Chakravarty as to whether he had conducted

any comparative rate of wear studies on PVC and epoxy cylinders. Mr. Chakravarty said no studies had been made.

Mr. Journey mentioned that his enquiries in 1975 indicated that no PVC rate of wear studies were available.

The rate of wear studies are now being conducted in Germany.

Mr. Fannon described the history of the evolution of the Battelle pump in the context of the Bangladesh rural water programme. He emphasized that cost and availability factors would become more important. He also stressed the importance of local manufacture, in order to ensure the availability of spare parts.



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

DAILY REPORT ON THURSDAY, JULY 15th

The morning session was opened with comments on the McJunkin handbook and the state of the arts regarding hand pumps by each group's chairman.

Chapter four was criticized first, concentrating on the following points:

1. Little importance is given to the financial aspects related to producing a hand pump.
2. The scope of the handbook is not clear.
3. Operation and maintenance procedures are neglected
4. A glossary of terms and definitions should be included in the handbook.

Chapter two and six were covered next, with the following observations:

1. There is a need for financial data, including cost ratios, quoted quantities of materials, man hours, and capital and revenue components.
2. A glossary of terms and definitions should be included.
3. The foundry section is overly emphasized with little mention of alternatives such as fabrication, plastics or assembly only.
4. Many of the drawings are incomplete or incorrect.
5. There needs to be mentioned in greater detail the pump types in current use, e.g. CREALIUS, BANGALORE, SHINYANGA, etc.

Chapters three and five were discussed also:

1. A glossary of terms is needed.
2. Drawings might be more complete, utilizing common nomenclature which is most descriptive of the component.
3. Additional information is needed concerning other types of pumps in use, particularly the chain pump and mono pump types.
4. A force diagram of the handle might be added using typical forces to illustrate the written explanations. It was also felt that typical leverage advantages ranged, in the handbook, from one to three and that more

reasonable numbers might be used in the illustrations.

5. There needs to be an expansion of the discussion on bearings.

Comments by the general audience were heard after each group chairman's critique. The comments, in general, were constructive and well-taken by the participants of the workshop.

Mr. Shawcross gave a presentation on the Bangladesh water programme. The presentation covered data gathered so far and the status of the water programme. Major points made were, as follows:

1. 1,200 deep wells were completed mid 1975
2. 160,000 shallow wells were completed mid 1976
3. 155,000 shallow wells have been started and will be completed mid 1979
4. 5000 deep wells will be completed by mid 1979
5. The overall rural drinking water situation shows 30 percent of the population being served in 1970, 60 percent in 1976, and there will be an estimated 80 percent by 1979 being served.
6. PVC pipe, instead of G.I. pipe, is used decreasing cost of pumps considerably
7. The hand pump used has been modified to where it is fairly reliable
8. Prototypes of new types of hand pumps have been completed (for family use inside of the house)
9. Manual irrigation pumps appear to have quite a bit of potential
10. The rationale for choosing a pump that will be suitable for widespread distribution depends on such things as tradition, existing pumps, cost of wells, cost of pump alternatives, intensity of use, stresses on pump, types of maintenance organization, social attitude of population served, and local production ability.
11. With regular maintenance any reasonable pump design can be kept in operation. However, a well designed pump is more easily maintained than a poorly designed pump.

Mr. C.J. Bonnier made a presentation on Shinyanga shallow wells. After a slide viewing a general discussion was held, concentrating on cost of the pump and well (both total about \$ 1625), environmental aspects, and alternatives available to the use of the Shinyanga well. Practices of maintenance were

questioned and how maintenance could be improved.

An interesting movie was shown by Mr. Robertson, covering the piping of water in Africa. It was obvious from the workshop participants that much was gained from the movie.

The workshop participants were broken into four groups for the remainder of the day. The groups were, as follows:

1. Planning (manpower training, education, selection of suppliers, financial planning, etc.)
2. Management (maintenance organization, wisdom of local manufacturing versus alternative methods such as assembly or importing, extension of programmes, staffing, etc.)
3. Technology (need for further research, field testing, comparative studies, government specifications, etc.)
4. Clearing-house functions (follow-up, information dissemination, glossary of terms, etc.)



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INTERNATIONAL WORKSHOP

ON HANDPUMPS

The Hague, 12-16 July, 1976

COMMENTS ON THE DRAFT GUIDELINES ON HANDPUMPS

received from:

1. Mr. S.B. Watt, National College of Agricultural Engineering, Silsoe, Bedfordshire, U.K., June 1976.
2. Mr. M.G. Beyer, Adviser, UNICEF, New York, May 1976.
3. Mr. R. Phillips, UNICEF Dacca, Bangladesh, June 1976.
4. Mr. A. Abrobah-Cudjoe, Kumasi, Ghana, July 1976.
5. Mr. K. Osei-Poku, Accra, Ghana, July 1976.
6. Mr. D. Donaldson, PAHO/WHO, Washington, July 1976.



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE:

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

SHORT DESCRIPTION:

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executorial)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

DATE OF SUBMITTANCE:



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE: laboratory Evaluation

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

Laboratory evaluation of all pumps possible under controlled conditions for comparison and evaluation

SHORT DESCRIPTION:

a rather permanent laboratory set-up to test hand pumps under various head conditions. All measurements would be the same

TIME REQUIRED:

continuous but low manpower

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

Data internationally distributed

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

DATE OF SUBMITTANCE:



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE: Assistance in formulation of national plan for well/hand pump rural water supply programme

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

The national plan (long term plan) should serve as the basis on which shorter term programmes may be based

SHORT DESCRIPTION:

A guideline on planning will assist national water supply planning authorities in formulation of the national plan.
Where local planning capacity is not available, outside assistance in formulating such a plan may be welcome.

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

PRIORITY INDICATION:

" A "

CODE AND NAME TASK GROUP: Planning - Group 1

DATE OF SUBMITTANCE: 16 July 1976



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER: 2

TITLE: Guideline on drilling procedures or techniques as applicable
to different ground conditions

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To provide information which may be necessary to planners

SHORT DESCRIPTION:

The guidelines should provide information on the most suitable drilling procedures for the various types of ground conditions that may be encountered. Information regarding equipment, accessoires, with inventory of supplies and rough cost will be useful.

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

PRIORITY: B

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

Planning - Group 1

DATE OF SUBMITTANCE:

16th July, 1976



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INTERNATIONAL WORKSHOP ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER: 3

TITLE: Community Involvement (in a hand pump programme)

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To give guidelines on how the communities can be involved and motivated in the installation and maintenance of the hand pumps

SHORT DESCRIPTION:

Study of customs & traditional beliefs
Health Education in formation of committees & local responsibility
in training in maintenance

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

PRIORITY a.

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

Planning - Group 1

DATE OF SUBMITTANCE:

16th July, 1976



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER: 4

TITLE: Existing maintenance systems in so far as it may affect
planning

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

Planning costs will be influenced by the responsibility for pump maintenance

SHORT DESCRIPTION:

A study of maintenance systems & responsibility therefore, in various countries of the regions will be useful. The ultimate goal will be to make the community responsible for this, although at present this is not so in some countries. Community responsibility will relieve the government of this cost and will also ensure higher success of the programme.

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

PRIORITY: B

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

Planning - Group 1
16th July, 1976

DATE OF SUBMITTANCE:



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER: 5

TITLE: Study of manufacturing capacity at Country level

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To access local production of hand pumps and encourage local production

SHORT DESCRIPTION:

Some countries still do not have local production facilities, local production of hand pumps is essential in this programme. Assistance in this direction would be useful, in the form of international or bilateral aid.

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executorial)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

PRIORITY B

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

Planning - Group 1

DATE OF SUBMITTANCE:

16th July, 1976



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER: 1

TITLE: Valve Engineering Approach to Design and Testing of Basic Piston Pump
Components to withstand heavy stress

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

Through valve engineering to improve designs for pump components, including:

1. bearing interfaces (pivots)
2. valves
3. cap seals/cylinder interface
4. fasteners
5. support structures for pump lever system

SHORT DESCRIPTION:

The following steps will be taken to achieve the objective:

1. information gathering
2. analysis and design
3. field and laboratory testing
4. evaluation of testing
5. recommendations for redesign and retesting

TIME REQUIRED:

3 years

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

absolutely; multi.agency, multi discipline approach

PRIORITY INDICATION:

Top, because of inadequate hardware available, as evidenced by failure rate of pumps in field

CODE AND NAME TASK GROUP:

DATE OF SUBMITTANCE: July 16, 1976



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE:

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To bring the workshops information to the hands of those responsible for hand pump installation and maintenance in the field, and where appropriate, to the users.

SHORT DESCRIPTION:

To prepare (pamphlets) handbooks and other instructutive material for low level consumption. This material to be prepared in the recipient country.

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP: **D**

DATE OF SUBMITTANCE:



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE: Standardization of materials and specifications and test methods.

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

Prepare recommended terms and definitions for the equipment, materials, and works for rural handpump water supply systems. Prepare recommended specifications for materials for all components of such systems and dimensions.

SHORT DESCRIPTION:

Compile available information on equipment, materials and facilities being built and utilized.

Select most common technology and component sizes.

Prepare materials specifications using available ones.

Prepare standard methods for testing the hydraulic efficiency, durability and mechanical efficiency of pumping equipment.

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

DATE OF SUBMITTANCE:



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE:

Handpump list — well tested pumps.

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To prepare a short list of tried and tested pumps suitable for the main kinds of situation where handpumps are needed. This might be as follows.

SHORT DESCRIPTION:

Shallow well

Deep well

High Intensity use

Low Intensity use

Domestic use

High Intensity use

Low Intensity use

Domestic use

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

DATE OF SUBMITTANCE:

INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

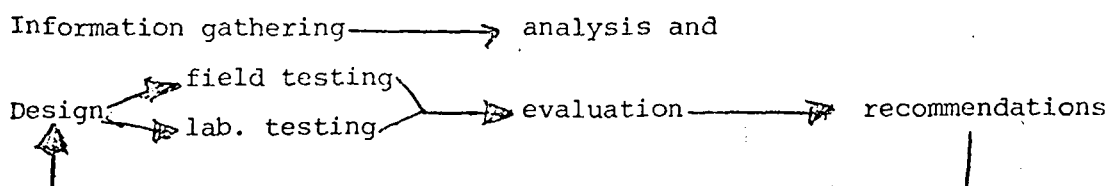
NUMBER: 3

TITLE : Design and Testing of basic piston pump components to withstand heavy stress

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

- A) to improve designs for pump components: 1) bearing interfaces (pivots)
2) valves
3) cap.scale/cylinder interface
- B) to enable standardization of these improved components with respect to:
(1) materials; (2) dimensions; (3) combination of interfaces

SHORT DESCRIPTION:



TIME REQUIRED: Three years

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE : Advisory Maintenance Group

OBJECTIVE OF THE ~~STUDY~~ ACTIVITY:

To get together professionals with experience (executive positions) in rural water supply, to carry out a study on Maintenance organizations, obtain funds, advise the participating countries as to the setting of maintenance organizations and evaluate results.

SHORT DESCRIPTION:

The group will need:

- make a survey
- identify possible types of organizations
- obtain commitments
- supervise progress & evaluate
- and especially ADVISE (Administrative & Technical)

TIME REQUIRED: 1 month - study
1 month - obtaining commitments & initiate
1 year - first step

ASSISTANCE REQUIRED: (financial, executional) :

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

CODE AND NAME TASK GROUP:

INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE : Follow-up Training for Operators "Hand Pump Programme"

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

1. To have a preventive maintenance of the Hand Pump
2. To supervise the operators or personal concern.

SHORT DESCRIPTION:

Training of Operators and Supervisor, Personnel Concern,
Hand Pumps Repair

TIME REQUIRED: 3 years programme

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

Agencies concerns both in central and local government



INTERNATIONAL WORKSHOP
ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE :

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

Comparative study of different types of hand pumps (8) and evaluation of their performance vis-a-vis cost (capitalized value of securing and a period of 2 years + capital cost) in similar situations.

SHORT DESCRIPTION:

i) study of the frequency of failures of different parts and pump as a whole

TIME REQUIRED: 2 years

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

CPHEEO

CODE AND NAME TASK GROUP:



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE :

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To compile information on the present types of organizations at regional and village level that are participating in rural water supply programmes, on the systems of rates and charges and prepare an analytical report from which orientation for future programmes can be taken.

SHORT DESCRIPTION:

Types of organizations at village and regional level
Functions, responsibilities and legal
Systems of rates and charge
Degree of success in collecting rates and charges
Use and application of rates and charges

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

CODE AND NAME TASK GROUP:

INTERNATIONAL WORKSHOP
ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE : The state of the art on Hand Pumps

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To keep available central records, of all available facts pertinent to the user, on handpumps being used for village supply schemes.

SHORT DESCRIPTION:

Series of 3 page documents including

1. name of pump + drawing
2. number in use and comments
3. head, delivery, efficiency
4. cost to an agreed system
5. manufacturing guidelines, materials, labour etc.
6. special points and addresses for further information

TIME REQUIRED:

continuous

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

MAJOR



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE : Directors of Manufacturers of Hand Pumps and its components

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

1. name, address, country
2. list of products, size range
3. special feature, if any
4. cross-reference-product/component
areas/regions where these products have been used

SHORT DESCRIPTION:

TIME REQUIRED: One year

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

CODE AND NAME TASK GROUP: Group D



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE : Bibliography of available literature relating to hand pumps - deep well and shallow well

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

Exhaustive list with full details of the name of author, publisher and year when published

SHORT DESCRIPTION:

Please see above

TIME REQUIRED: One year

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE : Preparation of a Glossary of technical terms and selection of
key words

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

This study will be basis for the development of a data bank

SHORT DESCRIPTION:

TIME REQUIRED: 1 year

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

CODE AND NAME TASK GROUP:

Group D.



INTERNATIONAL WORKSHOP
ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE : Development and technical improvement of a handpump made from pipe and related parts

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

Develop a simple and economical type of pump

SHORT DESCRIPTION:

TIME REQUIRED: 1 year

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE:

Comparative study of different kinds of
rural water supply systems -

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

quantity and quality vs cost
kind of systems and acceptance in
rural population

SHORT DESCRIPTION:

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

DATE OF SUBMITTANCE:



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE:

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To standardize construction and hand-pump installation.
Will require to select the best from several procedures for different
conditions, and to sub-divide them into sub-divisions to fit local
needs to solve the whole problem, as indicated on the plan (see
by the final document)

SHORT DESCRIPTION:

To have a handbook of basic designs and a method of
mixing them to obtain a fitted and very standardized product
with the least cost of engineering in a short time

TIME REQUIRED:

3 months.

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

DATE OF SUBMITTANCE:



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE: TOTAL PROGRAM COSTS

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To obtain and evaluate the total costs of projects and programs to facilitate the planning and execution of water supply programs.

SHORT DESCRIPTION:

Collect data from projects in execution and to include the costs of administration, engineering, construction, supervision, training, health education, dist. service, maintenance, and all other costs related to the program.

TIME REQUIRED:

Number of people served and definition of people served. Summary of basic consumption allowance.

ASSISTANCE REQUIRED: (financial, executional) :

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

DATE OF SUBMITTANCE:



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE:

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

There is much more involved in Rural Water Supply than the installation of a hand-pump. There should be a team aimed at executives in developing countries that will ensure the use of appropriate technology. The problem is to ensure that the use of appropriate technology is an important part of his programmes.

SHORT DESCRIPTION:

- A guideline, brief, in several languages, liaison with
- a) Motivation of the top level executives involved
 - b) Back thinking water within general development
- links with sanitation and housing programs.

TIME REQUIRED:

3 months.

ASSISTANCE REQUIRED:

(financial, executional)

A. less than US\$ 50,000

B. US\$ 50,00 - 100,000

C. US\$ 100,000 - 1.000.000

D. greater than US\$ 1.000.000

Need for a policy that will result in a methodology to give priorities to villages to be served and the bases for it.

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

DATE OF SUBMITTANCE:



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE:

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To assist the countries to work on a rural water supply by installing hand pumps evaluating certain parameters and adjusting in accordance with a procedure to be provided as to which will be agreed first.

SHORT DESCRIPTION:

- 1) Select parameters to be studied in a certain country
- 2) Modify basic procedure to suit the particular country
- 3) To study its application.

TIME REQUIRED:

2 months study and preparation, 1 year first step

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

DATE OF SUBMITTANCE:



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE:

solar energy and rural water supply -

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

*the state of the art and short
descriptions with experiences and plans
where solar energy has been applied*

SHORT DESCRIPTION:

*1. solar energy supply in
rural areas*

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional) :

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

DATE OF SUBMITTANCE:



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE:

LABORATORY EVALUATION

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

LABORATORY EVALUATION OF ALL HAND PUMPS
POSSIBLE UNDER CONTROLLED CONDITIONS
FOR COMPARISON & EVALUATION

SHORT DESCRIPTION:

A ZATHE PERMANENT LABORATORY
SET-UP TO TEST HAND PUMPS UNDER
VARIOUS HAND CONDITIONS, ALL HAND PUMPS
WOULD BE THE SAME

TIME REQUIRED:

CONTINUOUS BUT LOW HHP POWER

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

DATA INTERNATIONALLY DISTRIBUTED

PRIORITY INDICATION:

CODE AND NAME TASK GROUP:

DATE OF SUBMITTANCE:

INTERNATIONAL WORKSHOP
ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE: Assistance in formulation of national plans for
hand/hand-pump rural water supply projects

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

The national plan (long term plan) should serve as the
basis on which shorter term programmes may be developed.

SHORT DESCRIPTION:

A guide line in planning rural water supply
planning activities in formulation of the
national plan.

When some planning capacity is available, external
assistance in formulating such a plan may be required.

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

NEED FOR COORDINATION:

PRIORITY: A

CODE AND NAME TASK GROUP:

PLANNING, - GROUP 1

date of submittance:

16 JULY 1976



INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

2

TITLE :

Guidelines for finding problems & techniques of application
to various ground conditions

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To provide information & techniques for the selection of
pumps -

SHORT DESCRIPTION:

The guidelines should provide information on
the most suitable drilling procedures for the various types of
ground conditions that may be encountered. Information on the
equipment, accessories, costs, maintenance of supplies and safety
will be helpful.

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. - greater than US\$ 1.000.000

Priority : B.

NEED FOR COORDINATION:

CODE AND NAME TASK GROUP:

PLANNING - GROUP 1.

date of submittance:

16 July 1976.

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INTERNATIONAL WORKSHOP
ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

3.

TITLE :

Development of hand pumps
for rural areas in the Netherlands

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To give an idea of the possibilities
for the development of a hand pump
in the Netherlands.

SHORT DESCRIPTION:

Project: Development of a hand pump
for rural areas in the Netherlands.
The project is a study of the possibilities
for the development of a hand pump
in the Netherlands.

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

PRIORITY : A

NEED FOR COORDINATION:

CODE AND NAME TASK GROUP:

PLANNING - GROUP 1

date of submittance:

16 July 1976

INTERNATIONAL WORKSHOP
ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

4

TITLE :

Establishing maintenance systems, as far as it
may affect planning.

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

The Planning costs and the influence of the
for pump maintenance.

SHORT DESCRIPTION:

A study of maintenance systems to be planned and
in various countries of the region will be carried out. The study
you are to make the same as is planned for the future
at present this is not so in some countries. Community representatives

TIME REQUIRED:

will reduce the government of this cost, and will
also ensure higher success of the programme

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

PRIORITY : B

NEED FOR COORDINATION:

CODE AND NAME TASK GROUP:

PLANNING - GROUP 1

date of submittance:

16 JULY 1976.

INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

RECOMMENDATION

for a study, programme or activity

NUMBER:

TITLE :

Study of manufacturing capacity of hand pumps

OBJECTIVE OF THE STUDY, PROGRAMME OR ACTIVITY:

To determine the present and future manufacturing capacity of hand pumps in the Netherlands and to determine the need for additional capacity.

SHORT DESCRIPTION:

Summary: workshop on the use of hand pumps in the Netherlands, with local producers of hand pumps in attendance. The programme is intended to determine the need for additional capacity in the form of international or local aid.

TIME REQUIRED:

ASSISTANCE REQUIRED: (financial, executional)

- A. less than US\$ 50,000
- B. US\$ 50,00 - 100,000
- C. US\$ 100,000 - 1.000.000
- D. greater than US\$ 1.000.000

Priority: B

NEED FOR COORDINATION:

CODE AND NAME TASK GROUP:

PLANNING - GROUP 1

date of submittance:

16 JULY 1976



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

LIST OF RECOMMENDATIONS

No.	Title	Priority	Additional Remarks
1	Value Engineering approach to design and testing of basic piston pump components to withstand heavy stress.		
2			
3	Standardization of materials and specifications and test methods.		
4	Hand pump list - well tested pumps.		
5	Design and testing of basic piston pump components to withstand heavy stress.		
6	Advisory Maintenance Group		
7	Follow-up Training for operators "Hand Pump Programme"		
8			
9			
10	The state of the art on Hand Pumps		
11	Directors of Manufacturers of Hand Pumps and its components.		
12	Bibliography of available literature relating to hand pumps - deepwell and shallow well.		
13	Preparation of a glossary of technical terms and selection of key words.		
14	Development and technical improvement of a handpump made from pipe and related parts		
15	Comparative study of different kinds of rural water supply systems.		
16			



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

LIST OF RECOMMENDATIONS - Continued (-2-)

No.	Title	Priority	Additional Remarks
17.	Total Programme Costs.		
18.			
19.			
20.	Solar energy and rural water supply.		
21.	Laboratory evaluation.		
22.	Assistance in formulation of national plans for well/hand pump rural water supply programme.		
23.	Guideline on drilling procedures and techniques as applicable to different ground conditions.		
24.	Community involvement (in a hand pump programme).		
25.	Existing maintenance systems in so far as it may affect planning.		
26.	Study of manufacturing capacity at country level.		

CHARACTERISTICS SOUGHT FOR HAND PUMPS
FOR
DRINKING WATER SUPPLIES IN DEVELOPING COUNTRIES

* * * * *

LOW COST

CAPITAL COST

OPERATING AND MAINTENANCE COST

LOW POWER REQUIREMENT

SIMPLE TECHNOLOGY

LOW SPEED

BEARING, SEALS, PIVOTS, GEARS, CONNECTORS, ETC.

COMPATIBLE WITH USERS

LOCAL MAINTENANCE AND REPAIR

RESISTANT TO VANDALISM AND PILFERAGE

LOCAL MANUFACTURE

COMPATIBLE WITH LOCAL SKILLS, MATERIALS, AND OTHER RESOURCES

LOCAL CURRENCIES, LOWER TRANSPORT COSTS

STIMULATE LOCAL INDUSTRY

LOCAL EMPLOYMENT

LOCAL AVAILABILITY OF REPLACEMENT PARTS

SANITARY

RELIABLE

DURABLE

USER ACCEPTANCE

LOCAL CUSTOMS

ANTHROPOMETRICS

ERGOMETRICS

STANDARD PRACTICES

ECONOMIES OF SCALE

MAINTENANCE

PARTS AVAILABILITY AND STORAGE

TRAINING

COMPARISON OF PUMPS

VERSATILITY

SHALLOW WELL OR DEEP WELL

SMALL OR LARGE DIAMETER WELLS

FORCE PUMP

OTHER PRIME MOVERS

INTERNATIONAL WORKSHOP
ON HAND PUMPS

The Hague, 12-16 July 1976

REPORT WORKING GROUP I

Comments on Chapter 4, "Guidelines on Hand Pumps", by F.E. McJunkin.

It is the feeling of Working Group I, that the scope of the draft handbook is not very clear, so that we had to make assumptions as to our starting point. We think that a handbook of this type should deal with the subject in a very orderly way, and should be very practical if it is to be useful to planners and executive engineers in developing countries.

In order to complement what is missing, we wrote the subtitles of what we think should be dealt with in the chapter. We have omitted those paragraphs dealing with theory, and have tried to include some of a practical nature. There were examples of what should not be done, and some confusing paragraphs which we have disregarded. We strongly feel that the new subtitles cover in a greater depth the subject of installation, operation and management. Although an attempt was made to cover the subject in accordance with the new guideline, much work is still to be done, specially on operation and maintenance procedures.

Little importance is given to the financial aspect and to the motivation, education, and participation of the community.

A glossary of terms and definitions should be included as an annex of the handbook.

15 July, 1976



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

REPORT OF WORKING GROUP II - TECHNOLOGY, RESEARCH AND DEVELOPMENT

INTRODUCTION

As part of the International Workshop on Hand Pumps, small groups were formed to consider further certain portions of Guidelines on Hand Pumps, by Dr. F.E. McJunkin. Consideration at this time is to be given only to a review of the report. Those participating in this study are:

Mr. Abrobah-Cudjoe
Prof. de Azevedo Nettp
Dr. Ballance
Mr. Emmanuel
Mr. Fannon

Mr. Henry
Mr. Jagtiani
Mr. Journey

CONCLUSIONS OF THE REVIEW

TECHNOLOGY

It is the conclusion of the group that the technology, research and development sections of this report were well done, considering the time allowed for information gathering, organization of data and the actual composition of the report, as well as the multitude of material to be covered. However, it was the opinion of the group that improvements should be made in order that the

sections might be more useable by their readers.

RESULTS OF THE REVIEW

It is not intended that this brief report contain all of the suggestions made, but only a discussion of the more important thoughts of the group to make the information more complete, correct and clear to the readers.

GLOSSARY

It is suggested that a glossary of terms be added to help clarify many of the terms that are used in the various areas in discussing hand pump technology.

DRAWINGS

In addition to the glossary, those drawings with some call outs might be more complete utilizing common nomenclature and which is most descriptive of the component.

ADDITIONAL PUMP DATA

Although some information is given regarding various kinds or types of pumps, the technology section is quite reciprocating pump oriented. It is therefore recommended that additional information of similar content be added, concerning other types of pumps in use, and particularly the chain pump and mono pump types. This information is readily available and those having this information have been asked to give it to Dr. McJunkin or Dr. R. Ballance for eventual inclusion in the section.

COMPUTATION DATA

Computation for common hand pumps of the reciprocating type seem quite complete; however, a force diagram of the handle might be added using typical forces to illustrate the written explanations. It was also felt that typical leverage advantages ranged from 1 to 3 and that more reasonable numbers might be used in the illustrations.

BEARING DISCUSSION

Because bearing are such a critical component, it was believed that the bearing discussion could be expanded a bit to include importance of low unit pressure leaving, protected area importance of difference in hardness of adjacent parts for relative motion, types of bearings with relative costs, advantages and disadvantages.

VALVE DISCUSSION

Valves are discussed in two areas. Although it is pertinent to call out these important components in the sequence that they are with, perhaps their funtions, the main discussion of valves, types, etc. would be better in a separate section.

SECTION 3.17

It is the opinion of the group that section 3.17 should be deleted entirely and placed in section on installation, operation and maintenance.

RESEARCH AND DEVELOPMENT

This section is quite dependent upon those in charge of R & D programmes to be correct and complete in their reporting. A cursory review of programme presented showed that information not available here-to-fore or increased clarity could be obtained if up-dating is permissable. Authors or knowledgeable persons were informed that additional data or changes (that could be substantiated) would be accepted through the meeting time and Dr. McJunkin could be contacted for consultation.

There were numerous minor changes, not worthy of discussion in this report, but were recorded in the master copy for further editing.

It also seemed advisable that meaningful information regarding research and development costs, man hours expended and calendar time consumed would be helpful for those readers anticipating similar programmes.

This review was a pleasure and we look forward to further developments.

Respectfully submitted
for Committee II
Robert D. Fannon, Jr.
Chairman



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July 1976

GROUP 3 - MANUFACTURING - Chairman: Dr. Chakravarty

Covered chapters 2 and 6, also Appendix L/1 and Annex A

Points for Guidelines and for Group Discussion

1. We would like to see chapter 2 "Types of pumps" developed chronologically with the dependence of pump development on available materials technology emphasized; perhaps as a separate section.
2. The introduction, for a potential user, could lay more stress on the choices and decisions open to him.
3. The entire foundry section could become an Appendix.
4. We strongly felt the need for full reporting on pump types in current use, e.g. CREALIUS, BANGALORE, SHINYANGA, etc. giving fullest details of numbers in use, field experience, maintenance and cost. This could be a separate section, as we were unsure whether it came in Chapter 5 or Chapter 6. Possibly this reference information, in loose leaf form, could be kept up-to-date by WHO/IRC. The form is important as it would give common ground for pump testing programmes, reporting and comparison.
5. We have not reached conclusions on cost analysis. A value Engineering approach, each on in a project would be beneficial. Cost ratios, quoted quantities of materials, man hours, capital and revenue components could all be more helpful than total cost figures in these inflationary times.
6. The section on Manufacturers literature should be discussed in more detail with the aim of WHO holding a full, categorized directory.
7. Likewise to (6) on published work on hand pumps.

from M. S.B. Watt

Some comments on the Interim Report -

"Guide Lines on Hand Pumps....." by F.E. McJunkin

Prepared for the WHO. IRC. CWS

1. The report rightly emphasises that the "hand pump is a small technological instrument in a large sociological system", and this is shown centred around the users in the diagram in Fig. 1-2. However, the various aspects of this broader view described in the report are limited almost entirely to the use of the water lifting equipment. The choice of water well construction technique and the programmes to carry these out, have been overlooked. Water pumps, and the strategies and programmes to organise their maintenance, are only a small part of the total cost of improving water supplies in either rural or urban areas.

You know that we have prepared a manual on well digging. During the course of preparing this publication, I have become enlightened as to the scope and potential of this technique in comparison with surface constructed, small diameter wells. Running construction programmes is cheaper per metre of constructed well because of the fewer skills involved; there is much greater scope for a multiple use of equipment in integrated programmes building toilets, water tanks, grain bins etc., which all use cement and steel reinforcement; the choice of pumping equipment is correspondingly larger with the larger diameter of hand dug wells. Hand dug wells cannot, of course, be used in areas of deep water table (greater than 50m from the surface).

This seems to me one of the most serious omissions from the report.

My notes will add to this - to be sent next week.

2. The assumption that "appropriate, intermediate low cost..... technologies" are concerned primarily with locally produced, low life equipment is incorrect. Surely the reason for the current interest in hand pumps is because the pumps in use now are inappropriate?. Any approach which improves water supplies in a more positive way is surely to be called 'appropriate'. The error in this thinking is important because it relegates the critique of 'appropriateness' to hardware, whereas the criteria are much more profound than this. Pacey's contribution outlines this difference clearly, taking the social goals as the starting point. Well pump programmes then become part of either short term 'welfare' or longer term 'development'.

Schumacher has caused widespread confusion with his hazy distinction between the social, economic, and purely physical aspects of the term 'intermediate technology'. The report makes 'appropriate technology' a noun, whereas it is surely a critique of doing and describing doing, i.e. a verb or adverb.

3. *agreed!* The report is an interim one, and the final document will doubtless be revised. Who is it aimed at? Development workers will be confused by the hydraulic equations, for instance, which complicate the matter. If these have been included to make the simple positive displacement pump respectable to highly trained engineers, then this should be clearly stated in order not to discourage practical artisans, or non technical administrators.

One general comment for the revised report is that it should be considerably simplified, more in line with the N.A.S. type publications, for instance. Leave the complex stuff out, or publish it as a supplement.

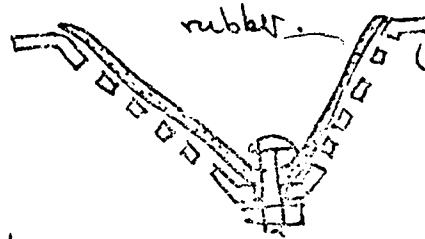
4. The classification of well pumps is confusing. The report starts out by concentrating on the piston type pump, then includes later sections on other types of pumps. It is clear that this former pump has and probably will constitute the most common type for water wells, but it narrows the field too early in the report. The publication would be better to start out with the name - 'Water Well Pumps', and from this stand point develop the obvious case for the piston pump. It is essential that the 'systems approach' be kept open and fluid so that equipment of whatever sort is seen as only one contribution to the system. Concentrating on piston type pumps closes the openings right from the start. This comment is related to my first comment.

5. The health aspects in Section 1-1 could be expanded to emphasise the health benefits from increased volume of water use. Lifting adequate amounts of washing water from a well is laborious even with the best of equipment.

6. Cast iron pumps manufactured in small foundries are given prominence. This overlooks the much more widely distributed skills of the blacksmith.

There is surely a strong case for batch production of pumps using good quality centrally produced steel worked by tools, by either hand forging or even welding. Repairing a poor quality cast iron pump is difficult, whereas repairing a pump made from locally forged parts is relatively easy. (It is not reasonable, of course, to expect to construct pipes by forging or welding). The 'Jalna' type pump can surely be made from welded or hand forged parts more easily than it can be cast.

7. A technical point. The foot and plunger valves may well be improved by using the high strength non-return conical valves at present being developed for the Water Supply Industry. These will initially be more expensive than the ball valves, but will have a much longer life.



Max working head 400 m.
Cost, \$12 for a 10cm ϕ valve.

K Sachin

S B Wadh.

23/June/76.

COMMENTS ON "GUIDELINES ON HAND PUMPS"
BY DR. A. ANIBRAH-JUDICE

GENERAL:

The draft report on "Guidelines on Hand Pumps" is very comprehensive and well-prepared. It is evident that a lot of effort has gone into it. The report in its final form is bound to be a useful companion to both designers, users and other bodies associated with hand pumps.

It is my feeling that chapter 6 on the local manufacture of hand pumps should not limit the manufacturing methods to casting only. Observations similar to casting could be made ^{for} welding. In my environment and certainly in some other countries it may be worthwhile on account of the availability of facilities and the requisite skills to resort to welding as a feasible production method. We at the University of Science & Technology, Kumasi, Ghana, have been able to produce satisfactorily welded pump bodies.

OBSERVATIONS:

- (i) Typographical mistakes: A number of typographical mistakes appear in the pages. These can be readily spotted out and corrected.
- (ii) System of Units: A dual system of Units metric and imperial appears to be used, but not consistently followed throughout the report.
- (iii) Title: The title of the report could be "HAND PUMPS for use in ~~developing~~ ^{developing} water supplies"
Should it be limited to developing countries only?

The following are comments on some specific pages:

COMMENT

<u>Page</u>	<u>Line</u>	
5	12	The statement does not apply to the developing countries only.
2-3	(1)	"..... a part of..... pipe" should read " <u>pressure on the surface of the water is reduced</u> "
	(3)	(a) The weight of the priming water counts here. Hence modify second sentence thus: " <u>When the pressure.....plunger, plus the weight of the valve and of the priming water, the air....</u> " (b) There should be a statement to the effect that at the bottom of the stroke the plunger valve closes.
3-3		Equation 3-3 and 3-4 may also read like $F \leq RM \text{ and } H \leq \frac{4RM}{D^2}$
3-7		The fulcrum must be identified in Fig. 3-4 and the missing arrows supplied.
3-8		There are missing arrows in Fig. 3-5
3-10	3	Failure, as described, results from <u>bonding</u> .

<u>Page</u>	<u>Line</u>	
3-16	last	Reference to "Bicket" in this sentence is not clear.
3-17	12	Reference be rather made to fig. 3-7 on line 9
4-2		The sections may be identified with different letters.
6-1	25	Gray iron foundries may be <u>ubiquitous</u> in Asia but not throughout the whole of the developing countries.
6-2		Reproduction of Fig. 6-7 poor; it is difficult to read.

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HOUSE NO. 150/B, ROAD NO. 13/1, DHANIMONDI R. A. DACCA

4 June 1976

Ref.BDMISC/56/308

Drs J.M.G. van Damme

Guidelines on Handpumps

Dear Drs van Damme:

I have had a chance to go through the guidelines, while waiting for fresh prints of the drawings. I think that most of my observations are already covered by my papers, so I have very little to add here.

The guideline goes a long way in bringing handpump technology from an art to a science. It certainly seems to be comprehensive. The only question I would raise is regarding its distribution.

I would wonder if limited distribution might be preferable to a more universal one. So many models and ideas are discussed that it might confuse someone not fully involved with handpump technology.

Also, much of the applied work at field level has only been done in the past 4-5 years. Much of the results of this work are only just now finding extensive application.

A guideline is intended to guide. But the present draft presents many options, but few conclusions. Publication of a formal guideline might wait until the options have been field tested extensively enough to warrant some firm conclusions.

Some of the work is still in a rather unconsolidated form. Perhaps within 2-3 years, a great deal of the work will have reached a more advanced stage. I wonder then if it might be worth considering issuing this guideline as an interim report, with a full guideline to be published in a few years.

....2/

My other general observation is that the most productive benefit per cost ratio in promoting handpump technology from now on would be at field level. Money would be well spent employing technicians and researchers at field level to evaluate designs now in use, and put to wider test ideas yet in the prototype stage.

In addition to these general suggestions, I can offer the following detailed comments on the text.

- Bangladesh
1. UNICEF programme commitments for new no.6 handpumps total about 300,000 units, to be installed between 1972-1978/79.
 2. The human engineering aspect is quite important. We may reconsider a slightly curved handle, rather than straight, if it is found that a curved handle is easier to pump, especially for women and childrens.
 3. Page 3-11, Para 3.5

We have not yet tried flame hardening, but have asked some of the suppliers about it. The one apprehension expressed was that of stresses in the iron resulting from heating one section of the part more than another. This is beyond my competence, but perhaps the point could be raised at the workshop.

4. Page 3-13 Para 3.10

We are now trying various plunger designs based on one or two discs, with and without flapper valves. It is too early to decide on this. Hopefully however, eliminating the poppet valve and a number of the machining operations will reduce first cost as well as working better and lasting longer.

5. Page 3-13 Para 3.11

We have not yet substituted PVC for leather as a check valve material. Early samples did not keep a good seal overnight. We are now trying some softer PVC check valves, which may work.

We are also trying various configurations and degrees of softness for the PVC bucket to see if we can optimize performance.

6. Page 3-15 Para 3.12

PVC cups are currently costing less than two Taka each compared to four for a good quality leather cup. (16 Taka= 1 \$ US.) That is about \$ 0.12 each. (W.P.V.C.)

7. Page 5-4 Para 5.2.3

The Battelle deep well pump with sliding block design was tested in Bangladesh. In about 3 months the block wore a 2" hole in the slide. The assembly was dismembered and sent back to Battelle via UNICEF HQ.

8. Page 5-22 Para 5.5

A report on the development of the handpumps in Bangladesh from 1972-76 is enclosed.

9. Page 5-23 Para 5.5.1 (3)

Piston rod utilizes jam nut only at plunger end. The Battelle "rod end" casting was replaced by a forged mild steel head, which eliminated a lot of practical maintenance and operation problems. This is indicated in the enclosed drawings.

10. Page 5-25 Para 5.5.3

The length of steel pipe used to join the handpump to the PVC pipe is 20'. Also we are now switching from threaded joint PVC pipe to solvent joint, the latter having thinner wall section, thereby resulting in considerable economies. Sekisui is providing the solvent cement in specially designed 50 gm "tooth paste tubes" at our request.

11. Page 5-31 Para 5.7.1

"Many of the ideas incorporated in the Bangladesh pump described earlier." should read Bangalore pump.

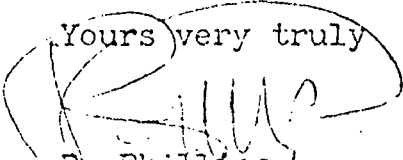
12. Page 5-36 Para 5.7.4

We are using a Dempster PVC cylinder for our deep well pumps. Results so far are good. Price is considerably cheaper than brass. We tested three for about a year and are now getting ready to instal 500.

- (4) -

I hope these comments will be useful, and once again wish you the very best for the workshop.

Yours very truly


R. Phillips

Dy. Water Programme Manager
UNICEF, Dacca.

cc: Mr. Martin Beyer, UNICEF, NYHQ
Mr. H.J.Lotje, UNICEF, NYHQ
Mr. A. Robinson, UNICEF, NYHQ

cc: Messrs. J.F.Shawcross/John D. Skoda
UNICEF, Dacca.

RP/pq



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EPC/AMRO-2172/28/2

6 July 1976

Drs. J. M. G. van Damme
WHO International Reference Centre
for Community Water Supply
Nw. Havenstraat 6
Voorburg (The Hague)
The Netherlands

Dear Hans:

In reply to your letter (Ref.10.178/May 11, 1976) on hand pumps, I just want to let you know that I have been in contact with Professor McJunkin and have discussed at length my ideas on the Hand Pumps document.

It is good as far as it goes. It is a state of the art document. Now what we have to do is the hard work of rethinking the problem. What we need is a pump that is:

1. Inexpensive to make (US\$20 to US\$30)
2. Requires $\pm$ 0.1 horsepower to operate
3. Has a minimum of moving parts
4. Is easy to operate and maintain
5. Can be repaired locally
6. Easy to replace
7. All bearings will be of the low pressure type and could be made of oil soaked wood.

This is a tall order but, I am sure the participants at the meeting will have some ideas.

16 July, 1976

EXPERIMENTATION AND PERFECTIONING OF THE VERGNET PUMP

by G. Garara (Upper Volta)

1. Introduction

The CIEH has since long undertaken studies on exploration conditions of underground waters in tropical Africa sedimentary formations, eruptive and metamorphic and such.

The main conclusion drawn from these studies has confirmed that drilling constituted a more rational means than wells for the exploitation of cristalline formation water resources. Indeed, their discharge is greater and costs are lower when large numbers are required.

Therefore one may say that the mastery of manual pumping is the key to the generalisation of exploitation by (means of) drilling, that is to say the condition for a satisfying water supply (quantity as well as quality) to villages in the cristalline substratum areas.

In Western Africa and in CIEH member countries, tens of thousands of villages are concerned with this problem. Unfortunately, pumping equipment used until today are rapidly and often out of order (rapidly and often suffer from breakdowns), which implies considerably maintenance costs for these countries that they are sometimes not able to assume.

2. Experimentation of the hand pumps

It is in this light that the CIEH has undertaken, since 1974, the field experimentation of several types of hand pumps. More than 30 pumps are actually installed in the Koupela area, 140 km east of Ouagadougou. These pumps are attended by a CIEH engineer and are of several makes (ABI-ROYAL, Bodin, Godwin, Brian, Uganda, Vergnet, ...)

The experimentation carried out by the CIEH has been possible thanks to the help of WHO Geneva and UNICEF

After two years of experimentation under field conditions of several types of hand pumps, the causes of the most frequent breakdowns have been found, they always occur at the control rod, the ascles, the piston pegs and rings. At the same time, Mr. Vergnet, then in Upper Volta, has completed, together with Mr. Benamour, engineer at CIEH, a new sort of pump we think should be more robust than any other equipment used until now.

The pump in question has hydraulic control, is completely made of PVC where underground parts are concerned. Control is achieved by means of a pedal moving in a vertical direction, there is therefore no problem of levers, ascles or pegs. All above-ground parts are made of rustproof steel. This pump has been created so as to confirm to usage imperatives under African conditions.

2.1 Financial imperatives

- construction costs; the simplicity of the construction and the use of plastics should, when produced in large quantities, the price which is 80.000 francs CFA (1.600 FF) at the moment.
- transport costs weight and space being produced (20 to 30 kg), packing will be easier and transport cheaper
- installation costs a quarter of an hour is sufficient for two persons to install the pump on a well or a drilling hole, and this without any heavy equipment
- maintenance costs: maintenance on the spot, at its most uncertain under African conditions, has been suppressed, there is no oiling or adjusting to be done. There are no friction parts inside the well, breakdown risks are reduced to the pedal joint. The new type of joint adapted to the new series of Vergnet pump allows the assumption that breakdown risks will be non-existent.

2.2 Usage imperatives

- This pumps is adapted to water pumping at all depths (0 to 50 m.) with discharges equal or superior to that of existing pumps
- The great use of plastics suppresses corrosion and disadvantages.
- The hydraulic control allows installation of the surface element at a distance from the exploitation point, which permits an efficient closure of the drilling or the well and avoids direct pollution of the underground water.
- The pump is adaptable to every type of drive: engine, wind mill, solar pumps. Mechanization attempts are being made on the Vergnet pump by the CIEH in Senegal. Mechanization of this pump will give discharges of approximately 3-4 m³/h. for pastoral and small irrigation uses.

3. Functioning

The pump comprises:

- a hydraulic press with simple effect (cilinder-piston entity)
- a control canalization
- a driving back canalization
- an immersed lower body made of rigid enclosure inside which a suction valve and a driving back valve lead the water to where it is used.

When the driving fluid is pushed back by the piston into the elastic chamber, the latter expands and pushes the water from the rigid cilinder through the driving back valve. Throughout the extension valve remains closed.

When the force exerted on the piston stops, the eleastic chamber restracts, and drives the fluid it contains into the cilinder, and forces the piston automatically back into its upper position.

The contraction of the elastic chamber causes the inspiration of the water from the well or the drilling hole into the rigid enclosure, the driving back valve being kept closed throughout the inspiration phase.

3.1. Automatic starting device

The pump being immerged, the water pressure causes the valves to open, and at first the rigid enclosure and the driving back canalization to be filled to its statical height. Secondly, the elastic chamber will be filled as well as the control canalization by means of the restarting valve.

Then the piston is set in action, the air - although compressible - will cause a slight extension of the elastic enclosure and a certain amount of water is driven back into the driving back pipe. This water, when the piston is in its upper position and the orifice is free (the air can thus escape) goes through the restarting valves and fills the primary circuit.

The volume becoming smaller in the control circuit, the piston action becomes more and more efficient and a few pedal strokes will fill the control circuit. The pump is then ready to function.

3.2. Automatic purge

If air enters the control circuit, the secondary circuit water under slight pressure will pass through the restarting valve and will thus purge the circuit, the air being able to escape through the aperture made in the upper part of the cylinder.

This slight pressure is obtained by making the driving back canalization let out above the control cylinder.

The originality of this pump lies in the fact that the return to the initial stage of the control circuit and the inspiration is achieved automatically by means of the elastic chamber retraction. Indeed, when all action on the piston ceases, the latter will return to its higher position without any external intervention, the energy needed for the piston to go up again having been accumulated during the active extension phase.

Furthermore, let it be mentioned that the user of the pump makes use of his own weight to set the piston in action, he only needs to climb on the pedal, to let himself drop and to raise the handle to make the piston return. The movement made equals that made when going up the stairs.

3.3. Construction details

Plastics are ample used, the main part of the pump being made of PVC, the control and driving back canalizations are of supply high density polyethylene. The valves are plastic, only the cylinder and the piston control rod are metallic (rust proof steel and brass).

3.4 Experimentation of the Vergnet water pump

Since July 1974, this pump is being tested in the villages and results therefrom have made it possible to perfect the construction of certain parts, such as the control pedal conductor, the piston and the valve box of the inferior body.

One may assert at this point that this pump is not adapted to real usage conditions and that it is in a position to fulfill its expectations: no maintenance, great reliability, discharge comparable with that of actual pumps. Indeed, one can achieve $1,5 \text{ m}^3/\text{h.}$ at 7 m and $1,2 \text{ m}^3/\text{h.}$ at 20 m.

It is expected that these performances will be improved on and that higher discharges will be achieved by the optimization of the components: piston diameter, characteristics of the elastic mantle.

Comments on the Draft Guidelines on Hand Pumps by Mr. E. McJunkin

From: M. G. Beyer, Adviser
Drinking Water Programmes
UNICEF Headquarters

New York, 19 May 1976

oOo

- Page 2-1: It would be worthwhile putting up the book "De Re Metallica" in the literature reference, preferably the English translation by Herbert Hoover. Even if most of the pumps shown there were for the drawing of mines, they are nice examples of appropriate technology of their time.
- Page 2-7: No mention has been made of the screw pumps ("Mono pumps"). In my rapid reading I may have missed out on that one somewhere. Although they are quite overpriced, they constitute quite a successful construction.
- Page 4-2: The examples shown for hand pump installations for wells and infiltration galleries possibly might be supplemented for sake of completeness with filter screen wells and open drilled wells in hard bedrock with proper sealing indicated on possible drawings.
- Page 4-5 and following: To the chapter on operation and maintenance, elaborate these and quote some of the relevant literature in the text as well, including Pisharoti's Guidelines (already included in the bibliography) and possibly White's book "Drawers of Waters".
- Page 5-6: In the figure of the Battelle pump as well as in some of the other reproductions of pump drawings, a clear indication of the scales in millimeters or inches would be helpful.
- Page 5-28: For the Vergnet pump, the text speaks of a "control hose". Is this the same as the "pilot pipe" in the drawing?
- Page 5-31: As you probably know, there still are certain restraints to the Vergnet pump, which presently the inventors and the manufacturers are trying to eliminate. An additional difficulty might be too great a degree of flexibility in the plastics hoses, absorbing some of the water volume that should go into the diaphragmatic hose on the downstroke of the pedal. The "rigid cylinder" on the figure probably should read "rigid".
- Page 5-35: The most recent development on the "Petro" pump makes it now possible to include more detailed material and illustrations of this particular type. The name of "Persson pump" is no longer used.



WS/148/76

- Page 5-36: Mention should also be made of the pump developed by Tim Journey with his use of a pendulum to facilitate the human traction. The World Bank certainly can provide data through its Rural Development Division or through Mr. J. Kalbermatten.
- Page 6-16: The rack and pinion principle of the pump head of the Korat pump from Thailand would be worthwhile mentioning, including possibly a drawing.
- Page 6-14: As to the reference on the Journey pump here, I suggest you better check with the World Bank (see also page 5-36).
- Bib-6: Now you could also include reference to the new bulletin by the IBRD: World Bank. Village Water Supply. A World Bank Paper. World Bank, Washington, D.C., 96 pp. March 1976.
- Bib-11: Mr. Unakul, to whom reference has been made in several places, I believe spells his name with a u at the end, not an e.
- Bib-12: Although the book does not concerns specifically with pumps it might be worthwhile to include White, Bradley and White, Drawers of Water, in the bibliography.

An index also would be very helpful for rapid reference.

In addition to the above after further consultation with our Supply Division, the following general aspects of commercial hand pumps might be elucidated more in detail.

- 1) closed vs. open top cylinder, the latter being much more expensive.
- 2) smoothness of the interior of the pump cylinder, machining or brass lining etc.
- 3) more details on cups of different materials.



who international reference centre for community water supply

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INTERNATIONAL WORKSHOP ON HAND PUMPS

The Hague, 12-16 July 1976

UNICEF - BANGLADESH WATER PROGRAMMES

OUTLINE NOTES FOR PRESENTATION

By J. F. Shawcross, July 15, 1976

Introduction: Unusual programme. Unusual situation.

1. Evolution of a partnership - WHO mid 50"s; USAID early 1960's; UNICEF from mid 1960's; massive expansion from 1971. (Govt; UNICEF; WHO).
2. UNICEF water programmes with Directorate of Public Health Engineering (D. P. H. E.)
 - a. 1,200 "Deep" wells - completed mid 1975.
 - b. 160,000 Shallow wells - completed mid 1976.
 - c. 155,000 Shallow wells - just started, complete mid 1979.
 - d. 5,000 Deep wells - 500 completed, overall completion mid 1979.
 - e. School wells, fringe area town wells, Non-government organization wells - approximately 50,000 to be completed mid 1979.
3. UNICEF manual irrigation water programmes with Integrated Rural Development Programme (I. R. D. P.)
 - a. 10,000 Shallow irrigation wells - completed May 1976.
 - b. Research development and extension project - to finish mid 1979.
 - c. 50,000 Shallow irrigation wells - complete May 1978.
4. Overall rural drinking water situation (Public and private wells).
 - 1970 - 400,000 wells - 30 percent of population served
 - 1976 - 600,000 wells - 60 percent of population served
 - est. 1979 - 800,000 wells - 80 percent of population served.
5. Bibliography - UNICEF Interregional Water Workshop - Dacca May 1976 and other reports.
 - a. Shallow handpumps design - Summary - Phillips - Circulated.
 - b. Handpumps in Bangladesh 1972-76 - Phillips - Circulated.
 - c. Outline of Choices associated with Handpump tubewells programme and handpump design - Phillips - Circulated.
 - d. New No. 6 pump drawings - Available UNICEF Dacca.
 - e. Bangladesh Programme - Summary of Developments 1972-76 - Shawcross - UNICEF Dacca.

- f. Use of PVC Casing Pipe and PVC well screen in Bangladesh 1½ inch diameter tubewells - Shawcross - UNICEF Dacca.
- g. Specifications for 1½ inch diameter tubewell PVC materials - Shawcross - UNICEF Dacca.
- h. Documents for local procurement of cast-iron handpumps - Shawcross/Phillips - UNICEF Dacca.
- i. Observations on UNICEF's experience with Battelle Pump Design in Bangladesh 1972-75 - Phillips - UNICEF Dacca.
- j. H. P. T. W. in Bangladesh, Distribution and Use February 1976 - Shawcross - UNICEF Dacca.
- k. Bangladesh Micro irrigation for Family Food Production - Griffith/Karim - UNICEF Dacca.

Copies of the above may be obtained from Dr. John Skoda, Chief Water Section, P. O. Box 58, Dacca, Bangladesh. One copy of each is available for inspection with John Shawcross.

- 6. Slides and photos.
- 7. Research works (relevant to The Hague International Workshop).

	<u>Status</u>
a. Redesign of Shallow and Deep well based on PVC materials based on thin wall solvent cement PVC pipe	Completed
b. New No. 6 pump and components	Intermediate completion
c. New No. 4 pump and components	Intermediate completion
d. New No. 2 pump components and well	Prototype made under testing
e. Manual irrigation pump selection and development	Various model under preliminary review
f. Testing PVC (Dempster) deep set well pump cylinder - testing Sholapur - well head	Satisfactory after one year - tests in progress.
g. Joint UNICEF/WHO Survey effects of tubewells on health - nationwide survey.	Details under discussion implementation WHO Smallpox team September 1976
h. PVC bucket (cup) comparisons	In progress.

8. Rationale of pump selection (Refer Phillips report).
 - a. Factors to be considered: - Tradition; existing pumps; cost of well; cost of pump alternatives; intensity of use; stresses on pump; type of maintenance organization; social attitude of population served; local production ability.
 - b. Actual sequence of events - drawings last.
 - c. Objectives - Keep largest number of people with steady water supply at least cost; make pump most suitable to obtain this objective the naturally accepted pump.
 - d. Programme 50,000 wells per year - total 350,000 Govt. wells. Then:
 - (a) save \$5 per well = Save \$250,000 per year.
 - (b) increase percent in operation by 10% = 9 months construction value = \$3.5 million
 - (c) decrease well life 5 years (say normal 15 years) lose 1/3 investment = lose \$1.5 million per year.
 - e. Construction demands - Intermediate solution essentially unable to wait for perfect pump - go as far as possible in time but remaining conservative - then freeze into production runs.
9. Maintenance and design of pump - More important than pump design. With regular maintenance any reasonable pump design will be kept in operation. Pump design can help by: -
 - a. Reducing frequency of repair.
 - b. Making repairs easier for Gov't. and private mechanic.
 - c. Reducing number of spares needed.
 - d. Spare available locally due to standard design.
10. Effect of ownership - extremes. The more remote the ownership generally the longer the interval between maintenance visits and therefore the more expensive the pump needed.



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INTERNATIONAL WORKSHOP

ON HAND PUMPS

The Hague, 12-16 July, 1976

Background Documents

Nr. Title/Source

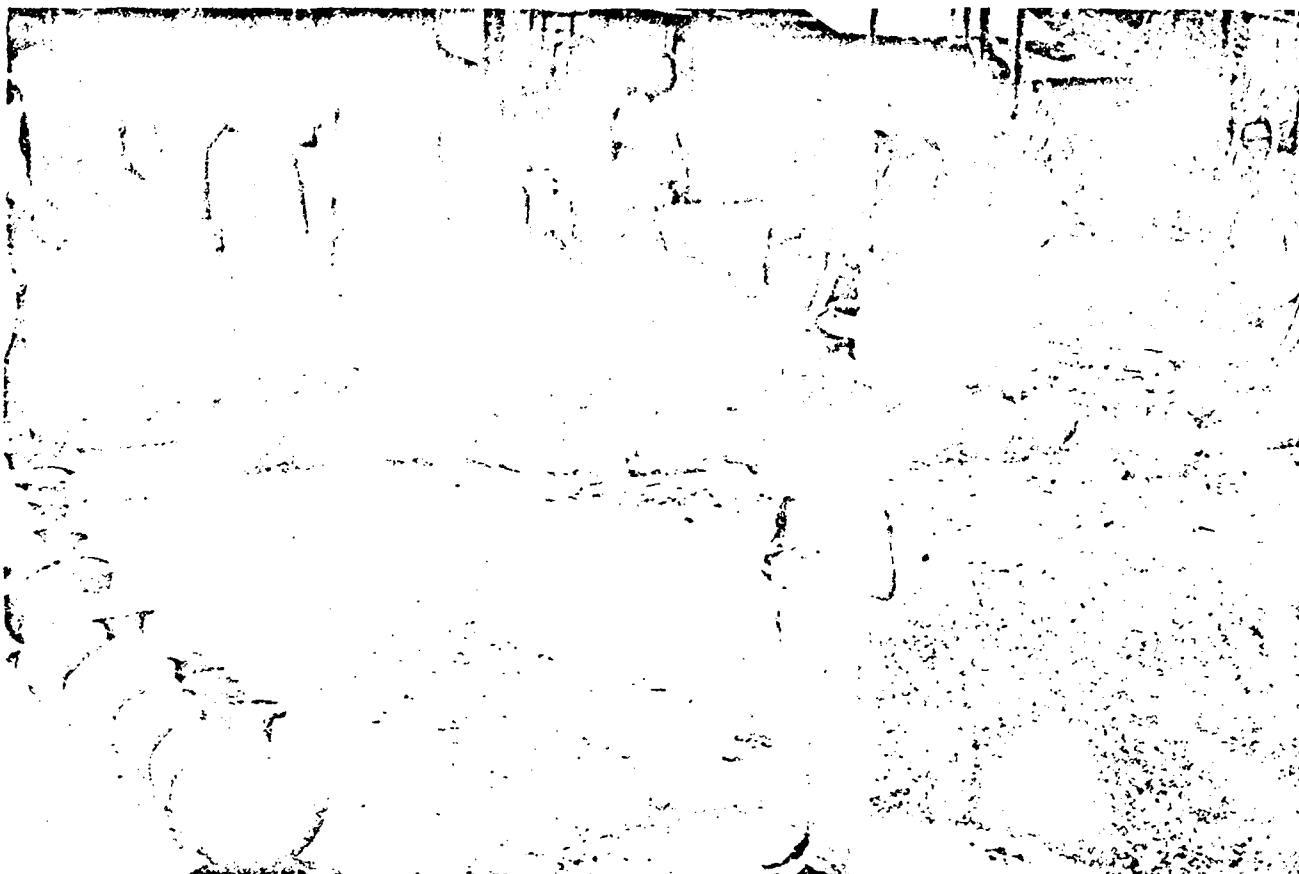
1. Workshop on Deepwell Handpumps in the Rural Water Supply Programme, Institute of Engineers (India), Bangalore, Karnataka, 24-26 June, 1975 Government of India/World Health Organization.
2. Shallow Handpump Design - Summary, Workshop on Rural Water Supply, May 1976
3. "A PVC Hand Pump - Low in cost, dependable, easily repaired", C. D. Spangler, April 1976.
4. Shallow Well Hand Pumps, Industry Profiles No. 66169
5. UNICEF Rural Water Supply Workshop, Bangladesh Rural Water Supply Programme, Handpumps in Bangladesh, 1972-1976, R. Phillips, Dacca, Bangladesh, May 1976.
6. UNICEF Rural Water Supply Workshop, Bangladesh Rural Water Supply Programme, An outline of choices associated with handpump tubewell programmes and handpump design, R. Phillips, Dacca, Bangladesh, May 1976.
7. Hand pump maintenance and the objective of community, Arnold Pacey (Embargo September 1976).
8. Machine for extracting water. (Taken from an ancient document, March, April 1974).
9. Drilling for drinking water in drought-prone India, Marcus F. Franda, South Asia Series, Vol. XIX No. 11 (India), September 1975.
10. The handpumps in West Java, Indonesia, D. Sukapradja, Bandung, June 1976.
11. The need for improved technology in manual pumping of irrigation water, Stephen V. Allison, October 1975.
12. The Petro pump, Fredrik Tröften, Sweden, June 1976.
13. A proposed programme for training village handpump caretakers, K. Forman, UNICEF, New Delhi, May 1976.
14. Learning components in "safe water for drinking" programmes, Janapala Alles and Jayananda Ratnaike, April 1976 (Joint UNESCO-UNICEF Programme of Education Assistance).
15. Well drilling programme and selection of suitable hand pumps for use in Ghana, K. Osei-Poku, Volta Region, July 1976.

16. Activities on the U. S. T. Hand Pump, A. Abrobah-Cudjoe, Kumasi, July 1976.
17. Discussion on future hand pump tubewells in rural areas of Bangladesh, M. A. Hussain, Dacca, Bangladesh, July 1976.
18. Burma and Hand Pumps, Ngwe San, Rangoon, Burma, July 1976
19. A Hand Pump and Well for Rural Areas of Developing Countries, W. K. Journey, July 16, 1976.
20. Introduction on Objectives of the Meeting, E. H. A. Hofkes
21. C. I. E. H. Bulletin de Liaison

INTERIM REPORT

on

DEVELOPMENT OF A HAND OPERATED WATER PUMP
FOR DEVELOPING COUNTRIES



August 1, 1974

DEVELOPMENT OF A HAND OPERATED WATER PUMP FOR DEVELOPING COUNTRIES

by

R. D. Fannon, Jr.

INTRODUCTION

A great number of requests have been received for information regarding the AID-Battelle program to develop an improved hand pump for rural domestic water supplies. Special funds have recently been appropriated to compile the results from this work to date and make it available.

BRIEF HISTORY OF EXPERIENCE

Early in 1966, the Agency for International Development (AID) and the Battelle Columbus Laboratories (BCL) discussed the increasing need for rural water supply systems for developing nations. It was decided during these meetings and subsequently substantiated that successful domestic water programs must be carried out within the country for which they are intended. Such programs not only provide a more reliable water system but also stimulate industry and business within the country.

The most basic need apparent was for a dependable hand pump. Basic specifications for such a pump were established early in the program and without exception they still prevail. These specifications are

- (1) Low production costs
- (2) Long life under severe conditions
- (3) Easy to maintain with simple tools and unskilled labor
- (4) Suitable for shallow or deep well installations with only minor changes (cylinder location)
- (5) Capable of being manufactured by established firms within the developing countries and/or with a minimum of capital investment

- (6) Easily operated by small people, including women and children
- (7) Include design features which will discourage pilfering and vandalism.

A shallow well pump is defined here as a pump in which the cylinder is attached to the pump body above the ground. A deep well pump is defined as a pump in which the cylinder is separated from the pump body and submerged below the level of the water being pumped.

In addition to these specification, it might also be appropriate to note here that any rural domestic water program of any size must contain the following:

- (1) Funds must be available by which pumps can be made and wells sunk and/or means by which pumps and their installation can be purchased by consumers.
- (2) Facilities must be available or provided in which pumps and associated products can be fabricated.
- (3) Governmental organizations or private sales organizations must be available for pump distribution and installation. This would also include well drilling.
- (4) Means must also be made available for spare parts distribution and pump maintenance.
- (5) Effectiveness of any program depends upon good coordination with the local people in regard to operations and pump configuration. Each area can be different depending upon the local conditions, customs, and aesthetic values.

The program to develop an improved domestic water pump was conducted by Battelle for AID in three steps.

- (1) Examination of existing conditions .
- (2) Pump development and laboratory evaluation
- (3) Field evaluation programs

Although steps 1 and 2 have been completed, some development in terms of improvements is still going on.

In the many visits to various developing countries the following conditions and practices are found to exist:

- (1) Lack of pumps and facilities to make them
- (2) Some areas had pumps given them, but many different kinds with little or no maintenance and with improper parts
- (3) Lack of community spirit toward community water supply systems even to the extent of vandalism
- (4) The reluctance of government officials to act as positively or as effectively as they could
- (5) Inadequate pump design, both those made in the country and those being imported. The inadequacies may be described as follows:
 - (a) Cylinders too rough
 - (b) Plunger cups improperly sized (generally too large)
 - (c) Highly stressed fulcrums and handles
 - (d) Bearing surfaces too small
 - (e) Valve seats poorly cast and machined
 - (f) Fasteners (bolts and nuts) poorly made.
- (6) Inadequate storage facilities--many of the parts are so deteriorated that they cannot be used.
- (7) In many areas hand operated water pumps are in such demand that even so-called good pumps will not stand up under such rigorous usage. Good maintenance programs are required under all conditions.

A deep well and shallow well pump configuration was developed incorporating improvements for many of the deficiencies noted. Sample pumps were tested in the laboratory and currently a field evaluation program is being conducted in three areas: Bangladesh (in cooperation with UNICEF), Nigeria (under direction of CARE), and Thailand (under direction of AID). The actual pump configurations vary some from one country to another, as it should, but the major design points remain the same. The pump configuration to be described reflects the latest field findings.

PUMP DESCRIPTION

Figures 1 and 2 are assembly drawings of the shallow and deep well pumps, respectively. A parts list follows the drawings for convenient part identification. It can be seen that there is little difference in the pumps except for the cap and fulcrum. It might be noted that the deep well configuration could well be used on both deep and shallow wells; however, the initial cost would be slightly higher than necessary for the shallow wells.

General Description

Except for the steel pipe and a few other parts, the pump is gray cast iron with a composition as close as possible to that shown in Table 1.

TABLE 1. RECOMMENDED SPECIFICATIONS FOR FOUNDRY PIG IRON

Silicon	Carbon	Manganese	Sulfur	Phosphorus
2.50 - 2.75	4.10 - 3.85	0.50 - 1.25	0.05 max	0.30 - 0.50
2.76 - 3.00	4.05 - 3.70	0.50 - 1.25	0.05 max	0.30 - 0.50
3.01 - 3.25	3.90 - 3.65	0.50 - 1.25	0.05 max	0.30 - 0.50
3.26 - 3.50	3.85 - 3.60	0.50 - 1.25	0.05 max	0.30 - 0.50

The carbon ranges listed are to be used only as an indication of the desired carbon content of the pig iron. It is very difficult, if not impossible, to make foundry pig iron to specified silicon and carbon contents. However, the carbon content and silicon content should be in balance in order to produce gray cast iron castings with less variations in composition. The silicon content should and can be supplied to the designated ranges, and the carbon content should be reasonably close to the values indicated. As an example, the silicon content may be specified as 2.76 to 3.25 percent - the corresponding carbon content should be in

the range of 4.05 to 3.65 percent. The carbon contents are shown in a reverse order intentionally because as the silicon content increases in pig iron, the carbon content will decrease.

Coke specifications are also necessary to produce a satisfactory product. Table 2 indicates minimum standards.

TABLE 2. RECOMMENDED SPECIFICATION FOR FOUNDRY COKE (WEIGHT PERCENT)

<u>Fixed Carbon</u>	<u>Volatile Matter</u>	<u>Ash Content</u>	<u>Sulfur Content</u>
88.0 min	1.0 max	12.0 max	1.0 max

The values specified are to be used as a guide when purchasing foundry coke; however, every effort should be made to obtain foundry cokes that have a minimum ash content. An 8.0 to 10.0 percent ash content is very desirable. Sulfur content should also be as low as possible. The higher the sulfur content in the coke, the higher will be the sulfur content of the gray cast iron produced, and the greater possibility for metal problems caused by excess sulfur.

General Construction Details

The sample shallow well pump cap provides a strong fulcrum for heavy use and the deep well cap provides firm wear resistant surfaces.

The pump has a 7-1/2 inch to 8-inch stroke which is quite important when the water table is low, and a 6 to 1 ratio handle to help ease pumping. The center section is made of steel pipe and within limits can be made various lengths increasing or decreasing pump height. Jam nuts are used at all pump rod connections to help prevent rod separations. The pump base is sized to fit over 6-inch well casing and will accept 1-1/4" to 1-1/2" drop pipe. General construction is such as to stand up under heavy use and yet be as light as possible.

Cylinder Construction

Laboratory tests and field evaluation indicate the secret of long cup life is the smoothness of the cylinder in which the plunger operates. An extruded brass cylinder has a smoothness of 8 to 12 micro inch (CLA)*. In contrast, some of the machined iron cylinders taken out of storage were so rough (over 600) due to rust and poor castings that measurements were hard to make. Better castings with more careful machining measured between 200 and 300 micro inch (CLA).

To obtain a very smooth finish, coated cylinders were developed. Two types of coated cylinders have been tested in the laboratory. One coating consists of an epoxy-phenolic resin requiring a low-temperature bake as part of the curing process. This coating is the toughest and most wear-resistant of the two coatings with a smoothness of 12 to 18 micro inch (CLA). This coating performed well in limited field use and would be preferred if baking facilities can be made available. The second coating is an air cure epoxy coating which is not quite as tough and takes longer to cure than the baked coating. This has a smoothness of about 40 micro inch (CLA). This coating has no field evaluation to date. Both types of coated cylinders can be used for shallow well and deep well pumps and are quite inexpensive to apply.

As an alternative, plastic pipe may be used for cylinder construction. Polyvinyl chloride (PVC) plastic pipe is as smooth as extruded brass, costs much less than brass, and field tests have shown it to wear as well. It is recommended for deep well applications. Although the PVC pipe cylinder is more expensive than a coated cylinder, the ease of manufacture (a simple cut-off operation) makes its use for sleeves in shallow well pumps very attractive.

* Center line average

Cups and Valves

Good quality leather is recommended for making plunger cups. Dyes should not be used; however, wax impregnant is acceptable. No special treatment has yet been identified; however, a particular tanning or special treatment may be indicated by current testing. Cups should not fit tight in the cylinders, but instead depend upon the water pressure or suction to seal the cup against the cylinder walls.

Two types of valves are currently in use, poppet and flapper. There is much discussion about which type is best, and no firm answer is available. However, both types depend upon a generous, smooth, well-machined seat. Poppet valves are cast iron or brass which is preferred and leather or rubber washers can be used to help improve the seal. Leather is still the standard material for flapper valves with a cast iron weight. Plastics and composite materials such as nylon impregnated with neoprene should also be considered.

Bearings

The pinned joints should be no less than 5/8-inch diameter and the length such as to insure a projected bearing area of at least 0.94 square inch. If hard use of the pump is to be expected, even larger pins are recommended. Lubrication where possible almost always improves wear. Generally speaking, most shops in developing areas cannot afford the cost of special bearings, nor are they capable of properly fitting bearings, but hardening the cast iron bearing (hole) can be done and is recommended to greatly improve bearing life at a minimum cost.

Pump Options

The pump shown as Option A utilizing a bolt-on cover with fulcrum and a screwed-on center section and base is recommended; however, circumstances may require other configurations. Option B utilizes pinned-on covers

and fulcrums for areas where bolts and nuts are of poor quality, nonexistent, or where vandalism or stealing is a problem. For tube wells, the base can be omitted and the bottom cap with valve of the deep well cylinder can be substituted making up Option C. Option D is where the pump body and cylinder (shallow well pump) are cast as one piece and a PVC liner is inserted to provide a smooth bore. Other variations are available to match facilities and skills available and type of consumer operation, but simplicity is the key to the most reliable and inexpensive configuration. However, care must be taken not to compromise pump operations.

CURRENT EVALUATION

The shallow well pump as fabricated under several options has been proven to stand up well. The plastic deep well cylinder is also being used quite extensively; however, the deep well pump cap is a relatively new arrangement and more data are needed before its capability of withstanding hard use can be confirmed.

Data on valves are conflicting in that both the poppet and flapper types are preferred in different areas. It has been noted, however, that poorly prepared sealings surfaces are not acceptable under any conditions.

PUMP DESIGN PRINCIPLES

The fabricator, installer, and user should be aware of certain design limitations. First, it is recommended that no cylinder sizes over 3-inches diameter be used. It has been observed that leather cups tend to fail rather than wear out in 3-1/2-inch shallow well pumps. It is our feeling that the strength of the cup is not sufficient to withstand the pressure or vacuum created by the pump action and buckling occurs during one portion of the stroke (stretching during the opposite portion of the stroke) causing the cup material to split circumferentially and fail.

Neglecting friction or insufficient flow passageway which can create a substantial load, 3-inch cylinders will require 3.06 pounds lifting force per foot of water being lifted. This means, for example, that for a shallow well with a 26 foot deep water level, about 79.5 (26×3.06) pounds of lifting force will be required. This is about the maximum lift for a shallow well pump, and for the pump illustrated approximately 14 pounds ($\frac{79.6 \times 5}{28.5}$) of force is needed at the end of the handle for operation.

In contrast, a deep well pump must operate under much more severe conditions. Again, for the deep well pump illustrated, a 100-foot water lift would require about 357 ($100 \times 3.06 + 51.1$) pounds of force (including the weight of 7/16 diameter pump rod but neglecting friction) and a handle force of over 62.5 ($\frac{357 \times 5}{28.5}$) pounds. Such an arrangement can be improved one of two ways: Make the handle longer or decrease the cylinder size. Most persons can see that increasing the handle length or lever arm decreases the force required for operation, but it may not be apparent in the case with the change in cylinder size. A 2-1/2-inch diameter plunger requires about 2.12 pounds per foot of water lift for operation and for a 100-foot water lift including the weight of the rod but neglecting friction, 263 ($2.12 \times 100 + 51.1$) pounds of force would be required. The handle force would be 46.2 ($\frac{263.1 \times 5}{28.5}$) pounds, over 25 percent reduction from the handle force required by the 3-inch cylinder. A 25 percent increase in handle length decreases the handle force about 20 percent to 50.13 pounds. Every effort should be made to keep the handle force below 40 pounds to permit operation by women and children. Table 3 summarizes the forces discussed.

Decreasing the bearing loading is another factor for reducing cylinder size. Loading is not appreciably affected by a change in handle length. 300 psi is a maximum bearing load for mild steel pins and cast iron journals when lubricated and with a close "running" fit. Since most pumps operate with moving joints of a very sloppy fit, the bearing levels should be kept as low as possible for long life--perhaps below 100 psi if possible. The pumps currently under evaluation have bearings from 5/8-inch diameter to 3/4-inch diameter and at least 1-1/2-inch total length each

TABLE 3. SUMMARY OF PLUNGER LOADS AND HANDLE
FORCES FOR VARIOUS PUMP/WELL CONDITIONS

Effective Handle Length, in.	Cylinder Size, in.	Water Depth, ft	Plunger Load, lbs	Handle Force, lbs
28.5	3	26	79.5	14
28.5	3	100	357	62.5
28.5	2.5	100	263	46
35.6	3	100	357	50.1
35.6	2.5	100	263	36.9

joint. Wear, although much improved, can still be a problem. To sum up these points, cylinder diameter, bearing area of each joint, and handle length must be seriously considered and balanced out to provide long life and easy operation.

One last comment on this topic; the greater the lift of water the greater pressure and increase of wear of the plunger cap. Therefore, as wear becomes excessive due to depth, the number of cups should be increased. Trial operation should soon determine when a second or third cup would be required. It has been suggested by one pump manufacturer that water levels at the 50- and 125-foot depths would be levels at which cups would be added for 3-inch cylinders. As pressures become too great, cylinder size would have to be reduced to increase the cup life.

ADDITIONAL REFINEMENTS

Four areas of further improvement to increase pump longevity are (1) Bearings, (2) Cups, (3) Valves, and (4) Piping. Bearing life, and consequently pump life with reduced maintenance, can be improved by the use of lubricated or nonlubricated ball bearings or bushings. The type chosen really depends upon the sophistication in machining the fabricator has available and the money available to buy and/or make the pumps. In most developing areas encountered to date, the degree of capability and money does not appear available; however, an improvement can be made that does seem within reason in many areas. The cast iron journals or "holes" should be hardened by heating to a cherry red and quenching in water. Almost any degree of hardness will improve the bearing life. Care must be taken, however, to guard against tempering one hole while hardening another.

New materials for fabricating plunger cups may soon be available including the reappearance of "Corfam", once manufactured by DuPont. For materials to be useful in cup fabrication, they must be leather-like in ability to expand against the cylinder wall proportionately to the pressure developed by the depth of water being pumped. Qualities to look for are

improved storage life, resistance to fungus, etc, improved abrasion resistance, and ability to withstand wet and dry cycling.

New materials available for plunger cups might also be considered for valves; here, the ability to expand is not required.

Plastic pipe for use as drop pipe should also be considered for cost-saving installations. Not only may plastic pipe be less expensive to buy, but lighter than steel pipe and cheaper to ship. Although plastic material has lower mechanical strength than steel, is more sensitive to temperature variation, and requires more careful handling, it is not as subject to corrosion as steel, has a lower friction factor, and can be easily jointed in the field. Care must be taken, however, to assure that no bending loads are placed on the pipe and that steel pipe be used for top sections and for securing the pump. Plastic screens are also being installed in some areas.

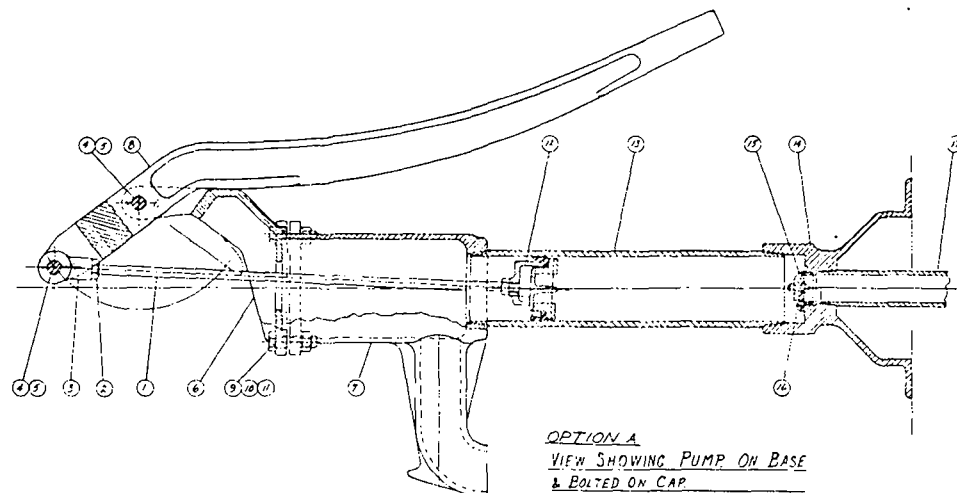
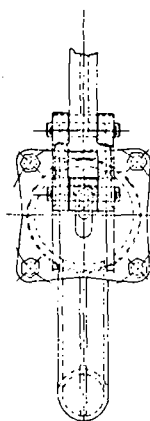
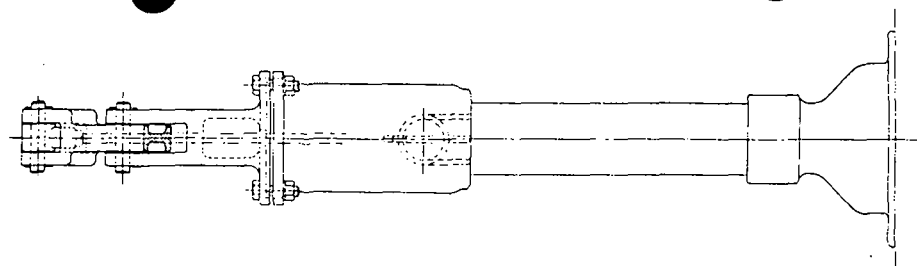
ADDITIONAL INFORMATION

It is hoped that the information included in this report is of some value to you. Additional data (Battelle's final report on Contract No. AID/csd-3305) will be available by Spring, 1975, and can be obtained through AID. If you are serious about pump production in your area or improving rural domestic water programs and additional information would be of help, please contact Mr. A. Dale Swisher of AID or Mr. Robert D. Fannon of Battelle at the addresses below. We also encourage you to participate with us in this program; and if you desire to do so, we invite you to contact us by writing to the addresses below.

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Office of Health
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Washington, D.C. 20523
USA

REVISIONS		
NO.	DESCRIPTION	DATE

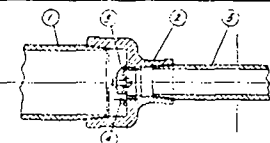


OPTION A
VIEW SHOWING PUMP ON BASE
& BOLTED ON CAP

NO.	DESCRIPTION	QUANTITY	UNIT	REMARKS
1	STEEL PIPE	1	INCH	
2	PUMP BODY PIPE & DISCH	1	INCH	
3	CHECK VALVE ASSEMBLY	1	INCH	
4	PUMP STAND ASSEMBLY	1	INCH	
5	PUMP CYLINDER ASSEMBLY	1	INCH	
6	1/2" PIN	1	INCH	
7	1/2" PIN	1	INCH	
8	1/2" PIN	1	INCH	
9	1/2" PIN	1	INCH	
10	1/2" PIN	1	INCH	
11	1/2" PIN	1	INCH	
12	1/2" PIN	1	INCH	
13	1/2" PIN	1	INCH	
14	1/2" PIN	1	INCH	
15	1/2" PIN	1	INCH	
16	1/2" PIN	1	INCH	
17	1/2" PIN	1	INCH	
18	1/2" PIN	1	INCH	
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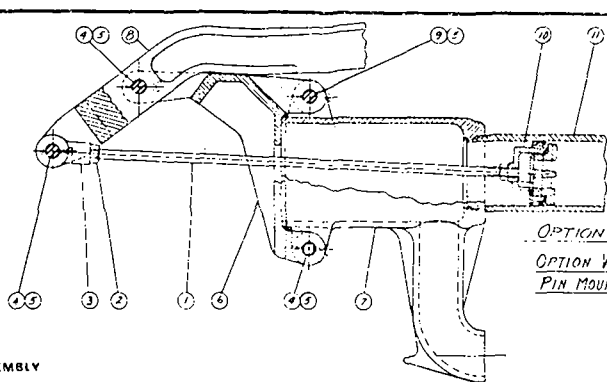
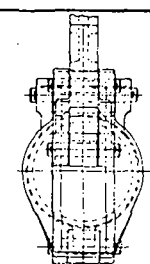
NOTE:
ASSEMBLY OF PUMP BODY PIPE &
PUMP STAND MUST BE TIGHT WITH
AT LEAST 1/2" THREAD ENGAGEMENT
AT EACH JOINT.

OPTION C
VIEW SHOWING LOWER VALVE HOUSING
MOUNT DIRECTLY TO WELL PIPE



NO.	DESCRIPTION	QUANTITY	UNIT	REMARKS
1	STEEL PIPE	1	INCH	
2	PUMP BODY PIPE & DISCH	1	INCH	
3	CHECK VALVE ASSEMBLY	1	INCH	
4	PUMP STAND ASSEMBLY	1	INCH	
5	PUMP CYLINDER ASSEMBLY	1	INCH	
6	1/2" PIN	1	INCH	
7	1/2" PIN	1	INCH	
8	1/2" PIN	1	INCH	
9	1/2" PIN	1	INCH	
10	1/2" PIN	1	INCH	
11	1/2" PIN	1	INCH	
12	1/2" PIN	1	INCH	
13	1/2" PIN	1	INCH	
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20	1/2" PIN	1	INCH	
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24	1/2" PIN	1	INCH	
25	1/2" PIN	1	INCH	
26	1/2" PIN	1	INCH	
27	1/2" PIN	1	INCH	
28	1/2" PIN	1	INCH	
29	1/2" PIN	1	INCH	
30	1/2" PIN	1	INCH	

NOTE:
ALL PARTS BELOW PUMP CYLINDER ARE IDENTICAL TO THOSE
SHOWN IN EITHER OF TWO VIEWS SHOWN ABOVE.



OPTION B
OPTION VIEW OF PUMP WITH
PIN MOUNTED CAP

NO.	DESCRIPTION	QUANTITY	UNIT	REMARKS
1	STEEL PIPE	1	INCH	
2	PUMP BODY PIPE & DISCH	1	INCH	
3	CHECK VALVE ASSEMBLY	1	INCH	
4	PUMP STAND ASSEMBLY	1	INCH	
5	PUMP CYLINDER ASSEMBLY	1	INCH	
6	1/2" PIN	1	INCH	
7	1/2" PIN	1	INCH	
8	1/2" PIN	1	INCH	
9	1/2" PIN	1	INCH	
10	1/2" PIN	1	INCH	
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22	1/2" PIN	1	INCH	
23	1/2" PIN	1	INCH	
24	1/2" PIN	1	INCH	
25	1/2" PIN	1	INCH	
26	1/2" PIN	1	INCH	
27	1/2" PIN	1	INCH	
28	1/2" PIN	1	INCH	
29	1/2" PIN	1	INCH	
30	1/2" PIN	1	INCH	

APPLICATION	DATE	SIGNATURE
DESIGNED BY	DATE	SIGNATURE
CHECKED BY	DATE	SIGNATURE
APPROVED BY	DATE	SIGNATURE
REVISIONS	DATE	DESCRIPTION
1	10/1/00	INITIAL DESIGN
2	10/1/00	REVISION
3	10/1/00	REVISION
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28	10/1/00	REVISION
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30	10/1/00	REVISION

FIGURE 1. SHALLOW WELL PUMP ASSEMBLY

FINAL REPORT

on

THE CONTINUED DEVELOPMENT AND
FIELD EVALUATION OF THE
AID HAND-OPERATED WATER PUMP

to

OFFICE OF THE WAR ON HUNGER
HEALTH SERVICES DIVISION
AGENCY FOR INTERNATIONAL DEVELOPMENT

August 28, 1970

Contract No. AID/csd-2174

by

R. D. Fannon, Jr. and D. W. Frink

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THE CONTINUED DEVELOPMENT AND
FIELD EVALUATION OF THE
AID HAND-OPERATED WATER PUMP

by

R. D. Fannon, Jr. and D. W. Frink

INTRODUCTION

One of the most immediate needs of rural families in the small communities of developing nations is a safe and adequate water supply. A water source can be easily contaminated if the water is obtained by direct dipping, or by a rope and bucket. Therefore, the best solution to this need is usually a well and a dependable hand pump. Because repair facilities are often limited, the hand pump must be dependable even though it is subjected to severe use. It should have few parts and few points of wear. Since low cost is also important, it should be easily manufactured in the country of its ultimate use. Unfortunately, in many underdeveloped areas no pumps are available to meet all, or even most of these requirements.

In recognition of this need, the Agency for International Development initiated a program (Contract No. AID/csd-1434) with the Battelle-Columbus Laboratories to define the requirements and specifications of hand water pumps suitable for developing nations. The results of this effort are summarized in Battelle's final report to AID dated September 29, 1967. In the conclusions of that report, the following additional work was deemed advisable:

- (1) Dissemination of information to interested agencies and organizations
- (2) Field evaluation of a proposed pump design
- (3) Further research on valves, cup seals, and cylinders
- (4) Development and implementation of educational programs.

On June 28, 1968, a second contract was initiated at Battelle in regard to Items 3 and 4. Assistance was to be given to the field evaluation of the basic pump design that was selected during the first contract. At the same time, the pump design was to be optimized with respect to life, reliability, and cost through the development of improved valves, cup seals, and cylinder coatings. The following report describes the results of the continued effort, which was concluded on June 28, 1970.

SUMMARY AND CONCLUSIONS

During the previous program, a simple piston pump design was identified as being the most suitable for the needs of developing nations. In the continued effort, it was envisioned that Battelle would contribute to the field evaluation of this basic configuration by assisting a manufacturer in the production of a number of pumps, by preparing a manual for field installation and operation, and by evaluating reports and components from the field. At the beginning of the program, manufacturing specifications and drawings were prepared for the previously selected pumps design. However, arrangements could not be made for fabricating and supplying the pumps for field evaluation. The remaining funds allocated for field evaluation were redirected toward additional component development, and toward the dissemination of information to interested parties. The different activities are summarized in the following sections.

Plunger-Valve Development

The metal valves presently used in pump plungers are subject to wear and malfunctioning. Two designs of improved plunger valves were evolved. One is a flapper valve made of neoprene-impregnated nylon. The valve is similar to the flapper valves commonly used in pump cylinders. The other design is a serrated flapper valve which requires a modified plunger configuration. Both types of valves were operated over 5000 hours in shallow-well and deep-well pumps without signs of deterioration. It was concluded that the serrated flapper valve, which is particularly simple and inexpensive to make, should be used for the majority of pump applications. The weighted flapper valve, which is more conventional in appearance and more resistant to pressure, should be used where the acceptance of something different might be a problem, and in deep wells where multiple cups are required.

Selection of Optimum Cup Material

Leather is the standard material for plunger cup seals, and its basic properties are specified for any materials to be used in plunger cups. The most important of these properties is the ability to stretch to conform to the cylinder walls. Because plunger cup wear is the most frequent cause of pump repair, other materials were studied in an attempt to find a better cup material. Corfam was found to be the best material available. It is very similar to leather, but is more uniform and more durable. Although the cost of Corfam is generally higher than leather, its improved performance capabilities will more than offset the price differential. Thus, it was concluded that plunger cups should be made of Corfam.

Evaluation of Cylinder Coatings

In the previous program it was concluded that the cost and maintenance of hand pumps could be substantially reduced if the cast-iron cylinder walls were made smoother by some type of nonmetallic coating. Effort during the follow-on program has been directed toward finding a satisfactory coating which does not require special processing, such as heat treating. Three types of coatings were evaluated--epoxy, vinyl, and uralkyd. All of the coatings performed well, with no peeling or wear. Epoxy was judged to be the most desirable because it is the hardest in the air-dried condition. The material cost of the epoxy is approximately 5 to 10 cents per cylinder.

Additional Component Investigation

During the above component testing, two additional problem areas were revealed: (1) excessive erosion of the iron cylinder seat beneath the flapper valve and (2) wear of the housing by the bronze plunger valve to the point that the pump would not operate. With the decision to discontinue the field evaluation work, design consideration was given to these problems. It is believed that the use of a bronze seat in the cast-iron cylinder would correct the erosion problem. The poppet-valve life could be extended by a longer guide for the poppet.

At the request of UNICEF, an investigation was also conducted to extend the life of the pump-handle pivots. A sleeve bearing material called Rulon J was selected to operate with pins made of 17-4 PH stainless steel hardened to about 35 Rockwell C. The ability of this bearing combination or equal combination to operate satisfactorily without lubrication should significantly extend the life of the pump-handle pivots. It is anticipated that this bearing combination would be needed only in those areas of exceedingly heavy pump utilization.

Information Dissemination

A press release regarding the development of the hand pump was made by AID and Battelle on June 27, 1969. As of June 28, 1970, 66 inquiries about the program had been received at Battelle from 20 countries. In response to those interested in making the pump, 25 packets of information were sent, each containing a set of drawings, a final report on the first program, and selected pictures. Reduced amounts of information were sent to 33 inquiries from those who were interested in more general aspects of the pump. In addition, 135 copies of the final report on the first program were sent to AID so information could be forwarded in response to inquiries received at AID.

RECOMMENDATIONS

Battelle believes that the basis has been established for the manufacture of satisfactory hand pumps for developing nations. The widespread interest in the pump is impressive evidence of the need for such a device. The following steps should be accomplished so the people in the developing nations can benefit from the work accomplished to date:

- (1) The specifications and drawings should be modified to include flapper-type plunger valves, a Corfam cup seal, and an air-dry epoxy cylinder coating, but it should remain clear that the final configuration and degree of sophistication is the choice of the indigenous manufacturer.
- (2) Manufacturers should be chosen in selected developing nations, and pump fabrication, with demonstrations, should be initiated.
- (3) Field evaluations should be conducted in areas of the selected nations with the indigenously manufactured pumps.
- (4) A course on pump fabrication and installation should be included in the AID-sponsored Ground Water School at the University of Minnesota.

RESEARCH ACTIVITIES

In accordance with the statement of work, the follow-on contract was consist of the following four tasks:

- (A) Supervise and evaluate the field testing of Battelle-designed pumps to be provided, installed, and field-monitored by others. This task was to include the following steps:
 - (1) Collaborate with the manufacturer in the production of pumps and provide patterns, molds, and fixtures devised during the previous contract
 - (2) Prepare a manual providing instructions for field installation, operation, maintenance, and reporting on pump performance
 - (3) Evaluate reports from the field

- (4) Evaluate valves, cups, and other pump parts returned from the field
- (5) Recommend necessary pump design changes
- (B) Develop and evaluate a flapper-type plunger valve of synthetic materials as a possible substitute for the presently used metal valves
- (C) Determine the optimum synthetic material and configuration combinations for plunger cups to replace presently used leather cups
- (D) Continue the testing of cylinder materials, undertaken under the previous contract, to find a suitable coating which does not require heat treatment in the manufacturing process.

When it was decided to discontinue the field testing effort, two additional tasks were undertaken:

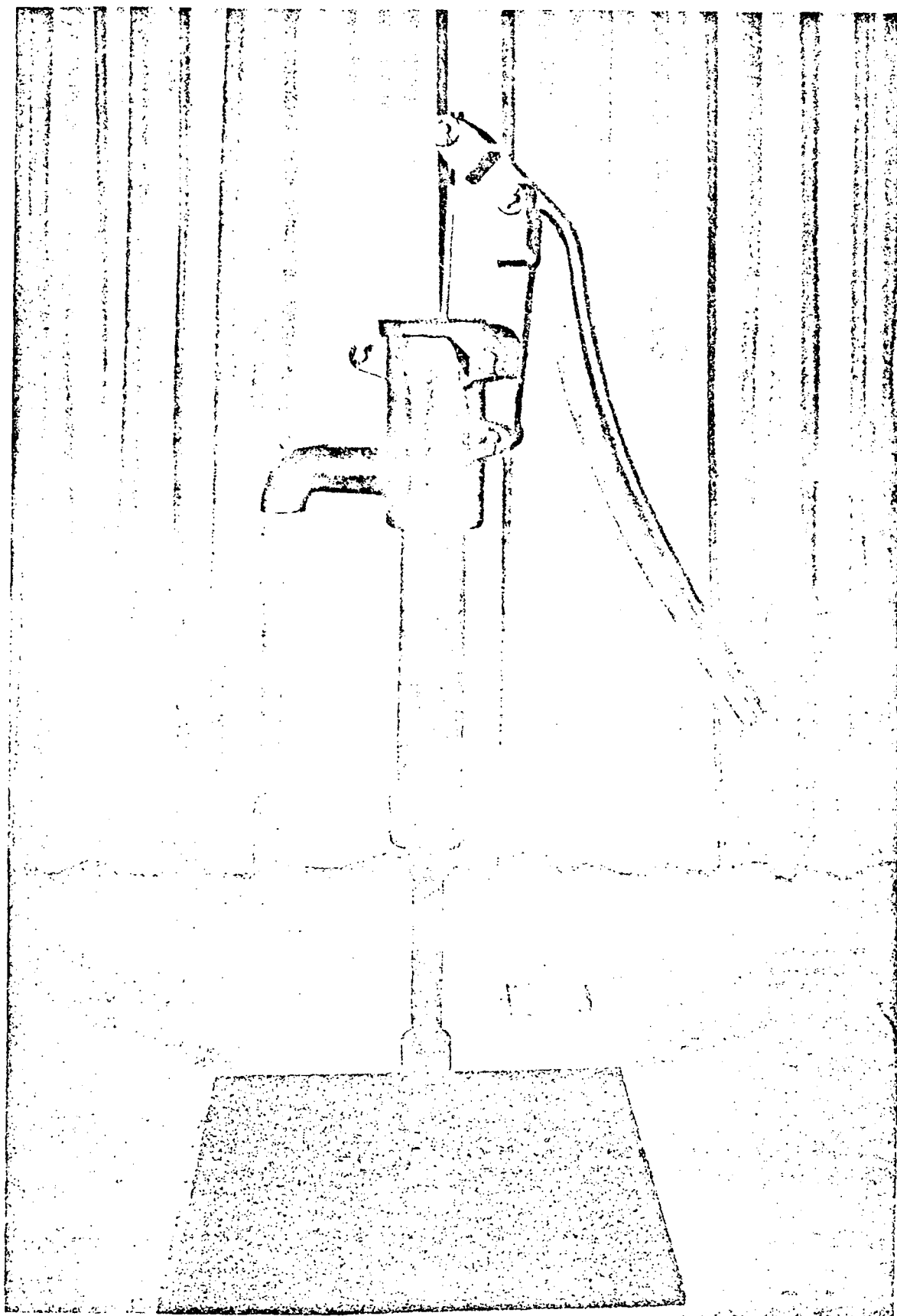
- (E) Investigate the adequacy of additional, selected pump components
- (F) Disseminate pump information to interested organizations.

Task A. Field Evaluation

During the previous program, a simple pump design was evolved to meet the needs of developing nations. The basic pump consisted of a body, a fulcrum, a handle, a single cylinder, a plunger, and two check valves--one in the plunger and one in the cylinder. Figure 1 shows the design incorporated in a shallow-well pump. In this type of pump the suction cylinder is attached above ground to the pump body since the water can be lifted from the ground by suction. Figure 2 shows the selected pump design incorporated in a deep-well pump. In this type of pump the suction cylinder is placed below ground in or near the water source. A rod extends from the pump handle down through the connecting pipe (shown foreshortened in Figure 2) to the suction cylinder. The primary action of the plunger in a deep-well pump, therefore, is to lift the column of water to the pump body. Appendix A contains assembly drawings and parts lists for both types of pumps.

Features that were incorporated in the basic pump design for developing nations were

- (1) Low production cost
- (2) Long life under severe conditions



39207

FIGURE 1. SHALLOW-WELL VERSION OF AID PUMP
BATTELLE MEMORIAL INSTITUTE - COLUMBUS LABORATORIES



39209

FIGURE 2. DEEP-WELL VERSION OF AID PUMP

BATTELLE MEMORIAL INSTITUTE - COLUMBUS LABORATORIES

- (3) Easy maintenance with simple tools and unskilled labor
- (4) Suitable for shallow- or deep-well installation with only minor changes (cylinder location and plunger rod length)
- (5) Capable of being manufactured in developing countries with a minimum of capital investment
- (6) Easily operated by small people, including women and children
- (7) Containing features to discourage pilfering and vandalism.

The field evaluation effort required a third party to arrange for the manufacture, installation, and field monitoring of the pumps. During discussions with the Contract Technical Monitor, it was decided that UNICEF would be the best agency for accomplishing these functions. Accordingly, meetings were held with representatives of UNICEF to discuss the pump design and to select specifications that would be mutually acceptable. Some conflict of objectives was encountered because the AID-Battelle approach was to have the pumps made in the nations that would use the pumps, while UNICEF wanted to purchase the pumps for distribution in selected outlying areas. However, a mutually acceptable design was established.

Drawings and specifications were then prepared for the selected design. The drawings consisted of assembly drawings, subassembly drawings, and detail drawings for 2-1/2-inch and 3-1/2-inch cylinders, for shallow-well and deep-well pumps. The specifications covered the necessary aspects of procurement, manufacturing, and shipping. (The drawings and specifications did not include the improvements that were investigated later during the follow-on program.)

Considerable time was spent in communicating, through telephone calls, letters, and visits, with the UNICEF Procurement Officer in New York. In addition, drawings and specifications were sent to the United Nations in New York, UNICEF in France, and WHO in Switzerland. Unfortunately, it was not possible to obtain approvals from all the necessary organizations in time to select a manufacturer, fabricate the pumps, and complete the field evaluation of the pumps.

When it became apparent that the field evaluation could not be completed as planned, it was agreed during discussions with the Technical Monitor that the work outlined under Tasks E and F would be conducted. This work is described in later sections of the report.

Task B. Plunger-Valve Development

The two most common types of check valves used in hand pumps are the poppet valve and the flapper valve. A poppet valve is always used in the plunger;

however, the lower check valve in the cylinder is either a flapper valve or a poppet valve. Most of the shallow-well pumps use leather flapper valves in the bottom of the cylinder, while most of the deep-well pumps use poppet valves.

During the previous program, three important conclusions were drawn concerning valves:

- (1) Nylon impregnated with neoprene is an excellent material for flapper valves since it has a high resistance to flexural failure and it is not adversely affected by changes in temperature or by wetting-drying cycling.
- (2) Metal plunger valves should be improved to minimize wear and increase life.
- (3) An attempt should be made to develop a flapper-type plunger valve using neoprene-impregnated nylon to reduce the cost and increase the reliability of plunger valves.

Two flapper-type plunger-valve designs were evolved and evaluated as a part of the follow-on program. Each of these is discussed below. In accordance with a request by UNICEF, the experimental valves were fabricated for a 2-1/2-inch-diameter cylinder.

Weighted Flapper Valve Design

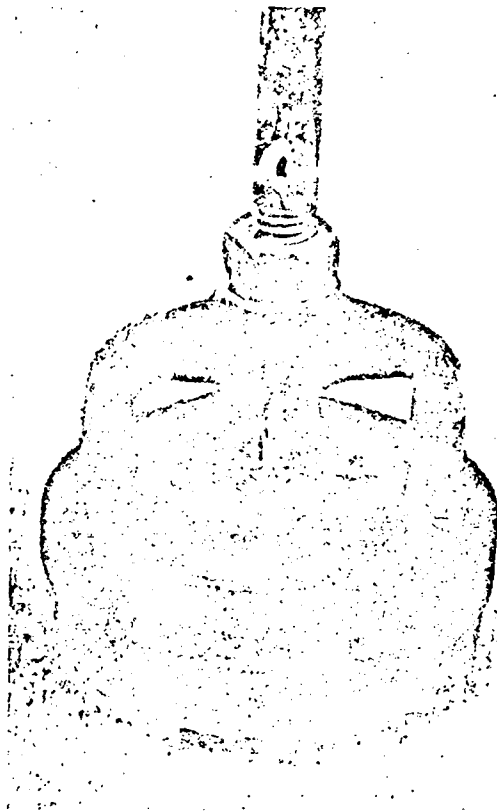
Figure 3 shows a typical pump plunger with a metal poppet valve located in the middle of the plunger. Figure 4 shows the typical wear sustained by a metal poppet.

Figure 5 shows a weighted flapper valve installed in a pump plunger in place of the metal poppet. The neoprene-impregnated nylon flapper is attached to the plunger with two screws. To facilitate this attachment, three supports are used for the pump rod attachment rather than the four shown in Figure 3. A metal weight is attached to the back of the flapper to keep the flapper from floating and to insure that the flapper makes a satisfactory seal with the seat.

The plunger shown in Figure 5 was cast from bronze. The assembly was operated in a typical shallow-well pump for more than 5000 hours. A visual examination of the parts after the test showed no sign of wear or fatigue.

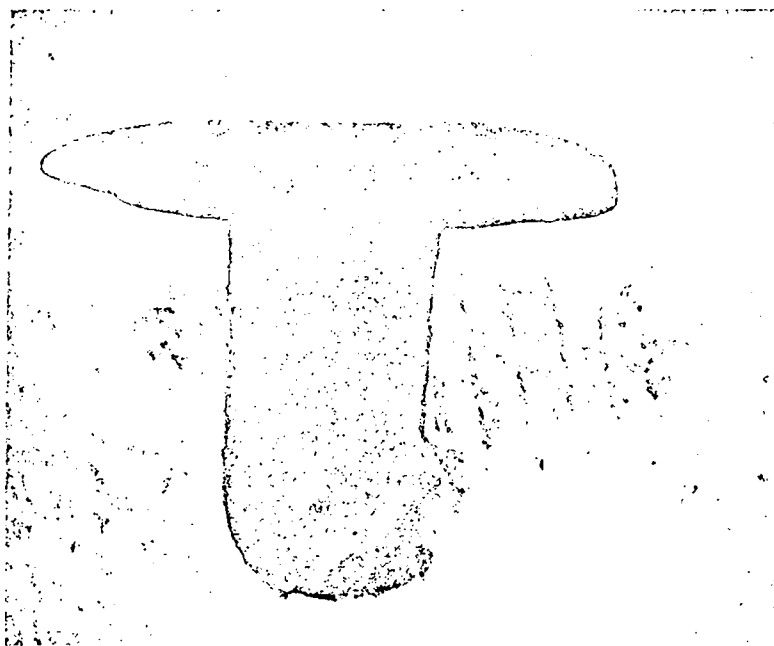
Serrated Flapper Valve Design

The second flapper-type plunger valve that was developed and evaluated is shown in Figures 6 and 7. It is similar to a valve described by drawings



35516

FIGURE 3. TYPICAL PUMP PLUNGER WITH
METAL POPPET VALVE



39826

FIGURE 4. WORN CAST-IRON POPPET FROM PLUNGER
VALVE AFTER SEVERAL TEST PERIODS

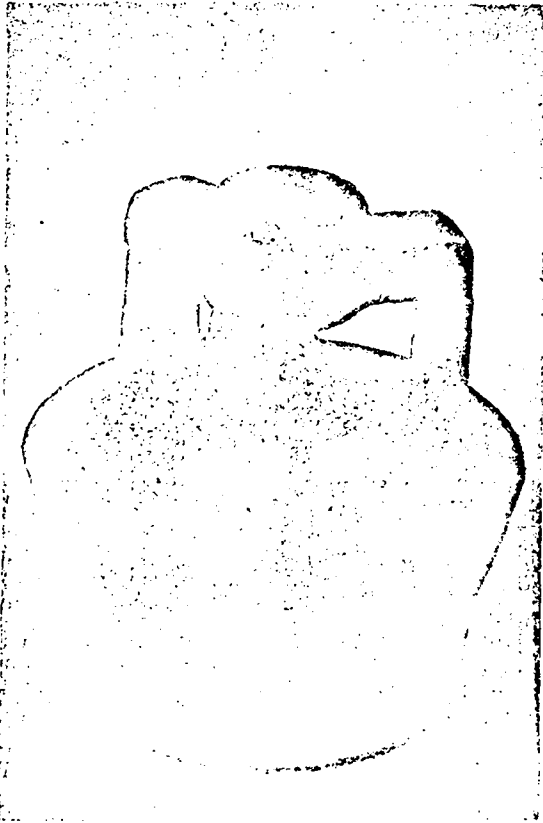


FIGURE 5. WEIGHTED FLAPPER VALVE
INSTALLED IN PUMP PLUNGER

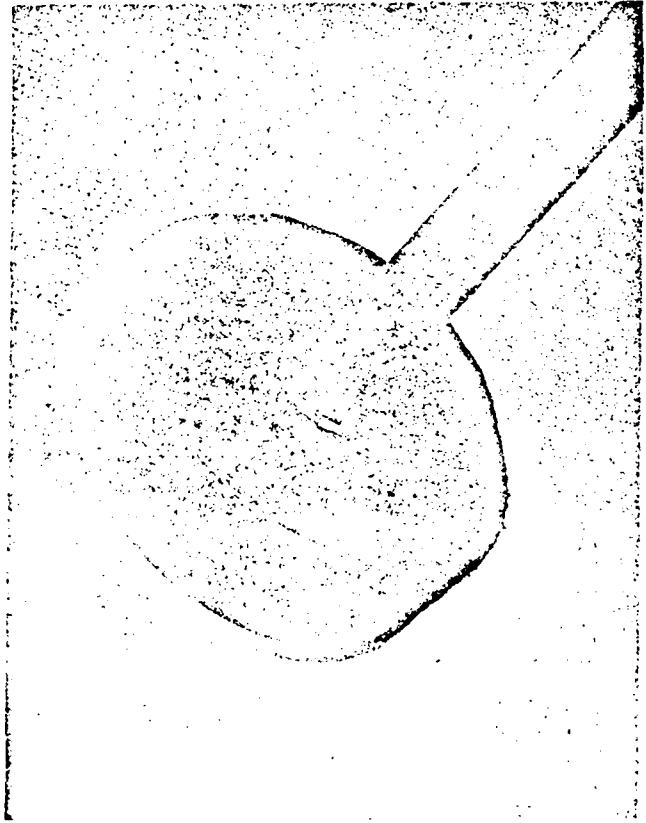


FIGURE 6. ASSEMBLED SERRATED FLAPPER
VALVE AND PLUNGER

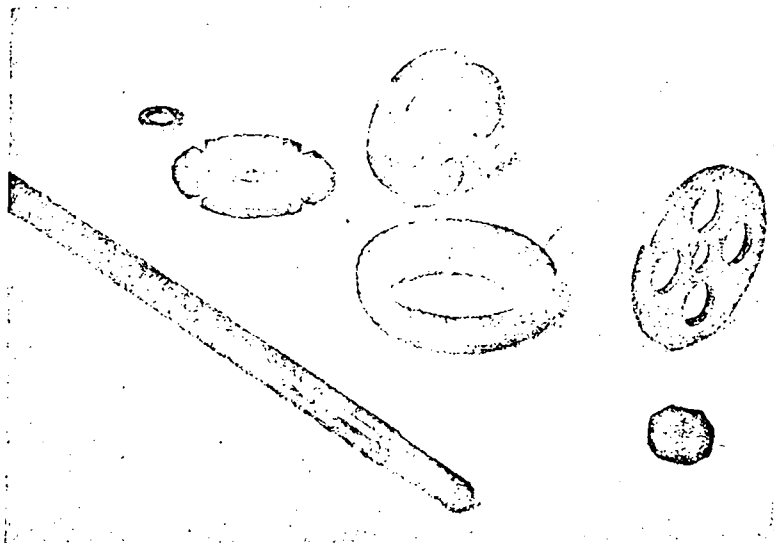


FIGURE 7. DISASSEMBLED SERRATED FLAPPER VALVE
AND PLUNGER

from the Department of Sanitation in Lima, Peru. The drawings were sent to Battelle by Dr. Charles Spangler, who was formerly with PAHO.

The serrated flapper valve is composed of parts which are simple to make. The cup seal is a standard shape. The flapper can be stamped or cut from sheet material, and the metal supports can be made from castings or from bar stock. As with the weighted flapper valve, the serrated flapper valve was operated for over 5000 hours with no detectable signs of wear or fatigue.

Valve Comparison

It is believed that both flapper-type plunger valves will provide significantly longer life than the conventional metal poppet valves. However, the two flapper valves are somewhat different, and their differences are summarized below:

- (1) The weighted flapper valve is more conventional in appearance and may be more acceptable to those who are familiar with standard pump plungers.
- (2) The serrated flapper valve is less expensive to manufacture.
- (3) Both flapper-type plunger valves operate equally well for shallow-well pumps and for deep-well pumps for depths to 50 feet.
- (4) The weighted flapper valve should be used for wells deeper than 50 feet primarily because of the ease of adding additional cups.

Task C. Selection of Optimum Cup Material

The work during the previous program showed that high-quality leather is a good material for plunger cup seals. (A typical cup seal is shown in Figure 7.) Wide tolerances are acceptable and long life can be expected with fairly smooth cylinders. However, very poor leather is produced in some geographical areas, and even good leather is deteriorated (cracked) by alternately wetting and drying. In addition, poor storage conditions can cause excessive deterioration of cups held in stock. Thus, a part of the follow-on program was directed toward finding a leather substitute that would have uniform properties and be less affected by wetting and drying and by poor storage conditions.

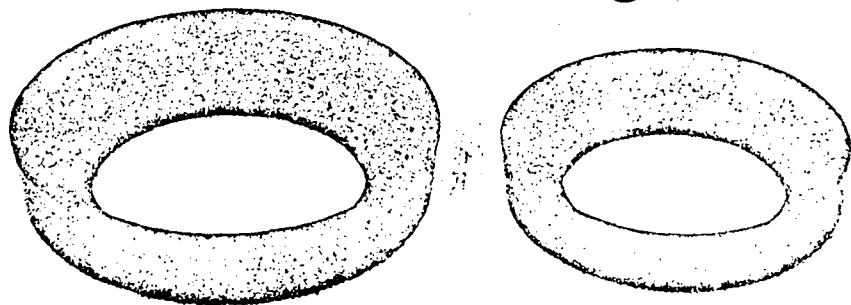
Five materials, including leather, were selected as being typical of the candidate materials that are presently available for cup seals:

- (1) Rek-Syn, manufactured by the E. F. Houghton & Company-- a relatively stiff elastomer-plastic material with a low coefficient of friction
- (2) Vix-Syn, also manufactured by the E. F. Houghton & Company--a relatively stiff elastomer-duck material
- (3) Corfam (in three compositions), manufactured by DuPont:
 - (A) A relatively thin Corfam coated on the exterior with graphite. Test cups were purchased from the Lubrikup Company, Williamsport, Pennsylvania
 - (B) A medium flexible Corfam impregnated with wax and coated on the outside with rubber. Test cups were purchased from the Page Belting Company, Concord, New Hampshire
 - (C) A stiff Corfam; test cups were purchased from the Page Belting Company
- (4) Rulon J, a flexible polymeric-reinforced Teflon; test cups were purchased from the Dixon Corporation, Bristol, Rhode Island
- (5) Leather of two types:
 - (A) Oak-tanned, with the hair side out; test cups were purchased from the Dempster Company, Beatrice, Nebraska
 - (B) Chrome-tanned, with the hair side out; test cups were purchased from the E. F. Houghton & Company.

All of the cup materials were operated for approximately 1000 hours in plastic cylinders or in epoxy-phenolic-coated metal cylinders at 55 strokes per minute with a 5-1/2-inch stroke. These hours of operation are equivalent to approximately one year of pumping at the rate of 1500 gallons per day. This quantity was established by AID as the average quantity of water pumped by hand in many communities of the developing nations. With the exception of a 2-inch Corfam cup molded by the Lubrikup Company and a 2-1/2-inch Rulon cup, all the cup materials were evaluated in both shallow-well and deep-well pumps.

Rek-Syn

Figure 8 shows Rek-Syn cup seals after 964 hours of operation. The test showed that the material has low friction and is wear resistant. However, as the cups wore, the material did not stretch to maintain good contact with the pump-cylinder walls. Pumping effectiveness was reduced and it was apparent that the cups had a shorter useful life than leather cups.



2

FIGURE 8. REK-SYN CUPS AFTER 964 HOURS OF OPERATION



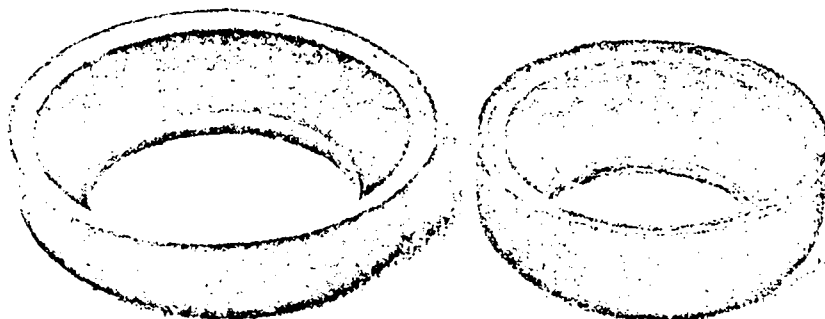
1

FIGURE 9. VIX-SYN CUPS AFTER 1020 HOURS OF OPERATION



4

FIGURE 10. VERY FLEXIBLE 3-INCH CORFAM CUP AFTER 1121 HOURS OF OPERATION AND 2-1/2-INCH RULON J CUP AFTER 949 HOURS OF OPERATION



3

FIGURE 11. MEDIUM FLEXIBLE 3-INCH CORFAM CUP AFTER 1040 HOURS OF OPERATION AND STIFF 2-1/2-INCH CORFAM CUP AFTER 1150 HOURS OF OPERATION

Vix-Syn

Figure 9 shows Vix-Syn cup seals after 1020 hours of operation. Although the cups were still functioning at the end of the test, they showed more wear than any other test material. In addition, as with the Rek-Syn cups, the Vix-Syn cups did not stretch as much as the leather cups.

Corfam

Cups made of the three Corfam materials were operated for over 1000 hours. Figure 10 shows a very flexible 3-inch cup, while Figure 11 shows a 2-inch medium flexible cup, and a 2-1/2-inch stiff cup. Good wear resistance was exhibited by all of the Corfam cups. However, the very flexible cup and the stiff cup had the same difficulty maintaining contact with the cylinder walls that was exhibited by the Rek-Syn and Vix-Syn cups. In contrast, the medium flexible Corfam cup exhibited good stretch and maintained good contact with the cylinder wall. In lots of 100 to 1000 pieces, the 3-inch cup was estimated to cost from \$90 to \$100 per hundred.

Rulon J

Rulon J is a fluorocarbon made to run dry against soft materials such as aluminum and brass. Figure 10 shows a 2-1/2-inch Rulon J cup seal after 949 hours of operation. Although the cup was still functioning at the end of the test, the plunger had begun to chatter during the last week of testing. This seemed to be caused by the narrow, stiff wall of the cup which did not conform well with the cylinder wall.

Leather

The leather cup seals were tested primarily as a control against which the other materials could be compared. Figures 12 and 13 show chrome-tanned and oak-tanned leather cup seals after approximately 1000 hours of operation. The more expensive, chrome-tanned, wax-impregnated leather cups showed very little wear and remained soft even after drying. The oak-tanned, nonwaxed leather cups showed a definite wear and became stiff when dry. The price of 3-inch chrome-tanned leather cups is approximately \$128 per hundred in lots of 500 cups.

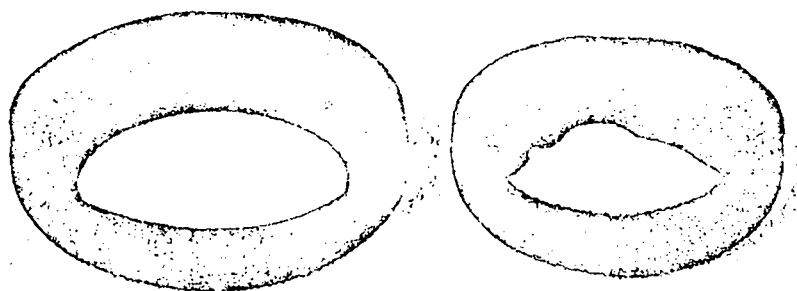
Plunger-Cup Material Comparison

Based on the laboratory tests summarized above, the following conclusions were reached concerning the selection of plunger-cup seal materials:



5

FIGURE 12. CHROME-TANNED, WAX-IMPREGNATED LEATHER CUPS AFTER 948 HOURS (3-INCH) AND 1106 HOURS (2-1/2-INCH) OF OPERATION



6

FIGURE 13. OAK-TANNED, NONWAXED LEATHER CUPS AFTER 1147 HOURS (3-INCH) AND 1039 HOURS (2-1/2-INCH) OF OPERATION

- (1) Wax-impregnation of leather is one of the major factors in extending the life of leather cup seals because the leather tends to remain soft whether wet or dry
- (2) Wax-impregnated Corfam cup seals of the proper flexibility, coated on the outside with nitrile or urethane rubber, will provide better performance than the best leather cup seals
- (3) The major factor limiting the performance of cup seals made from other materials is the reduced ability of the materials to stretch and conform to the cylinder walls as compared with Corfam and leather.

Task D. Evaluation of Cylinder Coatings

The greatest single factor in pump longevity is the smoothness of the cylinder bore. During the previous program, it was found that commercially available steel pipe could be converted into relatively smooth pump cylinders with a nonmetallic coating. However, the successful epoxy phenolic coating evaluated during the first program requires a moderate amount of baking on the pipe as a part of its processing. As simple and easy as this process is in the United States, a coating that did not require baking would be more acceptable in some developing nations. Therefore, one objective of the follow-on program was to find a satisfactory cylinder coating that did not require special processing, such as heat treating.

After a review of candidate cylinder coatings, three coatings were selected for evaluation:

- (1) Marine epoxy
- (2) High-build vinyl
- (3) Pigmented uralkyd.

The coating materials were evaluated by using each to coat a 2-1/2-inch-diameter pipe specimen and a 3-inch-diameter pipe specimen. Each of the six pipe specimens, as shown in Figures 14, 15, and 16, was then operated for over 1000 hours with leather plunger cup seals at 55 strokes a minute with a 5-1/2-inch stroke.

Prior to application of the coatings, the pipe specimens were cleaned in the following manner. The cylinders to be coated with the marine epoxy and the uralkyd were cleaned with methylethylketone, mineral spirits, and soap and water. The cylinders to be coated with high-build vinyl were cleaned with methanol, mineral spirits, and soap and water. The cleaning solutions were applied with rags and a steel brush, and the cylinders were allowed to air-dry.

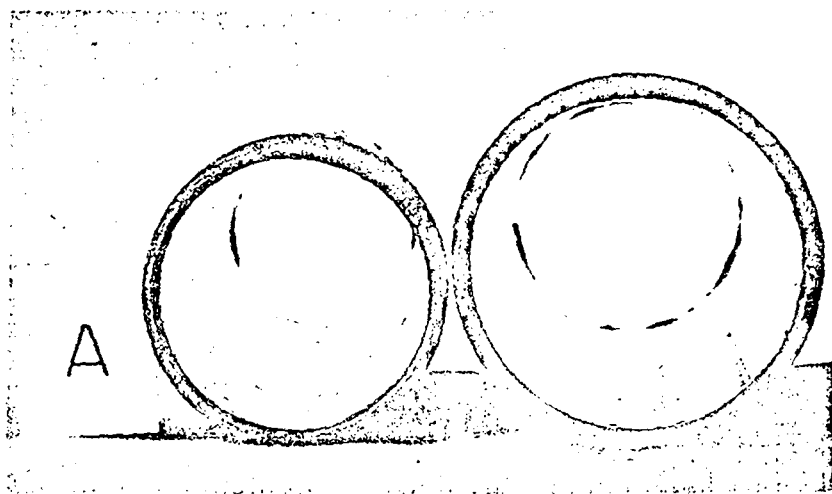


FIGURE 14. VINYL-COATED PIPE SPECIMENS AFTER
1000 HOURS OF OPERATION

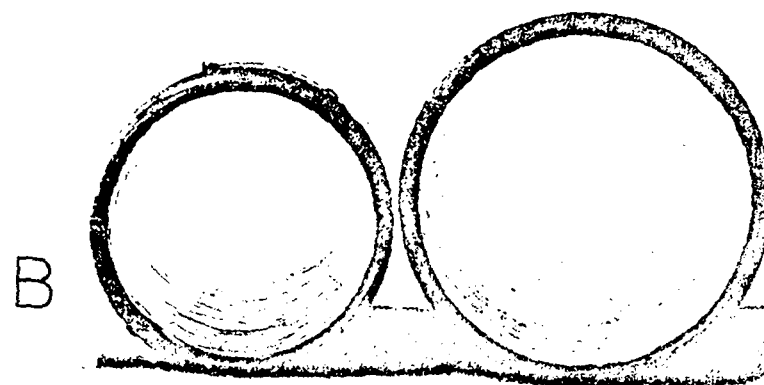


FIGURE 15. EPOXY-COATED PIPE SPECIMENS AFTER
1000 HOURS OF OPERATION

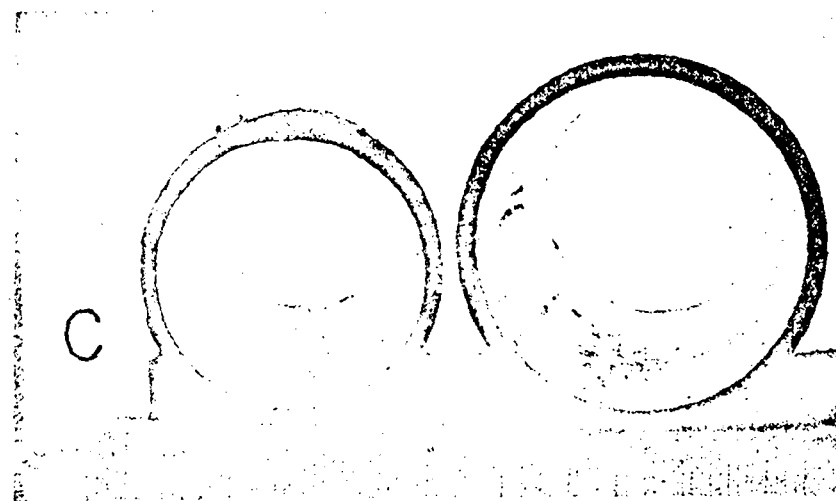


FIGURE 16. URALKYD-COATED PIPE SPECIMENS AFTER
1000 HOURS OF OPERATION

Each coating was applied by placing a cap over one end of the pipe, placing the selected solution in the pipe, placing a cap over the other end of the pipe, and rolling and turning the pipe to distribute the solution over the pipe wall. The end caps were then removed and the excess solution was allowed to drain back into the container.

Primers were required for two of the coatings. For the epoxy, the primer consisted of epoxy thinned at the rate of 1 pint of solvent to 4 pints of epoxy. A vinyl wash primer was used for the vinyl.

The pipe specimens were allowed to air-dry in the vertical position with a free flow of air. To limit the amount of running, an electrical fan was used to circulate air through the cylinders to accelerate drying. With this arrangement, the specimens were dry to the touch in 8 to 10 hours, but should be allowed to cure 24 hours before recoating and 2 weeks before use.

The marine epoxy coatings were approximately 0.008 inch thick and had a smoothness of about 40 to 60 CLA (centerline average). The high-build vinyl coatings were about 0.006 inch thick and had a smoothness of about 26 CLA, while the pigmented uralkyd had a thickness of about 0.004 inch and a smoothness of about 10 CLA. The CLA values included the roughness due to running. For comparison, good cast-iron cylinders made in the United States have a smoothness of from 40 to 200 CLA. The baked epoxy phenolic that was tested during the previous program had a smoothness of from 12 to 18 CLA.

The cylinders were inspected following the 1000 hours of testing. No appreciable wear could be detected visually, and there were no breaks in any of the coatings. Likewise, very little wear was noticed on the leather cups. Thus the performance of the coatings was estimated to be equal and satisfactory.

The epoxy and vinyl coatings are estimated to cost about 10 to 15 cents per cylinder, while the uralkyd coating is estimated to cost somewhat less. Because the epoxy coating was found to be somewhat harder than the other coatings, and because a harder coating should be more resistant to wear from the cup seal, the epoxy coating was judged to be the best for pump use.

Task E. Additional Component Investigations

Two types of additional component investigations were completed as a result of the decision to discontinue the work related to field evaluation of the pumps. One type consisted of an investigation of cylinder-foot-valve performance, while the other type consisted of an investigation of pins and bushings for the pump-handle pivots.

Cylinder-Foot-Valve Investigation

In conjunction with the tests of the plunger cup seals and the cylinder coatings that have been described previously, over 10,000 hours of operation were achieved for the cylinder foot valves. This was equivalent to 10 years of hard use.

After approximately 5500 hours of operation, the flapper foot valve of the shallow-well pump showed excessive erosion of the valve seat. It is believed that this condition could be improved if a bronze seat were placed under the flapper valve. Bronze has been used successfully to combat such erosion in other applications. Because of the cost of inserting the bronze seat, this design should be used only for installations where particularly long life is required.

After approximately 8300 hours of operation, the metal poppet in the cylinder of the deep-well pump wore the poppet valve housing to the point that the poppet tended to cock and stick open. This prevented pumping. The best solution to this problem is believed to be neoprene-impregnated nylon flapper valves. Longer operation could be obtained with the metal poppet valve by using a longer guide section.

Pins and Bushings

Bearings are required where the pump handle pivots on the body, and where the pump handle attaches to the oscillating rod. UNICEF requested that an investigation be made to find better bearings for these locations.

A search was made for nonlubricated bushings which would have good weatherability, long life, low absorptivity, and low cost. Although several materials seemed to be candidate, Rulon was judged to be significantly better relative to the other materials. Rulon is a specially compounded TFE fluorocarbon made by the Dixon Corporation.

The material selected for the pins was a hardenable stainless steel, 17-4 PH. This material is in general use, and it has not only corrosion resistance, but also good hardness. The heat-treated condition selected for evaluation was H1025, which gives a pin hardness of about 32 Rockwell C.

A Rulon T-Liner was chosen to be evaluated first. A T-Liner bearing is made up of a shell of metal (stainless steel or cadmium-plated steel) in which a strip of Rulon is placed. T-Liner bearings were placed in the handle at the fulcrum and at the rod end. The bearing at the rod end lasted satisfactorily over 10,000 hours. After 5133 hours of operation, one of the steel shell bearings at the fulcrum which had been improperly inserted had worn through and the Rulon had been destroyed. The T-Liner bearings were replaced with a solid-Rulon bearing and no wear could be detected after 5300 hours of operation. The performance of the pins was satisfactory in all cases.

It is thus recommended that solid Rulon bearings and 17-4 PH stainless steel pins or equal be used when improvement of the handle bearings is justified. For long-term retention, it is recommended that the Rulon bearings be pressed and glued into place.

Task F. Information Dissemination

A joint AID-Battelle press release prompted a surprising response from all over the world. Appendix B shows the release and the recipients of the release. With the discontinuance of the field-evaluation effort, and with a large expression of interest as a result of the press release, it was decided that the dissemination of project information to interested parties would be in keeping with the overall objective of eventually having the pumps used by the developing nations.

Of the 66 requests for information that were received, 58 were believed to be of sufficient merit to receive project information. Represented in the requests were: 20 countries, 21 universities and foundations, 12 Government agencies, and 24 businesses.

As listed in Appendix C, 25 responses consisted of packets containing a full set of drawings, a parts list, a final report on the previous program, and a letter containing pertinent information. The remaining 41 replies contained all of this information except the drawings and the parts lists. A few replies contained selected assembly drawings. In addition, 135 copies of the final report on the first program were forwarded to AID for distribution in response to requests for information.

FUTURE WORK

Countless people in the developing nations need reliable hand pumps to supply them with life-giving water. The most difficult steps for satisfying this need still have to be accomplished. Although there are a number of ways of reaching the ultimate objective, the following appear to be principal steps in any program:

- (1) Incorporate the information gained during the follow-on program in the drawings and specifications
- (2) Select areas in developing countries for pump fabrication, demonstration, and evaluation
- (3) Assist manufacturers and government agencies in the selected countries
- (4) Establish personnel to obtain and evaluate data on the fabrication and operation of the pumps
- (5) Arrange for instruction in pump fabrication to be taught during the Ground Water Course presently available at the University of Minnesota.

Step 1

Drawings and specifications were prepared at the beginning of the follow-on program for the field evaluation efforts. Since the pumps for field evaluation were not made, and since pump improvements were developed in the follow-on program, the pump drawings and specifications should be revised to include the results of the follow-on program. This will insure that the pumps which are eventually fabricated for field testing will include all of the recommended features. This can be done by Battelle-Columbus in about one week.

Step 2

It is expected that a number of developing countries will eventually use the AID pump. However, certain areas are more desirable than others for field testing the hand-pump configuration. In selecting countries for field testing, it will be important to identify those which maintain good relationships with the United States and for which there are no major problems of communication--either because of language difficulties or because of poor mail service. It will also be necessary to select countries that recognize the need for hand pumps. This will insure good cooperation during follow-up to obtain the test results. Finally, it will be necessary to select countries that have typical water problems so that the performance of the test pumps can be fairly evaluated. It appears that this selection process should be conducted by personnel from AID and from Battelle-Columbus.

Step 3

Considerable discussion will be required with personnel from the selected countries concerning manufacturing and field evaluation procedures. Meetings will probably be held first with personnel from the government agencies of the selected countries to discuss the overall manufacturing and field testing plans. If these discussions are held with one person from AID and one person from Battelle-Columbus, it should be possible to select the best approach to be used in each country. Follow-up discussions will probably then be necessary between the Battelle employee and personnel from the manufacturing facilities to discuss technical features of the pump. Although no large problems are envisioned in making the necessary arrangements, such discussions should avoid the development of unnecessary misunderstanding and confusion.

Step 4

Probably the most critical aspect of the field evaluation effort is the feedback of information from the manufacturer and from the operation of the

pumps. In some cases it may be possible to have local government personnel obtain the necessary information. In general, however, it is believed that two procedures should be followed. In the case of the manufacturer, it will probably be best for a person from Battelle-Columbus to visit each manufacturer after the field pumps have been fabricated to obtain a detailed description of the manufacturer's experience. In the case of the pump installations it will probably be best to have a record kept of any parts needed for a period of time, say a year, and then to have selected pumps returned to Battelle-Columbus for examination. Information from the manufacturers and the pump installations can then be examined to determine whether changes should be made in the pump design.

Step 5

The Ground Water Course which is available at the University of Minnesota would seem to be a good place to start the systematic description of the operation and benefits of the AID pump. With materials available from the development program, it should be easy for a short course to be set up on the pump. This could be accomplished by a person from Battelle-Columbus.

APPENDIX A

ASSEMBLY DRAWINGS AND PARTS LISTS
FOR AID HAND PUMP

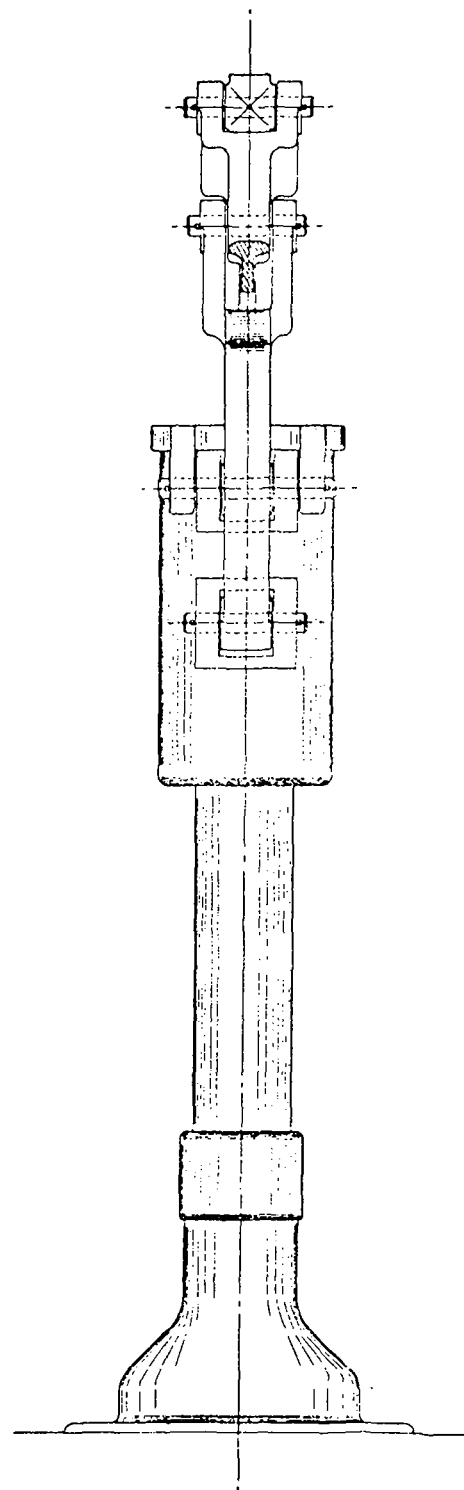
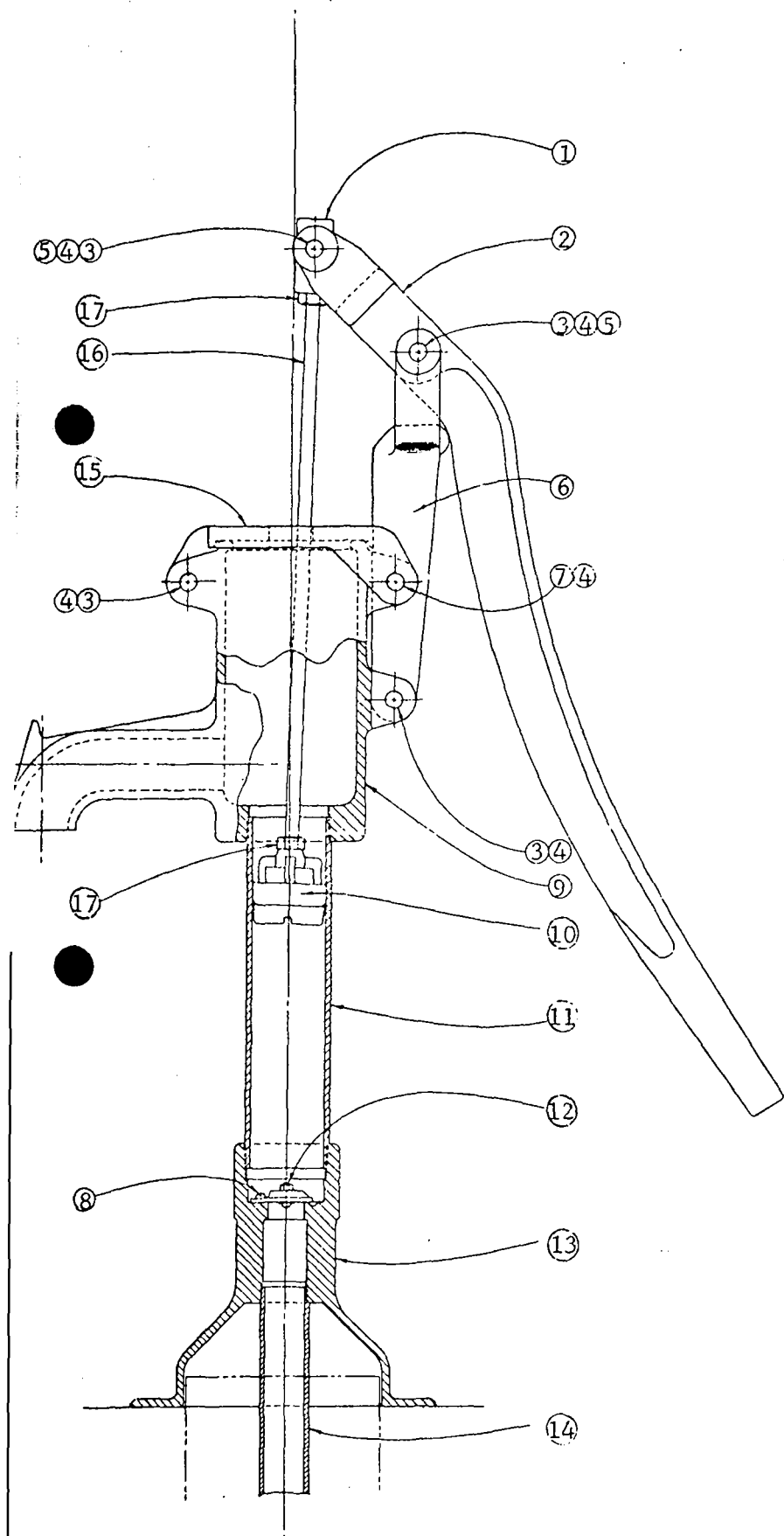


FIGURE A-1. SHALLOW-WELL PUMP

A-2

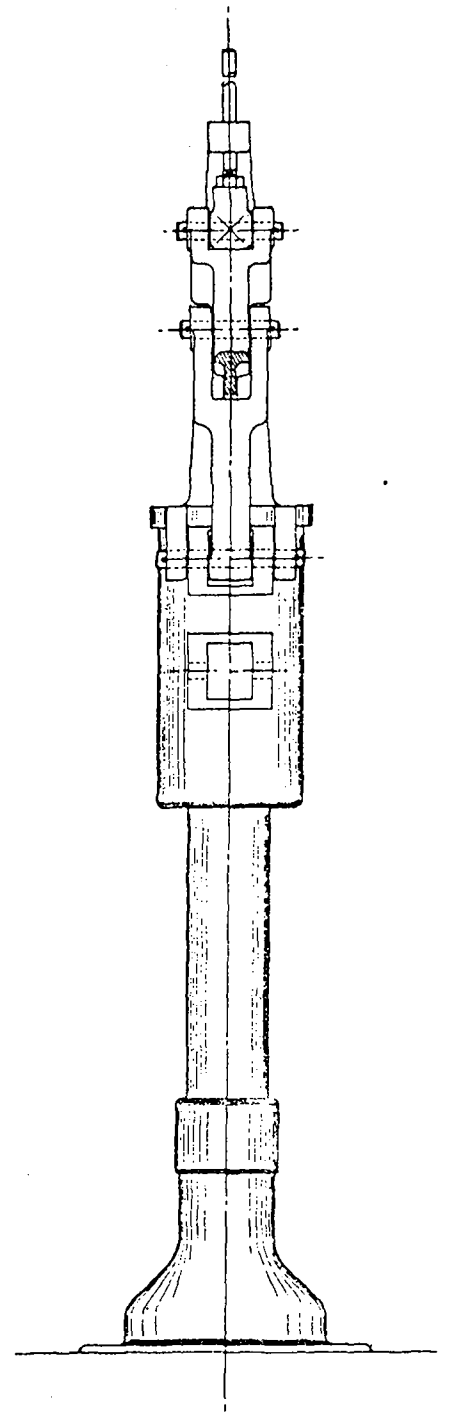
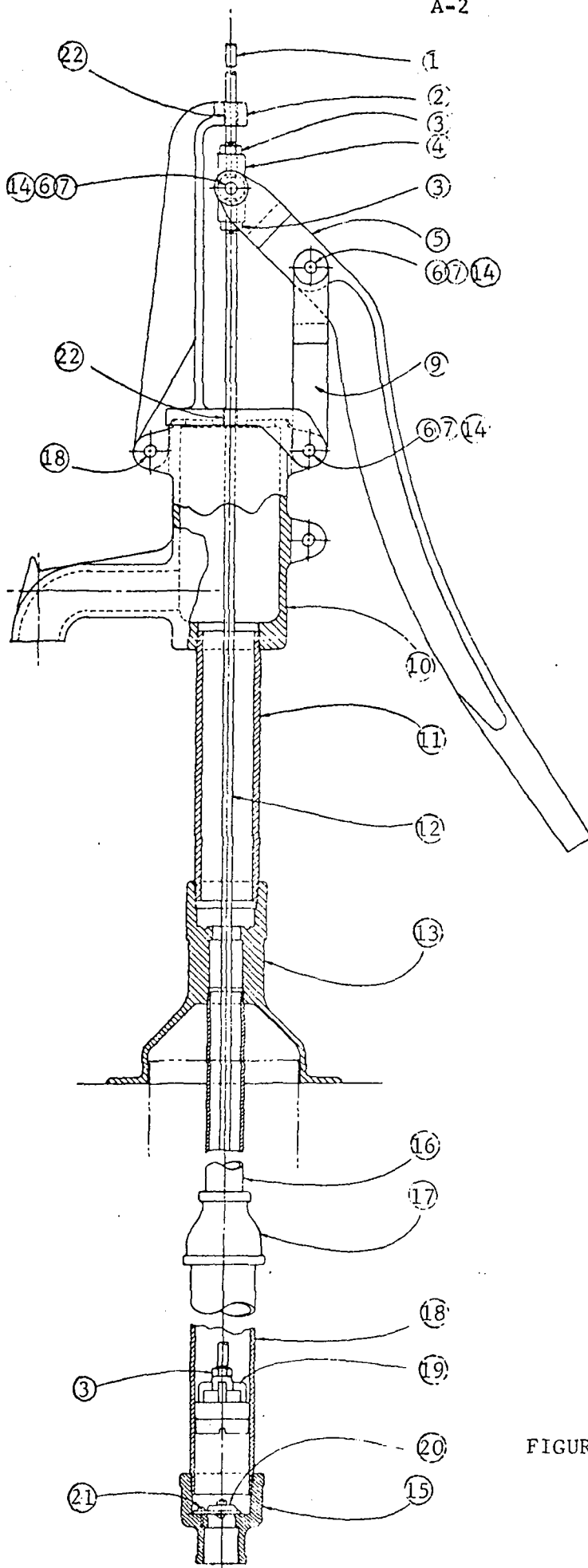


FIGURE A-2. DEEP-WELL PUMP

PARTS LIST FOR SHALLOW-WELL PUMP

1. Rod End
2. Pump Handle
3. Pin
4. 1/8-in. Extended Miter - Cotter Pin
5. Experimental Bearings*
6. Fulcrum
7. Pump Cap Pin - Rear
8. No. 10-24 x 1/2-in. -long Brass Round Head Screws
9. Pump Body
10. Plunger Assembly
11. Pump Cylinder
12. Lower Check Valve Assembly
13. Pump Stand
14. 1-1/4-in. Galvanized Steel Pipe
15. Pump Cap
16. Pump Rod
17. 7/16-14 UNC-2B Hexagonal Jam Nut

* Various Bearing Materials Being Considered

PARTS LIST FOR DEEP-WELL PUMP

1. Bearing Rod
2. Pump Rod Guide
3. 7/16-14 UNC-2B Hexagonal Jam Nut
4. Rod End
5. Pump Handle
6. Pin
7. 1/8-in. Extended Miter - Cotter Pin
8. Pump Cap Pin - Rear
9. Fulcrum
10. Pump Body
11. 12-in. -long Sch. 80 Seamless Galvanized Pipe - Thread Each
End 8 N. P. T. x 2-1/2-in. long
12. 7/16-in. -diameter Standard Galvanized Pump Rod and Couplings
13. Pump Stand
14. Experimental Bearings*
15. Lower Valve Housing
16. 1-1/4-in. Galvanized Steel Pipe
17. Cast Iron Pipe Reducer
18. Pump Cylinder
19. Plunger Assembly
20. Lower Check Valve Assembly
21. No. 10-24 NC-2A x 1/2-in. -long Brass Round Head Screws
22. Sleeve Bearings*

* Various Bearing Materials Being Considered

APPENDIX B

PRESS RELEASE ON AID HAND PUMP

APPENDIX B

PRESS RELEASE ON AID HAND PUMP

The following news release about the AID hand pump was issued in June, 1969, to news media in the United States, Canada, England, France, Germany, India, Spain, Sweden, and Venezuela. Total distribution included 128 technical, 65 national, and 2 local publications. Foreign distribution was made to 5 publications in Canada, 5 in England, 2 each in India, Sweden, and Venezuela, and 1 each in France, Germany, and Spain.

It is interesting to note that even though only 8 countries outside the continental United States received copies of the release, requests for additional information about the pump have been received from 20 foreign countries (see Appendix C).

NEWS FROM

Battelle Memorial Institute
COLUMBUS LABORATORIES
505 KING AVENUE, COLUMBUS, OHIO 43201 • TELEPHONE 293-3151 • AREA CODE 614

For Immediate Release

A new version of the once-common hand water pump has been designed by a Columbus, Ohio, industrial research organization for manufacture and use in the less developed countries.

Engineers of the Columbus Laboratories of Battelle Memorial Institute produced the design under a \$58,000 research contract with the Agency for International Development (AID). It includes features which should help solve some of the major problems in the developing countries in the manufacture and operation of standard pumps.

The design for the new pump is said to make possible:

- * long life under rigorous operating conditions
- * ease of maintenance with simple tools and unskilled labor

(MORE)

- * manufacture in developing areas with minimal investment
- * adaptation to both deep and shallow wells
- * low production costs.

Prior to the start of the pump development program in July, 1966, AID and Battelle officials surveyed the need for water pumping equipment in urban and rural communities in East Pakistan, India, Jordan, the Philippines, and Thailand. They found numerous areas in which as many as 300 people depended upon a single pump for their water supply. This resulted in day and night operation and consequent heavy strains upon equipment often substandard in design and manufacture.

Thus, in addition to a shortage of pumps, there were frequent breakdowns of pumps already installed. Some of the causes were poorly fitting parts, corroded parts, and lack of replacement parts. Fits were so poor in some instances that bolts had to be wrapped with jute before they would hold the parts together.

Pump maintenance is also hampered by the scarcity of skilled labor. Chances are that when a pump breaks down it will be disassembled and forgotten, while the people revert to using rope and bucket.

(MORE)

The research team evolved a design that incorporates inexpensive corrosion-resistant cylinders and a minimum number of parts and threaded fasteners. Most of the components are of cast iron. The simple piston design is flexible enough to adapt to the technical levels of nations with a small industrial base.

Research is continuing in an effort to develop simpler methods of insuring cylinder smoothness, find substitutes for the leather used in cups, and evaluate designs for improved valves.

In addition to developing the design, the research team devised a plan under which the pump can be manufactured in the less developed countries in small foundries with very few power tools.

Mailing Date: 6/27/69
44-69

APPENDIX C

LIST OF INQUIRIES FOR AID HAND-PUMP
INFORMATION

APPENDIX C

LIST OF INQUIRIES FOR AID HAND PUMP INFORMATION

Requests for information were received from 66 sources, as listed below. The 25 sources marked with an asterisk received packets of information containing a full set of drawings, a parts list, a final report from the previous program, and a letter. The remaining 41 sources received similar information with the exception of the drawings and the parts list.

Government Agencies

*CEDECO Kimpese Rep. Dem, du Congo	*Department of Agriculture, Stock and Fisheries Port Moresby, Papua
Shelter Research Division Office of Civil Defense Department of the Army Washington, D.C., USA	Sanitary Engineering Division Edgewood Arsenal Edgewood, Maryland,,USA
*Forest Industrial Advisor U.S. Embassy (U.S. AID) Vientiane, Laos	*U.S. AID, Capital Development and Industry Rio de Janeiro, Brazil
*U.S. AID Bureau for Latin America Washington, D.C., USA	*U.S. AID Mission to Nepal Kathmandu, Nepal (c/o Washington, D.C., USA)
U.S. AID "Punto IV" Quito Washington, D.C., USA	*U.S. AID, Department of Agriculture Bangalore, India
	*U.S. AID, U.S. Embassy Vientiane, Laos

Businesses

*American Alloy Corp. Cleveland, Ohio	*Amrit Banaspati Company, Ltd. Rajpura, Punjab, India
*Banaspati Company Rajpura, Punjab, India	Camp, Dresser, & McKee International, Inc. Boston, Massachusetts, USA
Clark Equipment Company Buchanan, Michigan, USA	Dames & Moore Atlanta, Georgia, USA

Businesses (Continued)

*Dinamica, SA San Jose, Costa Rica	Do Buzi Company Beira, Mozambique
General Merchant & Importer Saigon, Vietnam	Gould Pumps, Inc. Seneca Falls, New York, USA
Indocean Engineers Hyderabad, India	James M. Jennings Associates Columbus, Ohio, USA
*Larsen & Toubro, Ltd. Bombay, India	Manufacturer's Representative Saigon, Vietnam
Miller Felpax Corporation Winona, Minnesota, USA	Modern Agriculture Company Alexandria, Virginia, USA
Penn Central Company Cleveland, Ohio	Punji Sons, Private, Ltd. New Delhi, India
Raymond Beunet Associates Concord, N.S.W., Australia	Republic Steel Corporation Cleveland, Ohio USA
*Singapore Foundry & Machine Singapore	Southern Alloy Foundries Private, Ltd. Madras, India
*TNC International, Ltd. Bangkok, Thailand	*Tropical Products Institute London, England
Union Carbide, India, Ltd. Madras, India	

Universities

*Engineering Research Institute (Central Public Health) Nehru Marg, Nagpur-3, India	Massachusetts Institute of Technology Department of Mechanical Engineering Cambridge, Massachusetts, USA
Research & Training Institute- Mlingano Tanga, Tanzania	*University of Lagos (College of Medicine) Lagos, Nigeria
*University of Philippines (College of Veterinary Medicine) Quezon City, Philippines	University of Reading London, England

Foundations

AFPRO New Delhi, India	American Council of Voluntary Agencies for Foreign Service New York, New York, USA
*CARE, Inc. (for Chile) New York, New York, USA	*ICAITI Guatemala, Central America
International Institute of Rural Reconstruction New York, New York, USA	*Material Resources Program Church World Service New York, New York, USA
Meals-for-Millions Foundation Santa Monica, California, USA	National Institute of Agricultural Engineers Bedford, England
*Pan American Development Foundation Washington, D.C., USA	Public Welfare Foundation, Inc. Washington, D.C., USA
Dr. Jose P. Rizal - Gen. Douglas MacArthur Memorial Foundation Milwaukee, Wisconsin, USA	The Thomas A. Dooley Foundation, Inc. San Francisco, California, USA
VIDSCO California, USA	VITA Schenectady, New York, USA
*World Neighbors Oklahoma City, Oklahoma, USA	

Publications

Engineering London, England	Foundry Cleveland, Ohio, USA
New Scientist London, England	World Farming Kansas City, Missouri, USA

Individuals

Mr. S. R. Bhatt Surat, India	Mr. Amin M. Lakhani Cambridge, Massachusetts, USA
Mr. R. Mahaderan Madras, India	Mr. S. Sood West Bengal, India
*Mr. Robert G. Unruh Asuncion, Paraguay	

C-4

Countries

Australia
Brazile
British West Africa
Congo
Costa Rica
England
Guatemala
India
Laos
Mozambique

Nepal
Nigeria
Papua
Paraguay
Philippines
Singapore
Tanzania
Thailand
United States
Vietnam

GUIDELINES ON HAND PUMPS
FOR USE IN DRAINING WATER SUPPLIES
IN DEVELOPING COUNTRIES

The above-mentioned document has been carefully studied and I would like to make the following comments and suggestions.

PUMP HANDLE: 3.4

The use of wooden handle should be highly encouraged in the manufacture of hand pumps in the developing countries. As the report rightly points out the wooden handle has several advantages such as low cost, readily replaced locally, etc. However emphasis should be placed on the type of wood to be used. Local wood of the hardy, non-splinter, termite-proof type is preferable. The operating mechanism, either lever or wheel, should be of suitable material and also most convenient to operate.

HAND LEVER FULCRUM

This part of the pump has been one of the major failures of many pump programmes. The failures are mainly due to poor material used in the manufacture of the Fulcrum arrangements. Such arrangements as "steel-on-steel" with a loose bolt arrangement tends to wear much faster than say, cast iron-on-steel. I further suggest that to ensure a tight non-moving bolt arrangement at the Fulcrum a lock washer with a nut should be used. Because of the heavy weight at the Fulcrum we suggest that all bearings specified should require minimum attention, and where possible should be self-lubricating, such as sintered bronze bearing which is an oil impregnated bearing that requires no oiling. This type of bearing will be slightly more expensive but will prolong the life of the hand pump.

PUMP BODY: 3.7

It is suggested that where the pump body is fabricated the pump base should be given double welding as this part tends to break. The base plate of the pump should also be slightly thick to allow big bolts with high tensile strength to be used to hold the pump firmly to the platform.

The pump body is to be constructed with non-corrosive materials suitable for use with waters of low pH value; the same can be said of the material of the drop pipe.

PUMP ROD: 3.8

The design of many of the hand pumps in the market today did not make provision for guides for the pump rod in order to eliminate lateral movement of the pump rod and this has been the cause of excessive wear and eventual failure of the pump rod. The design of the Battelle Pump is a typical example of this shortcoming.

CYLINDER: 3.13

In selecting material for the manufacture of Cylinder for the hand pump attention must be given to the quality of water as waters of low pH value tend to attack Cylinders made of cast iron and other iron bearing materials. Chemical examination of the ground water must be carried out in order to determine whether the water is aggressive or otherwise. The report has outlined a number of non-corrosive materials which can stand waters of low pH value.

COMMUNITY ACCEPTANCE AND EDUCATION: 4.2.3:

Social Welfare staff and local teachers can also be used to educate the rural people about the proper use of hand pump. Children normally play with the hand pump handles and cause damage to them therefore, the local teachers who are in constant contact with the children can play a useful role in educating the children regarding the use of hand pumps. It is important that the users be acquainted with the proper manner of operating the pumps.

INSTALLATION AND MAINTENANCE: 4.3.1.

The keeping of proper installation and maintenance records is not emphasised in the report. The importance of proper installation and maintenance records must be over-stressed. Therefore, I suggest that a Format for installation and maintenance should be designed and attached to the report. A draft copy of a Format is annexed. The establishment of a limited preventive maintenance capability at the local level should be sought.

WELL DEVELOPMENT

Another common cause of the excessive wear of the leather washers in the Cylinder is poor or inadequate well development. Development work is an essential operation in the proper completion of a water well. Development stabilizes the sand formation around a screened well so that the well will yield water free of sand. If a well is not properly developed fine sand particles tend to find their way into the Cylinder and cause excessive wear of the leather washers. Where there is excessive sand in the Cylinder operation becomes difficult due to binding of the plunger, which results in the snapping of the pump rod. In the case of Mono Pump (U.K.) the handle cannot be operated at all when fine sand particles find their way into the stator.

MANUFACTURE OF HAND PUMPS

The need for hand pumps in many developing countries has already been well established, but for many reasons the capacity to manufacture these hand pumps locally is inadequate. For example, some countries have not enough hand pump programme to warrant the manufacture of hand pumps locally; in some cases financial constraints may not permit local manufacture of hand pumps. I would like to suggest that W.H.O. being an International Body should organise some of these developing countries to pull their resources together and establish a hand pump Factory. For instance some of the West African countries like Ghana, Ivory Coast, Nigeria, Senegal and Sierra Leone could come together and establish one hand pump Factory in say, Ivory Coast to serve the other sister countries.

K. OSEI-POKU
GHANA WATER AND SEWERAGE
CORPORATION, ACCRA-GHANA

ACTIVITIES ON THE U.S.T. HAND PUMP

INTRODUCTION

Millions of people in the developing countries are known to lack access to safe drinking water, a situation which has been responsible for the high incidence of water-borne and water-related diseases in these countries. The provision of potable water therefore can be viewed as an important factor in the eventual eradication of such diseases. Among the possible sources of water, ground water appears safe since it normally requires no further treatment. It can be readily obtained using a hand pump installed on a borehole or well and it can be relatively cheaper than pipe-borne surface water.

To help satisfy the ever increasing demand for potable water, Ghana, like many developing countries which have embarked on extensive rural water schemes, have had to import a large number of different makes of hand pumps with its scarce foreign exchange. Unfortunately the overwhelming percentage of these pumps cannot endure the constant, rigorous usage and consequently break down after a short while. The countryside is literally "littered with these pumps". Many are the causes of this high "mortality" and amongst them are bad designs, poor manufacture, inadequate or absence of maintenance and the lack of spare parts.

In its desire to assist in the realisation of the rural water supply scheme and in consonance with the prevalent policy of self-reliance, the Faculty of Engineering at the University of Science and Technology,

Kumasi, Ghana, undertook the design of a hand pump for local manufacture using local materials and skills. The initial work based on the AID/BATTELLE pump originally designed by the Battele Memorial Institute, Ohio, U.S.A., was done by a Visiting Professor, M. Blaho, who in 1972 produced the prototype in cast iron. Field tests however revealed defects in the manufacture of the pump body and as a result it was decided to change to fabrication by welding. Though Ghana is noted for its high quality, indigenous, ornamental casting industry in non-ferrous materials such as brass, bronze, gold, etc., the art of iron casting is not very widespread and except in a few industrial concerns has not developed to a comparable level. Welding on the other hand is comparatively more widespread in the industrial and larger towns and the quality of welded products is high. Based therefore on the availability of better facilities and the requisite skills as well as on the low number of pumps to be produced initially the design of the pump body and the handle was modified for fabrication by welding.

DESCRIPTION OF PUMP

In the design of this pump the emphasis has been on the use of local materials and the utilisation of existing local skills for its manufacture. The main components of the pump as shown in the attached sketch are:

(i) Pump Body:

It is an all-steel column fabricated by welding a 76mm diameter pipe to the base plate. Provision is made at the top of the

column for a fulcrum on which the handle is mounted, and at the bottom for attaching of the drop pipe. The body is capped with a removable cover.

(ii) Plunger:

The plunger is cast from brass and fitted with a leather cup which serves as a seal. It can operate in any part of the plastic drop pipe which hangs from the pump body.

(iii) Handle :

It is welded from steel and terminates in a short piece of pipe at one end. It is therefore possible to increase its length and consequently the mechanical advantage by fixing a wooden handle inside the pipe. A minimum mechanical advantage of about 6 to 1 is assured.

(iv) Bearing:

Use is made of two types of bearings viz. rolling bearing at the fulcrum and brass bush at the coupling.

(v) Valve:

Both poppet and leather flapper valves are used in the plunger and foot valves respectively.

PERFORMANCE

The pump can be readily operated by small men including women and children. It has a capacity of 0.8 litre per stroke and has worked satisfactorily for depths down to 30 metres. Some of the vulnerable

components such as the leather cup and pin joints have survived field operation for about a year without any failure or appreciable wear, ~~of~~.

The following are some of the advantages of the pump.

- (i) The local material content is high. Apart from the steel plates, pipes and rolling bearings all the other materials are locally available.
- (ii) Locally available skills in welding and casting are employed in the fabrication of the pump parts. The brass parts can be cast by indigenous craftsmen using the lost wax casting method.
- (iii) Spare parts are readily available.
- (iv) No specially designed cylinder is needed. The plunger can work in any part of the drop pipe.
- (v) The friction between the leather cup and the pipe walls is greatly reduced with resultant reduction in the required operating force.
- (vi) The length of the handle can be conveniently increased as and when necessary.

FIELD EVALUATION

To date field testing has been undertaken on a limited scale only. The number of pumps tested is small and the period of testing is less than a year. Though the sample is not large enough to permit definite conclusions to be drawn nevertheless it was noted

...../5

that there were some of the typical problems such as wear of the coupling pin, loosening of the rod couplings and rusting of the ferrous parts. Measures taken to reduce these problems include the use of brass bush and jam nuts, case-hardening of the pin, provision of lubrication and appropriate painting.

A few pumps have been purchased by such bodies as the Ghana Rubber Estates Ltd., WIIO/UNDP, and the Ghana Water and Sewerage Corporation for installation on bore holes in various parts of the country. Here again the number is small; their performances however are being checked with a view to possible further modifications of the pump and assessment of their capabilities.

PROBLEM AREAS

Two main problems associated with maintenance have been identified and are receiving attention. They involve

(i) Silting:

While in some bore holes the casing may act also as a screen, in others, and in wells, this may not be the case. The present design of the pump makes no allowance for a screen and therefore the vital parts are exposed to silt which finds its way into the bore hole. Silt has been responsible for fouling of valves, rapid wearing of the leather cup and plastic pipe and the seizing of the plunger. A situation like this not only aggravates maintenance problems but can put the pump out of action.

(ii) Removal of plunger and foot valve:

When repairs are needed on the plunger and/or the foot valve

they must be removed from the bore hole. This can be a tedious exercise since normally there is a column of water trapped on top of the plunger or the foot valve the weight of which can be substantial especially for deep wells. All this column of water must be lifted ^{pump} in order to get to them. In much the same way if the whole [^] must be removed from the borehole the column of water in the pipe must be lifted too.

PROJECTS

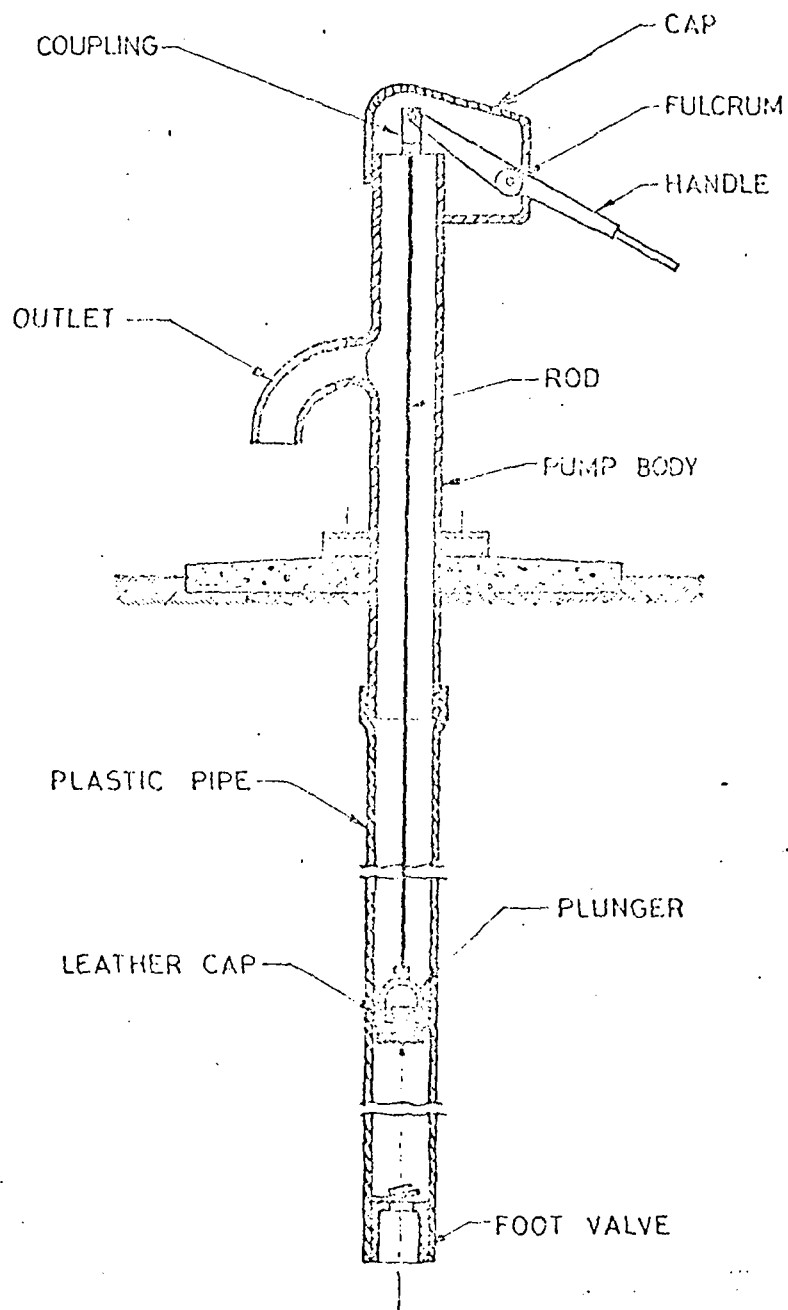
(i) Large Scale Evaluation

It is proposed to organise large field evaluation of the pump in various types of environment. The constraint has been financial. Bore holes, pumps, equipment, personnel, etc. are needed. Bodies outside the University are being contacted for assistance and in this respect mention should be made of the considerable interest in this project shown by the Canadian International Development Research Centre (IDRC). A detailed proposal is being prepared for its study and possible support. It is envisaged under the project to evaluate other makes of pumps in use in the country as well, and to study pump maintenance problems and requirements.

(ii) Pump Production :

In order to satisfy the increasing demand for pumps by organisations and individuals and in anticipation of the pump requirements of the above project, a Pump Production Unit has been set up in the Faculty of Engineering to produce the UST Hand Pump using the facilities of the Engineering Workshops. Meanwhile contacts have been made with some industrial establishments to interest them in large scale production of the pump.

Prepared by
Dr. A. ABROBAH - CUOJOE



NOT TO SCALE

U.S.T. HAND PUMP.

The purpose of this Manual is to illustrate developments that have taken place in the utilization of handpumps within India's village water supply programme.

1. More than 80% of the Indian peninsular is underlain by hard rock.

2. Traditional methods of utilizing ground water resources trapped in fissures and cracks within these hard formations include hand dug open wells and large diameter tube wells drilled by cable percussion rigs.

3. Both methods are time-consuming and expensive. In addition, the open well results in a polluted water source and its success in terms of yield depends on an adequate depth being attained. The depth to which an open well is dug depends upon the hardness of the formation encountered. Generally, open wells are dug to bed rock, which, being too hard to penetrate without explosives results in a well of inadequate depth. Tube wells drilled by the cable percussion method offer a protected water supply but one machine may drill only twelve wells per year or less.

4. In 1967, a new technique to tap deep water sources in hard rock at the rate of one well per 2 or 3 days was introduced to India. This is known as the down-the-hole hammer method.

5. Between 1967 and 1975, UNICEF imported 135 of these fast, mobile, pneumatically operated hard rock rigs to drill 4" - 6" diameter tubewells in what are known as the technically difficult, drought prone, endemic areas of India.

6. These areas are broadly indicated in the adjoining map, covering in the main, ten states, these being:- Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, Madhya Pradesh, Rajasthan, Gujarat, Bihar, Bengal and Orissa.

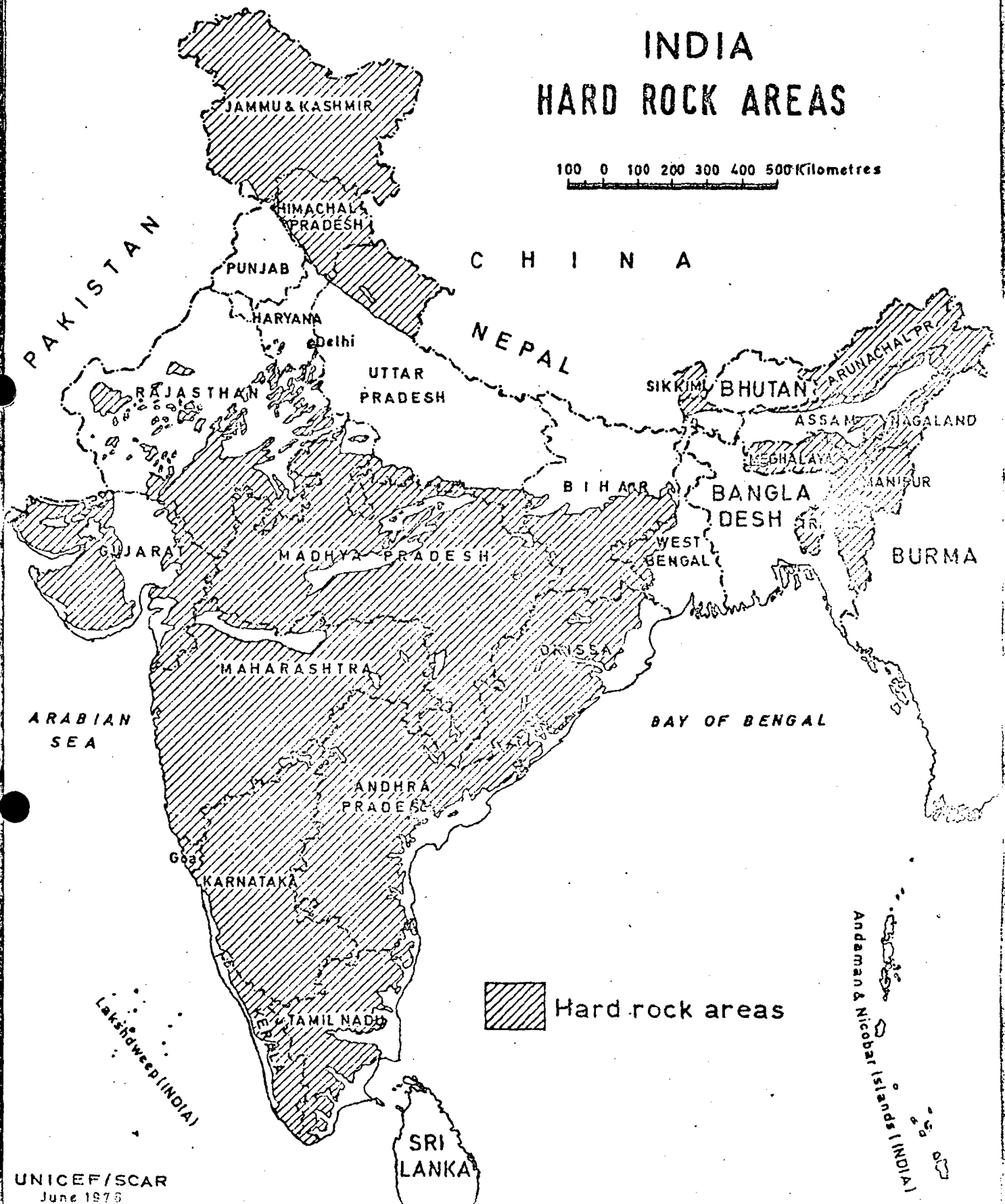
7. India's fourth (1969-1974) and fifth (1974-1979) Five Year Plans indicate 125,000 villages as being within the criteria already mentioned.

8. Plans of action were formulated to drill one tube well for 500 head of population and as the water delivery system - to fit a handpump.

INDIA

HARD ROCK AREAS

100 0 100 200 300 400 500 Kilometres



The deep well handpump

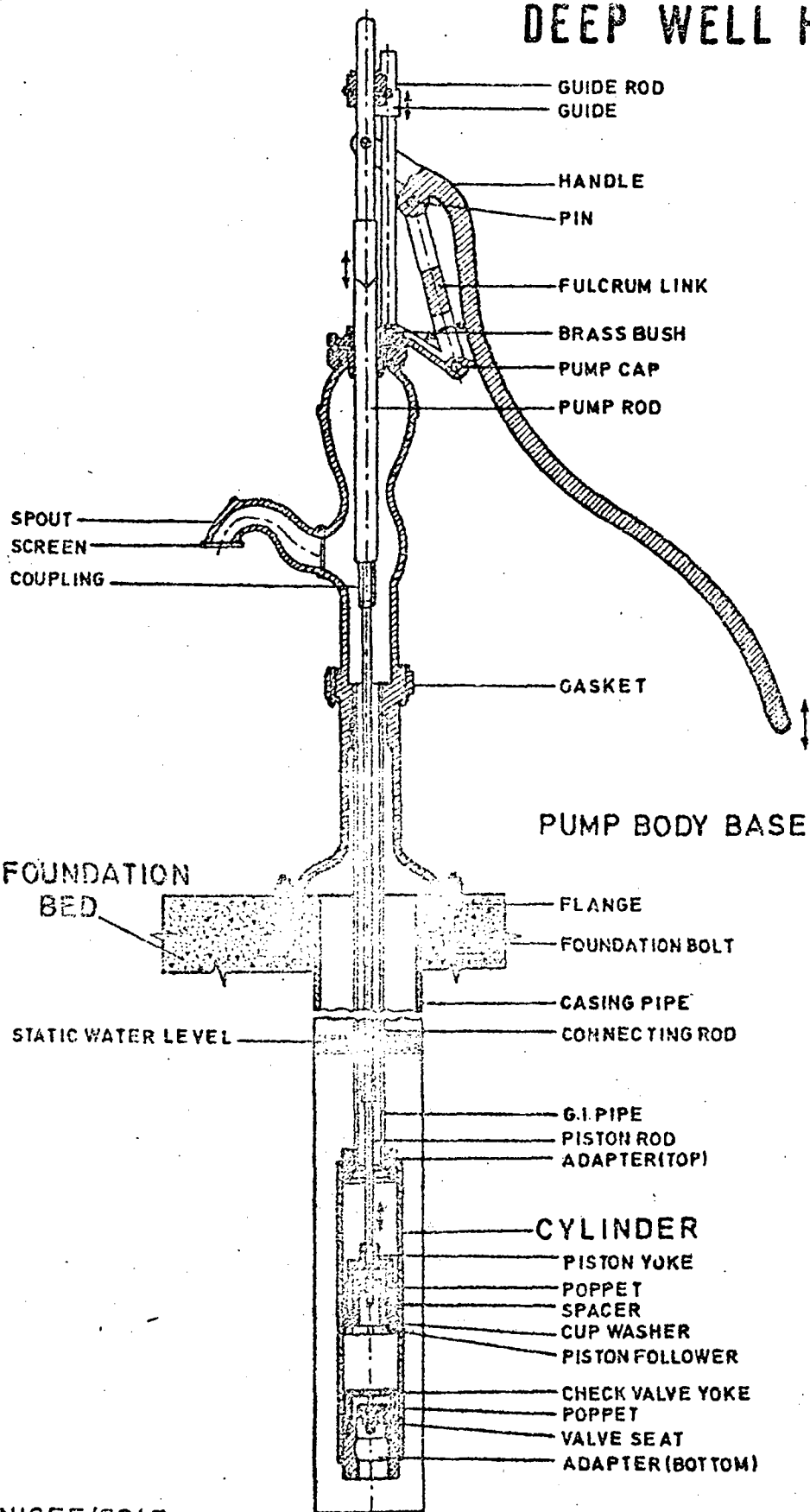
1. Because the water sources tapped in hard rock are sometimes very deep, a deepwell handpump is utilized that will bring water from these depths to the surface.

2. Tubewells drilled in hard rock range from about 100' to over 300' in depth. Water sources may be encountered anywhere from 30' and beyond.

3. The handpump commonly used in India is illustrated. It is of cast iron, has many moving parts, and was originally designed for use by one or two families. It consists of four major components, these being:

- .1 The well head - which includes everything that is visible above ground level.
- .2 The rising main or 'drop pipe (here called simply G.I. pipe) which carries the water from the source to the surface.
- .3 The connecting or plunger rod which connects the piston in the cylinder to the handle on the pump.
- .4 The cylinder - within which operates piston and valves in such a way when the pump handle is moved up and down, that water is drawn in through its base and discharged through its upper end.

DEEP WELL HAND PUMP



This photograph illustrates a typical deep well handpump of the design already described. The pump is flange mounted on top of a well casing. Two points are emphasized with this installation.

1. The pump is situated some distance from the village; and
2. No platform, drainage or soak-pit has been provided.

The platform is of great importance if

- sanitary surroundings are to be ensured
- waste water is not to collect in stagnant pools
- polluted water is not to seep back to the source

1. An indication of the necessity of a good platform with adequate drainage is clearly illustrated.
2. This handpump is mounted on a platform of inadequate size with no drain, resulting in waste water forming a stagnant pool of polluted water around the installation, seepage of the water back to source may occur - and stagnant water offers breeding grounds for mosquitoes.

1. In terms of wells drilled, the village tubewell drilling programme in India has been a success. Measured in terms of the end-result - the provision of clean water to villagers by means of the handpump - it has been a failure.

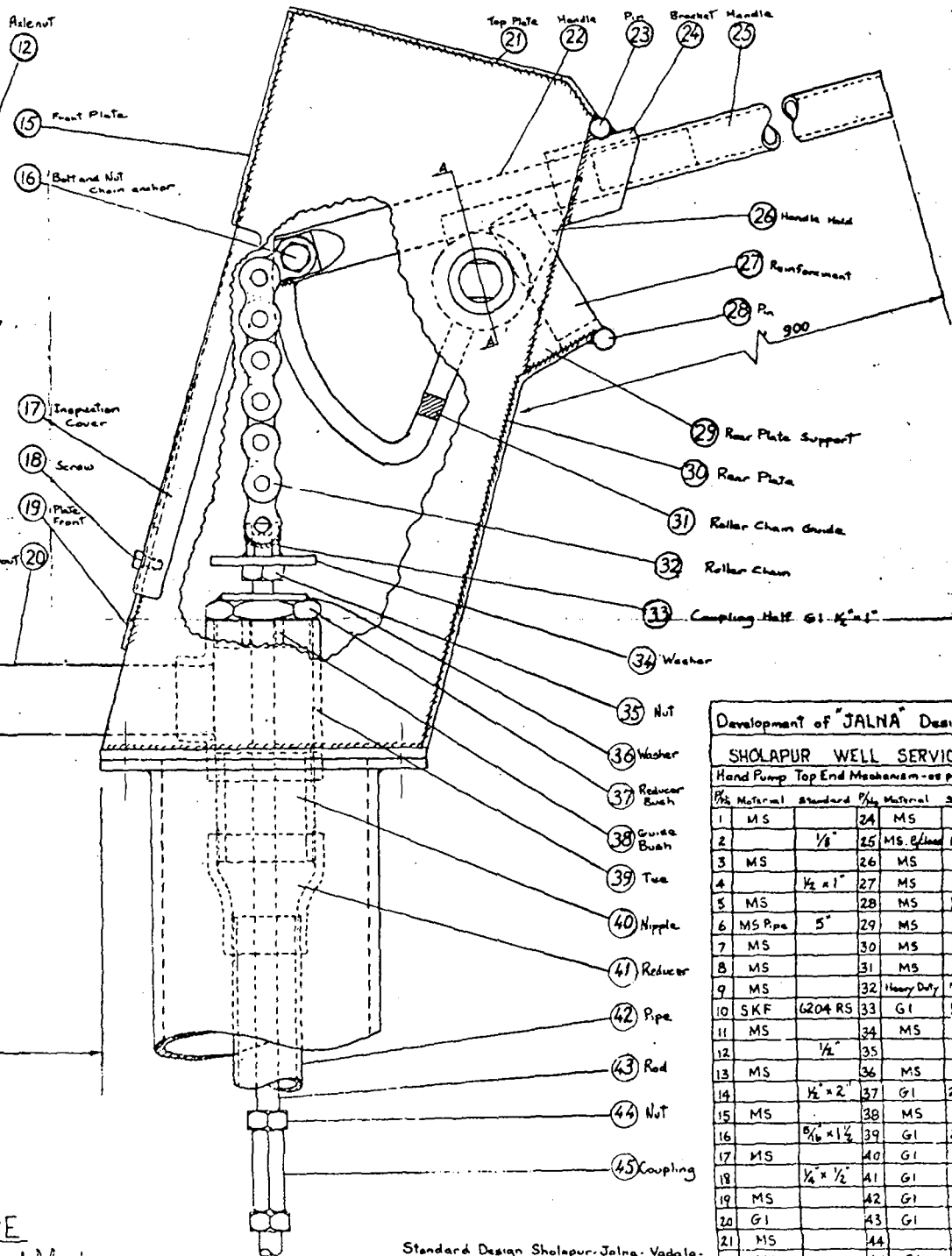
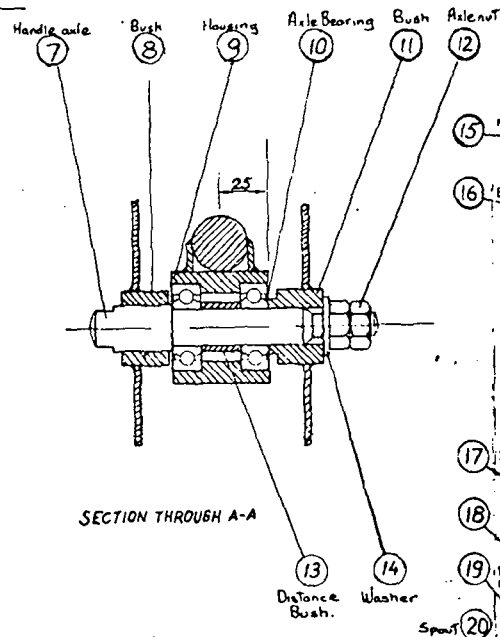
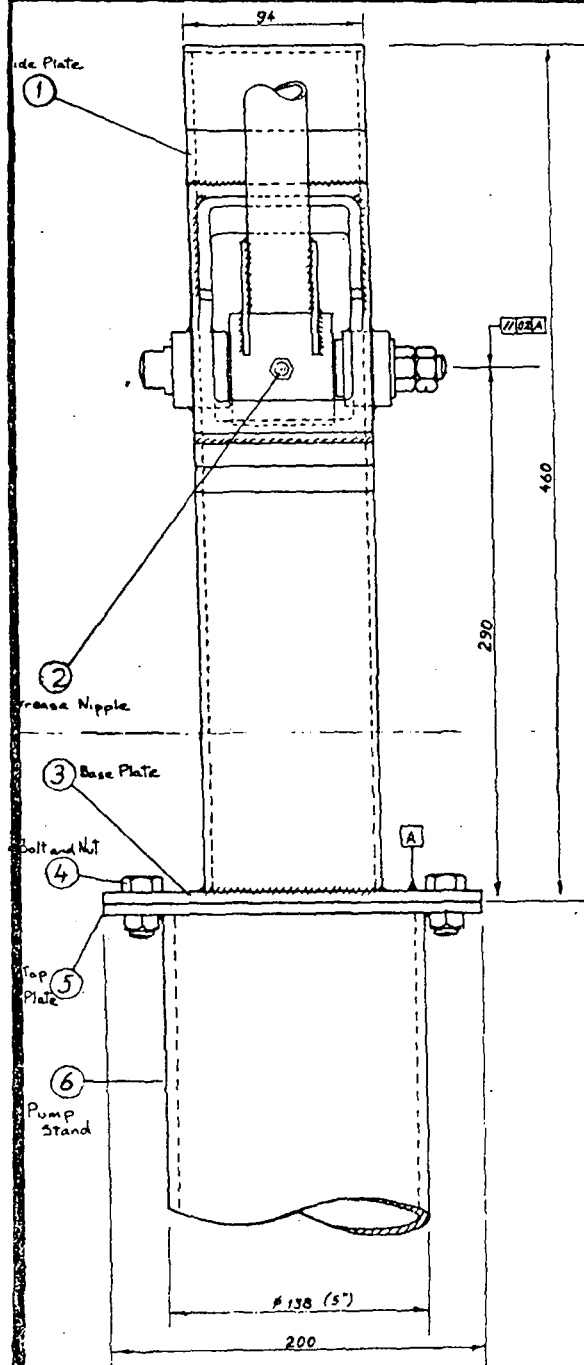
2. One of the causes of this failure is illustrated.

In this particular state, programme implementation is entrusted to three separate agencies, one of which drills the wells, the second fits the pump while the third builds the platform.

This pump has not been bolted to the casing and no platform or drain has been provided. Lack of coordination between the three agencies is the cause. A single agency carrying out the three functions is ideal.

3. A second cause of failure lies with the handpump itself. That illustrated is not designed for heavy use. Being of cast iron, it breaks easily when roughly used and unlubricated pivots mean rapid wear. Poor maintenance organizations cannot keep pace with frequent breakdowns. Pumps which frequently break are often not repaired - because of the effort required and because of the cost. The majority of handpumping systems which have gone out of repair are caused by early failure of the mechanism in the well head.

1. A mechanism designed to overcome the weakness of the multi-pivot well head is illustrated.
2. The original design by a voluntary agency based at Jalna in Maharashtra has been developed by a second agency operating from Sholapur in the same state. The design eliminates the use of cast iron. The mechanism, fabricated entirely from steel, is, therefore, very robust.
3. The principal feature of construction is the utilization of a single pivot rocking on ball bearings with a heavy duty 1" pitch roller chain running over a quadrant which maintains the alignment of the plunger rod in the vertical plane.



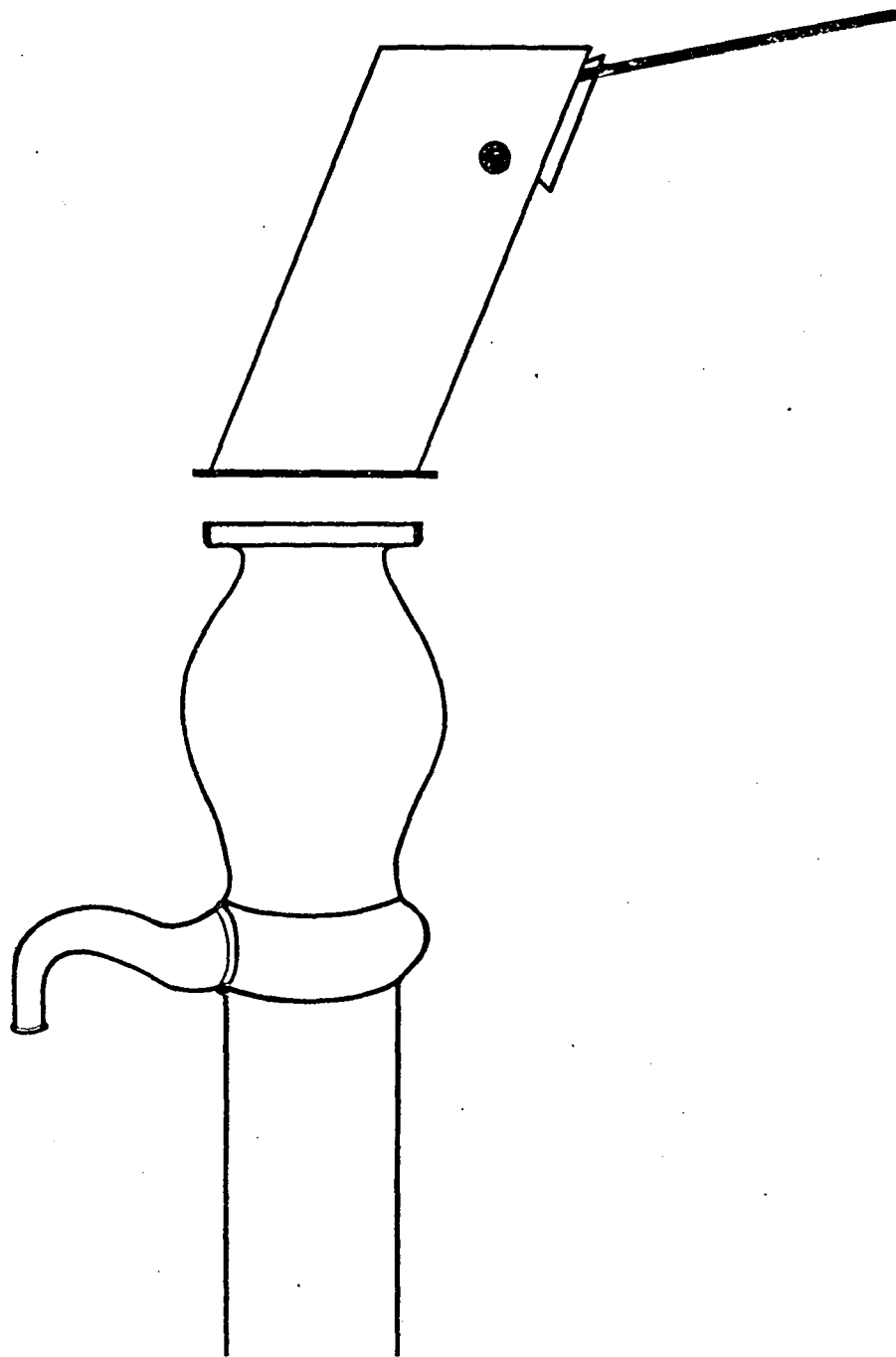
Complete with Base Plate or Spragg Footing

"JALNA" TYPE Heavy Duty Hand Pump Top End Mechanism

Standard Design Sholapur, Jalna, Vadala.
WESS UNICEF, New Delhi, Aug 6th 74

Development of "JALNA" Design.					
SHOLAPUR WELL SERVICE					
Hand Pump Top End Mechanism - as per Dr.					
Sl. No.	Material	Standard	Sl. No.	Material	Standard
1	MS		24	MS	
2		1/8"	25	MS, Gilded	1" x 8"
3	MS		26	MS	
4		1/2" x 1"	27	MS	
5	MS		28	MS	1/2" x 5"
6	MS Pipe	5"	29	MS	
7	MS		30	MS	
8	MS		31	MS	
9	MS		32	Heavy Duty	M/cy
10	SKF	6204 RS	33	GI	1/2" x 1"
11	MS		34	MS	
12		1/2"	35		1/2"
13	MS		36	MS	
14		1/2" x 2"	37	GI	2" x 1"
15	MS		38	MS	
16		5/16" x 1/4"	39	GI	2" x 2"
17	MS		40	GI	2" x 2"
18		1/4" x 1/2"	41	GI	2" x 1"
19	MS		42	GI	1 1/2"
20	GI		43	GI	1/2"
21	MS		44		1/2"
22	MS		45	GI	1/2"

1. Appreciating the main weakness in the pumping system as being the well-head working mechanism, UNICEF, in 1975, using noted funds, embarked upon the rejuvenation of existing cast iron handpumps by removing the existing 'weak link' - the working mechanism - replacing it with a Sholapur designed steel conversion head. The principle is illustrated.



1. Although the concept behind "The handpump rejuvenation programme", as it came to be known, consisted simply of the substitution of the original working mechanism with that of Sholapur design, much additional work was often needed to bring an installation to good condition. This work included renewal of the cylinder or reconditioning of the existing one and building an effective platform, drain and soakpit.

2. The opportunity was taken by utilizing noted funds, provided by Radda Barnan to completely recondition 400 installations. The aims of so doing were three-fold, as follows:

To

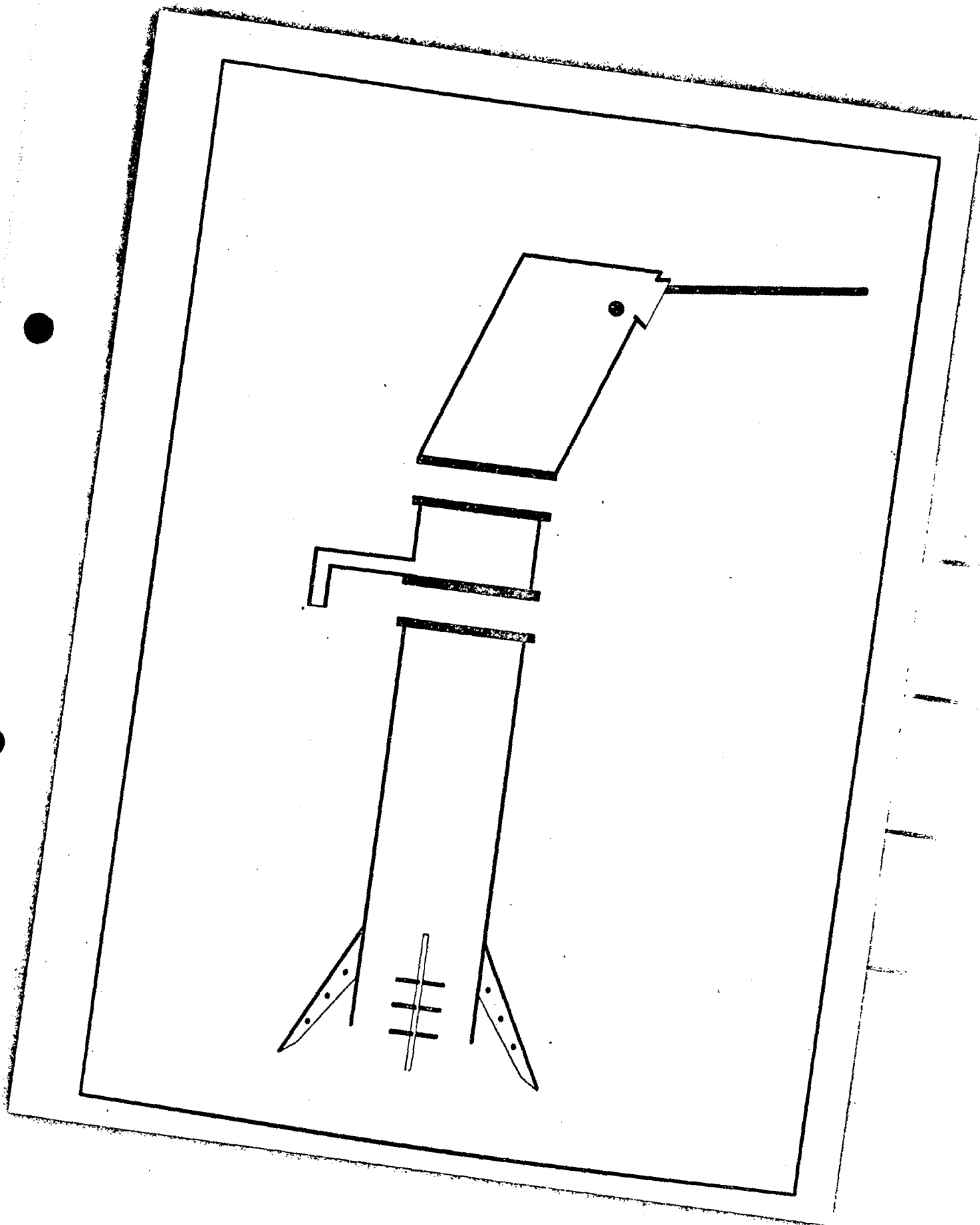
- .1 Demonstrate to Government the reliability of a handpump, purpose designed for village use.
- .2 Construct or repair platforms, drainage and soakpits thereby demonstrating and emphasising the environmental sanitation aspects of the programme.
- .3 Demonstrate that with the introduction of a purpose built handpump, a maintenance network becomes viable and economical, and to establish such a network.

3. A mobile maintenance team was established in each district of the state. These were equipped by UNICEF with regular and special pump fitting tools. The following photographs demonstrate some of the results achieved.

1. One of the special pump fitting tools supplied to the teams is illustrated. A simple but effective self-locking clamp used when installing or removing a pipe line. Use of this device reduces pump fitting time and eliminates possible dropping of pipes in the bore.

1. The Sholapur designed pump when used with new wells where no old cast iron pump exists is constructed in three parts, as shown:-

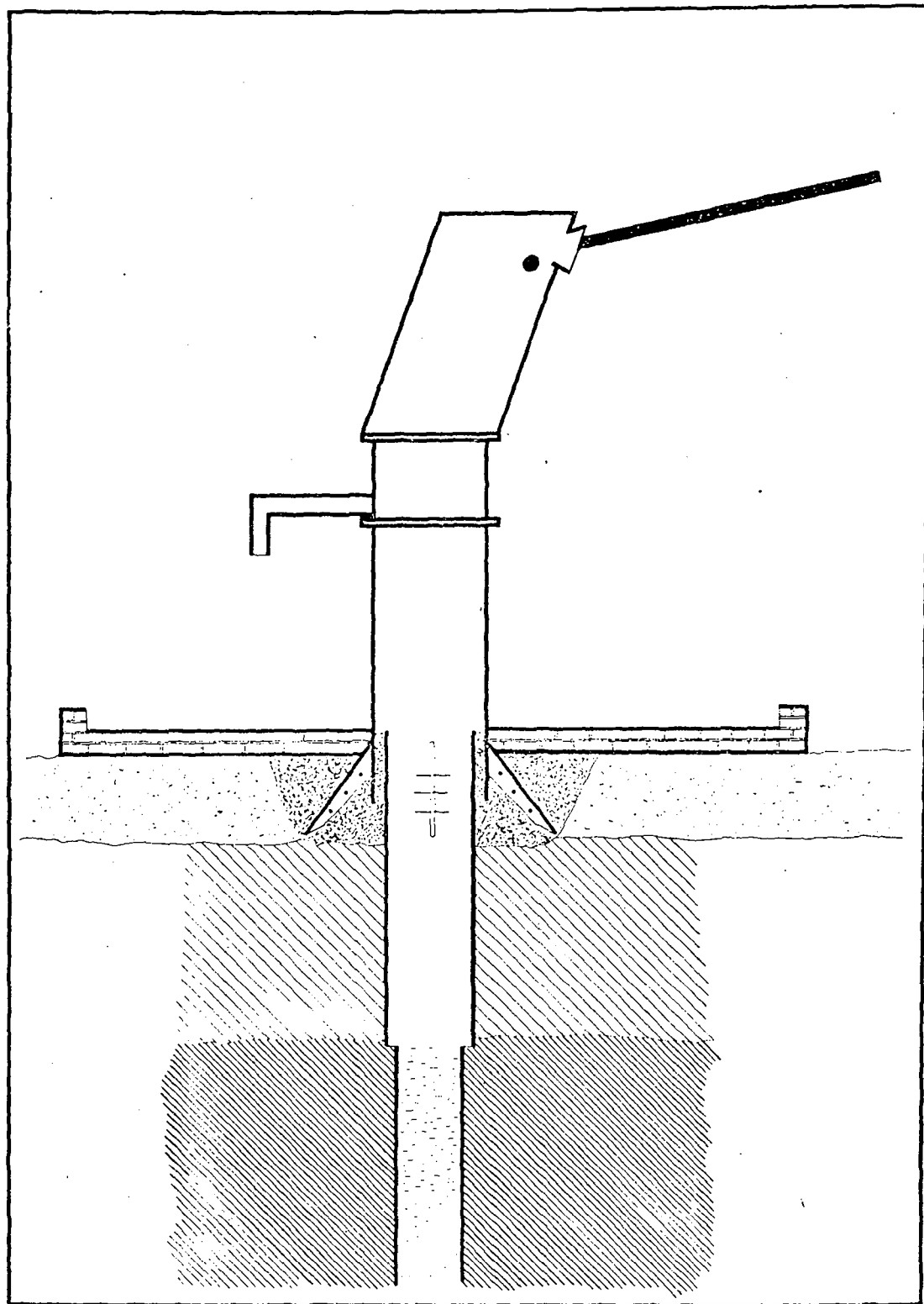
- | | |
|-----------------|---|
| The first part | : <u>The Head</u> - containing the working mechanism (already described). |
| The second part | : <u>The Water Tank</u> - which acts as a surge chamber and also prevents water wetting the working parts of the pump if the spout is covered by the hand while pumping - a common game amongst children. It is also the part which will rust first and can, therefore, be renewed at low cost. Water tanks can either be coated internally with red oxide or galvanized. |
| The third part | : <u>The Pedestal</u> - or pump stand - which supports the water tank and head, fitting over the well casing and being bonded to the platform in such a way as to prevent dirty water entering the borewell, a seal being effected between the well casing and the Pedestal. |



1. A complete Sholapur pump properly installed will, therefore, look like the illustration on the right.

Points to note -

1. Height of pivot approximately 40" from the platform top. This height is convenient for most operators.
2. The installation procedure is clearly seen to provide a strong concrete foundation around pump base, the cement mix filling the annular space between pedestal ID and casing O.D thereby providing a seal.
3. The platform should be 6' dia. minimum with 4" edges to prevent spillage and a 20' min. lead off drain ending, where ground conditions permit, in a stone filled soakpit.



Sholapur Pump Costing

	Rs	\$
Conversion head	300.00	33.33
Handpump (Head + Pedestal)	530.00	58.88
Pedestal + Water Tank	230.00	25.55
Cylinder	250.00	27.77
Per ft. 1½" dia pipe + 5/8" rod 1/2"	10.00 per ft.	1.11
Pump + 100 ft. + cylinder	1,700.00	188.88
Bearing	15.00	1.5
Buckets	4.00	0.5

(Conversion rate used: Rs.9.00 = 1 US \$)

Pump maintenance (Approx) Rs. 200 - Rs. 300 per pump per year.

Weight of Bangalore Pump Body C.I.

		Kgs
(a) Pump Body top	..	32.0
(b) Pump Body Base	..	55.0
(c) Spout	..	2.5
(d) Flange Pipe & Adaptor	..	2.5

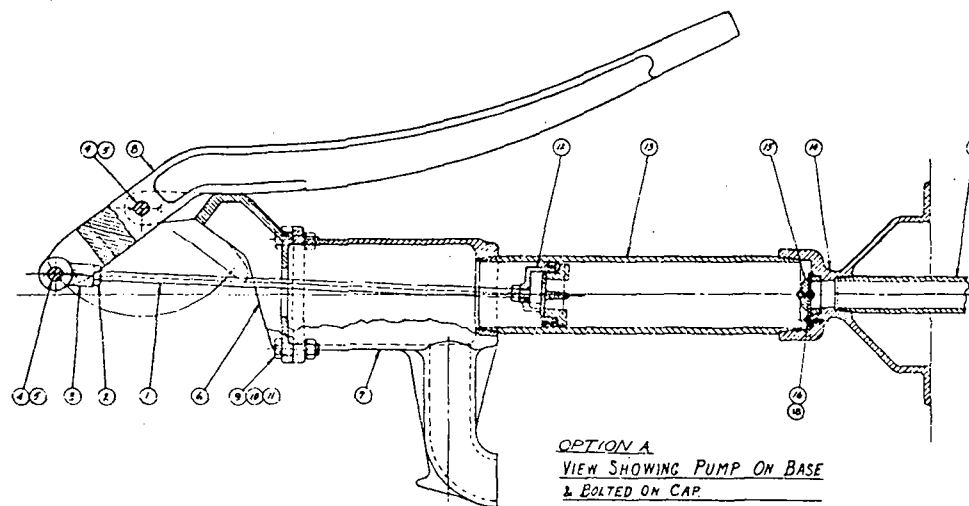
Cost analysis of improved Bangalore
Hand-operated Pump Head

<u>Item</u>	<u>Estimated cost (Rs)</u>	<u>R & C Estimated cost</u>
1. Cost of casting pump head 50 kg. at Rs.3.50 per kg.	175.00	350.00 (100 kgs)
2 Machining	25.00	25.00
2. Cost of handle, including MSP bushes	60.00	62.00
3. Cost of pivot pin and nut	10.00	15.00
4. Cost of hex-head screws for spout	2.00	4.00
5. Cost of pipe and tee	20.00	42.00
6. Threading collar and providing bush	10.00	15.00
7. Cost of 4 Nos. 16 mm dia. bolts & nuts	4.00	4.00
	<u>306.00</u>	<u>Rs. 517.00</u>
	S.T. 4%	Rs. 20.68
		<u>Rs. 537.68</u>
	Assembly charges ..	Rs. 55.00
		<u>Rs. 592.68</u>
	10% margin	59.26
		<u>Rs. 651.94</u>

Cost Analysis of improved Bangalore Cylinder
Assembly

<u>Component</u>	<u>Material</u>	<u>Estimated cost (Rs)</u>	<u>R & C Est.cost.</u>
1. Cylinder body	G.I. Pipe	9.00	20.00
2. Reducing socket Cap.	G.I. (Malleable CI)	6.00	15.00
3. Sealing ring	Rubber or neoprene	1.50	1.50
4. Spring buffer	Steel wire	3.00	
5. Piston rod guide	HDP (Nylon)	2.20	3.50
6. Piston rod guide bush	Hylam TF 2211 or nylon	0.60	
7. Piston yoke	Hylam TF 2211 (Nylon)	14.00	20.00
8. Cup Washers (2 No)	Acrylo-nitrile rubber or neoprene	6.50	6.50
9. Spacer	HDP (Nylon)	2.50	2.50
10. Ball (2 Nos.)	Steel core, rubber covered	10.00	6.00
11. Valve seat (2 Nos)	Neoprene	6.00	3.00
12. Follower	Hylam TF 2211 (Nylon)	3.00	6.00
13. Buffer	Rubber	1.65	2.00
14. Check Valve body	HDP (Nylon)	4.00	10.00
15. Seat Retainer	HDP (Nylon)	3.50	3.00
16. Sealing ring	Rubber or neoprene	1.50	1.50
17. Retainer cap	G.I.	5.00	7.50
18. Sleeve			

	50.00
Rs. <u>79.95</u>	<u>158.00</u>
Say	Rs.160.00
4% S.T.	<u>6.40</u>
	166.40
Assembly charges	<u>60.00</u>
	Rs. 226.40
10%	<u>Rs. 22.64</u>
	Rs. 249.04



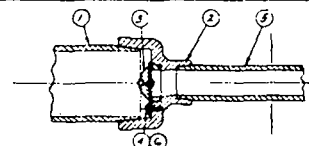
OPTION A
VIEW SHOWING PUMP ON BASE
& BOLTED ON CAP.

[illegible]

NOTE:
ASSEMBLY OF PUMP BODY, PIPE &
PUMP STAND MUST BE TIGHT WITH
AT LEAST 1/2" THREAD ENGAGEMENT
AT EACH JOINT.

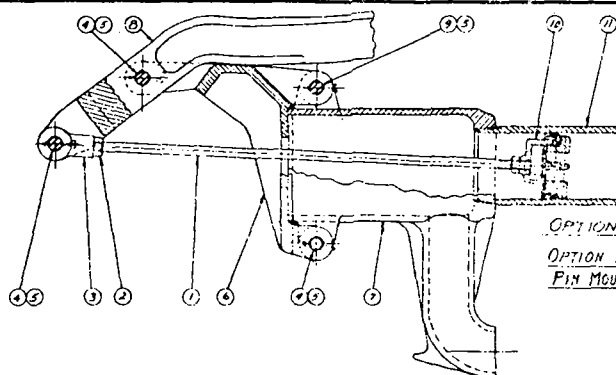
OPTION C

VIEW SHOWING LOWER VALVE HOUSING
MOUNT DIRECTLY TO WELL PIPE.



NOTE:
ALL PARTS ABOVE PUMP CYLINDER ARE IDENTICAL TO THOSE
SHOWN IN VIEW OF PUMP MAIN ASSEMBLY OR B.P.

6	2	-	-	PO PLAIN FLAT WASHER	DRESS	
5	A/R	-	-	1/8 NIPER		
4	1	-	-	PLAIN SCREW - PUMP BPMS		Page 15, PC 10
3	1	20 S	P	CHECK VALVE ASSEM.		
2	1	20 L/B	L	COUPLER HAVING ASSEN		
1	1	B-4	P	PUMP CYLINDER		
Part No	QTY	Part No	QTY	Description	Specification	
				HARTS LIST		

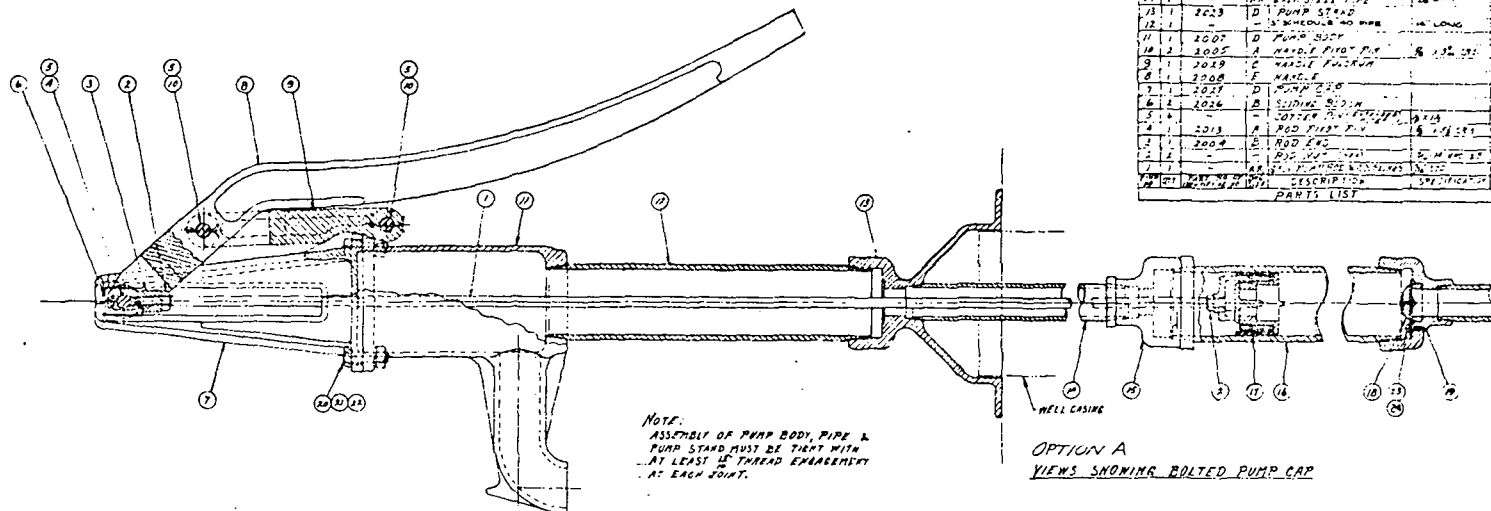


OPTION B
OPTION VIEW OF PUMP WITH
PIN MOUNTED CAP.

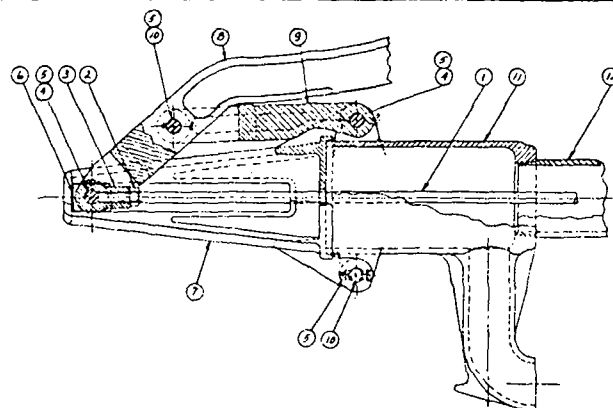
NOTE:
ALL PARTS BELOW PUMP CYLINDER ARE IDENTICAL TO THOSE
SHOWN IN EITHER OF TWO VIEWS SHOWN ABOVE.

11	1	2014	D	PUMP CRINDER	1	W-1000-1000
10	1	2009	D	FLUOR ALUM. 1000 CPT	1	W-1000-1000
9	1	2013	A	CAP RIN	1	W-1000-1000
8	1	2003	F	HANDLE	1	W-1000-1000
7	1	2012	D	PUMP BODY	1	W-1000-1000
6	1	2012	D	PUMP BODY	1	W-1000-1000
5	0			COLTER P. 1000-1000	1	W-1000-1000
4	3	2003	A	PISTON PIN	1	W-1000-1000
3	1	2004	F	NOV ENG	1	W-1000-1000
2	2		F	PUMP BODY IN 4	1	W-1000-1000
1	1	2003	F	NOV ENG	1	W-1000-1000
WTS				NOV ENG	1	W-1000-1000
				NOV ENG	1	W-1000-1000

[illegible]



2	+	-	-	10 DRAIN PLAT WASHER	DRASS
3	+	-	-	LOCKING SCREW 1/2 RD BUSH	7 1/2 X 1/2 X 1/2
21	+	-	-	TOUCH NUTS	1/4 3/8 HEAT
21	+	-	-	NUT 1/2"	1/2 1/2 1/2
21	+	-	-	1/2" C	1/2 1/2 1/2
15	+	-	-	2 1015	
16	+	-	-	2 1015	
17	+	-	-	2 1015	
18	+	-	-	2 1015	
19	+	-	-	2 1015	
20	+	-	-	2 1015	
21	+	-	-	2 1015	
22	+	-	-	2 1015	
23	+	-	-	2 1015	
24	+	-	-	2 1015	
25	+	-	-	2 1015	
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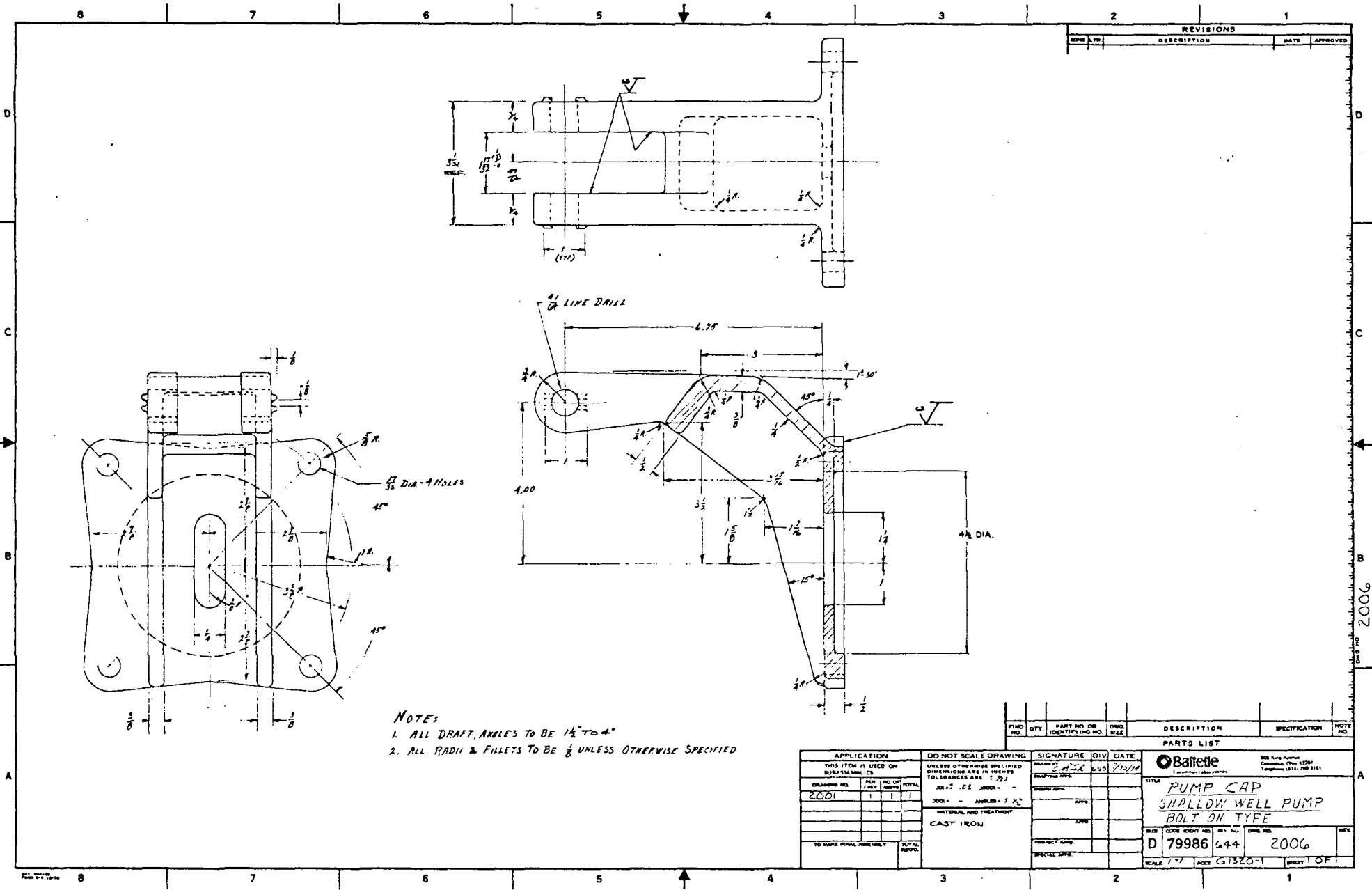


OPTIONAL VIEWS SHOWING
PIN MOUNTED PUMP CAP.

NOTE:
ALL PARTS NOT SHOWN BELOW ARE THE SAME
AS LISTED IN ASSEMBLY ABOVE

[illegible]

APPLICATOR NAME (PRINT OR STAMP) ADDRESS CITY STATE ZIP		DO NOT WRITE IN THESE SPACES PRODUCT OR SERVICE TO BE INSURED POLICY NUMBER POLICY DATE		SIGNATURE DATE		 400 West Highway Suite 100 Berkeley, CA 94704 (415) 863-2000	
Insured by Insured as Insured for Insured to Insured by Insured as Insured for Insured to	Insured by Insured as Insured for Insured to	Insured by Insured as Insured for Insured to	Insured by Insured as Insured for Insured to	Insured by Insured as Insured for Insured to	Insured by Insured as Insured for Insured to	HAND PUMP ASSEMBLY DEEP WELL PIPE E 79986 LOC 2002	



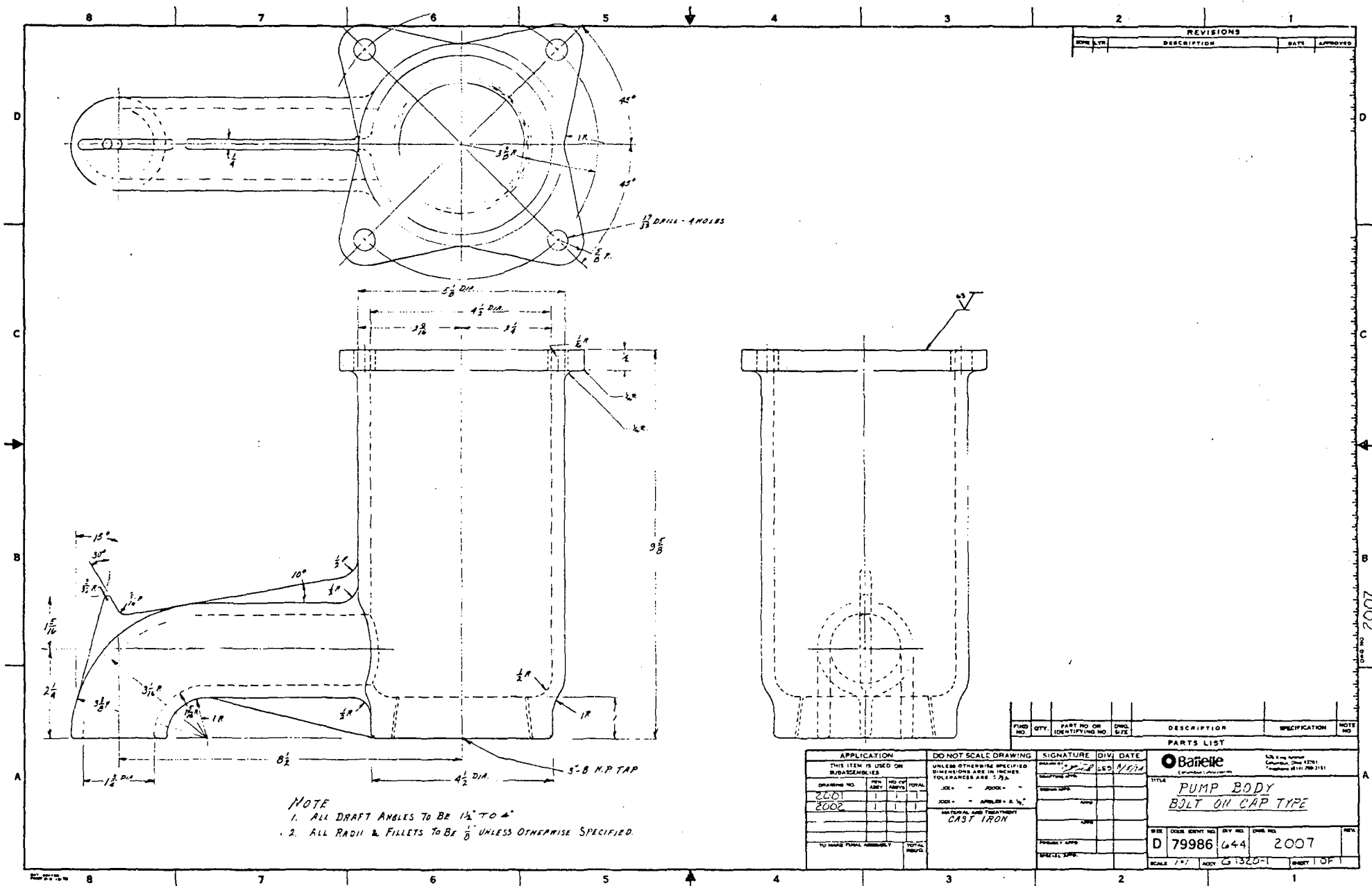
REVISIONS			
NO.	DATE	DESCRIPTION	APPROVED

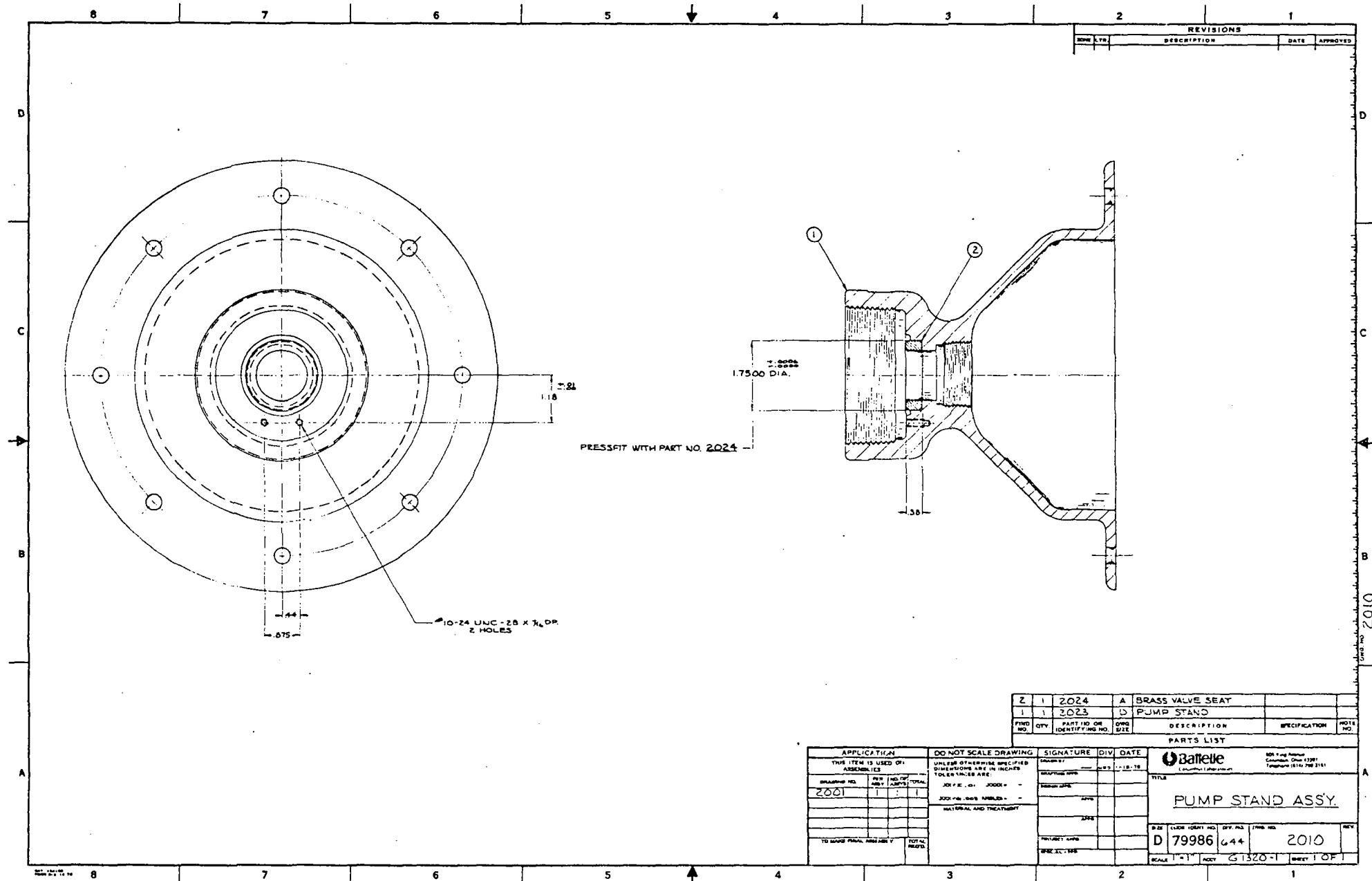
FINED NO.	QTY.	PART NO. OR IDENTIFYING NO.	DRG. SIZE	DESCRIPTION	SPECIFICATION	NOTE NO.
PARTS LIST						
APPLICATION				DO NOT SCALE DRAWING		
THIS ITEM IS USED ON				UNLESS OTHERWISE SPECIFIED		
DRAWING NO.				DIMENSIONS ARE IN INCHES		
2001				TOLERANCES ARE: 1/32"		
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1				CAST IRON		
TOTAL				TO MAKE FINAL ASSEMBLY		
1				TOTAL		
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1				DATE		
1				BY		
1				CHECKED		
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1				SPEC. DATE		
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1				ADT G1320-1		
1				SHEET 1 OF 1		

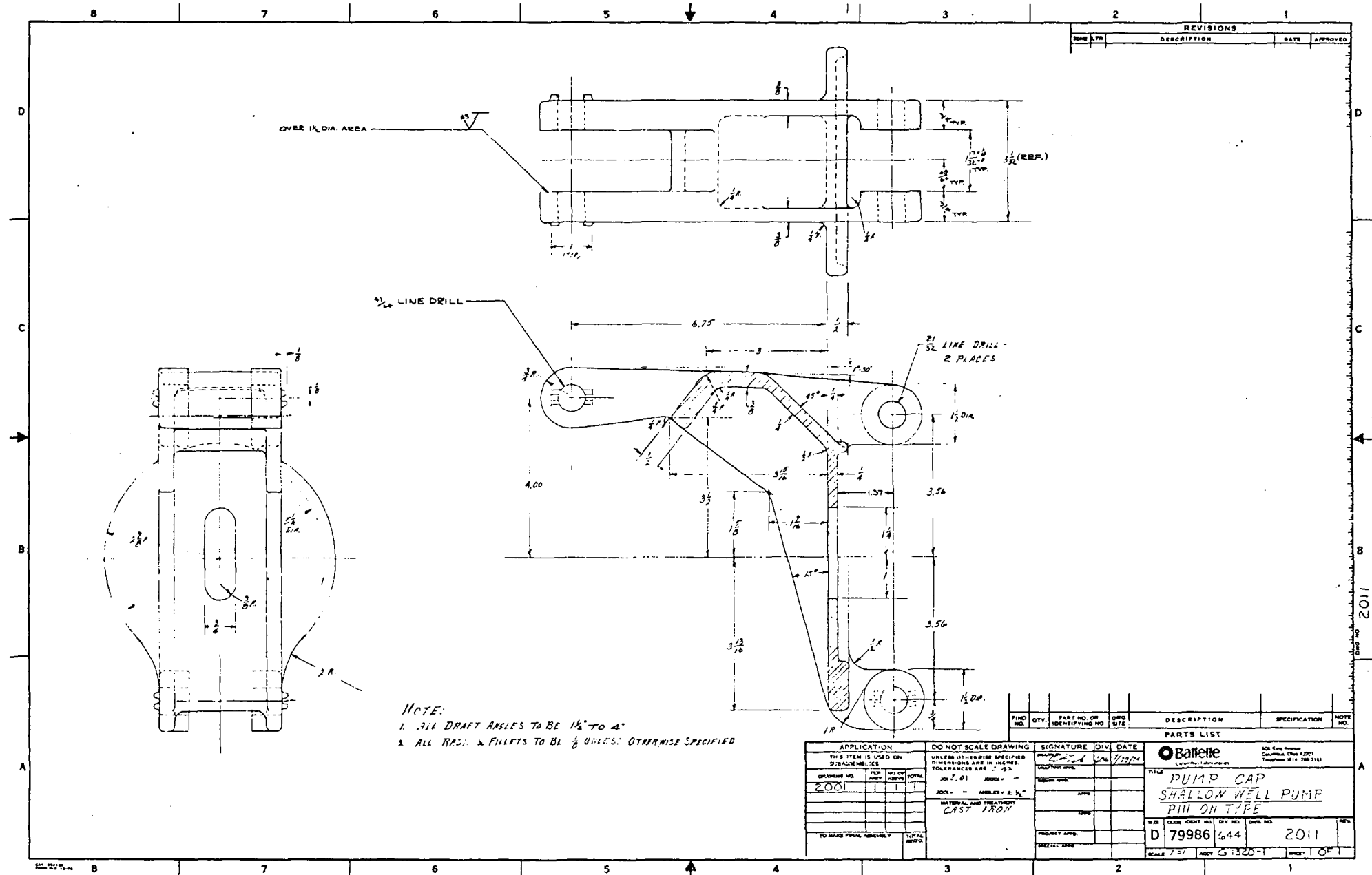
Barclay
 808 King Avenue
 Columbia, Ohio 43201
 Telephone (614) 768-3151

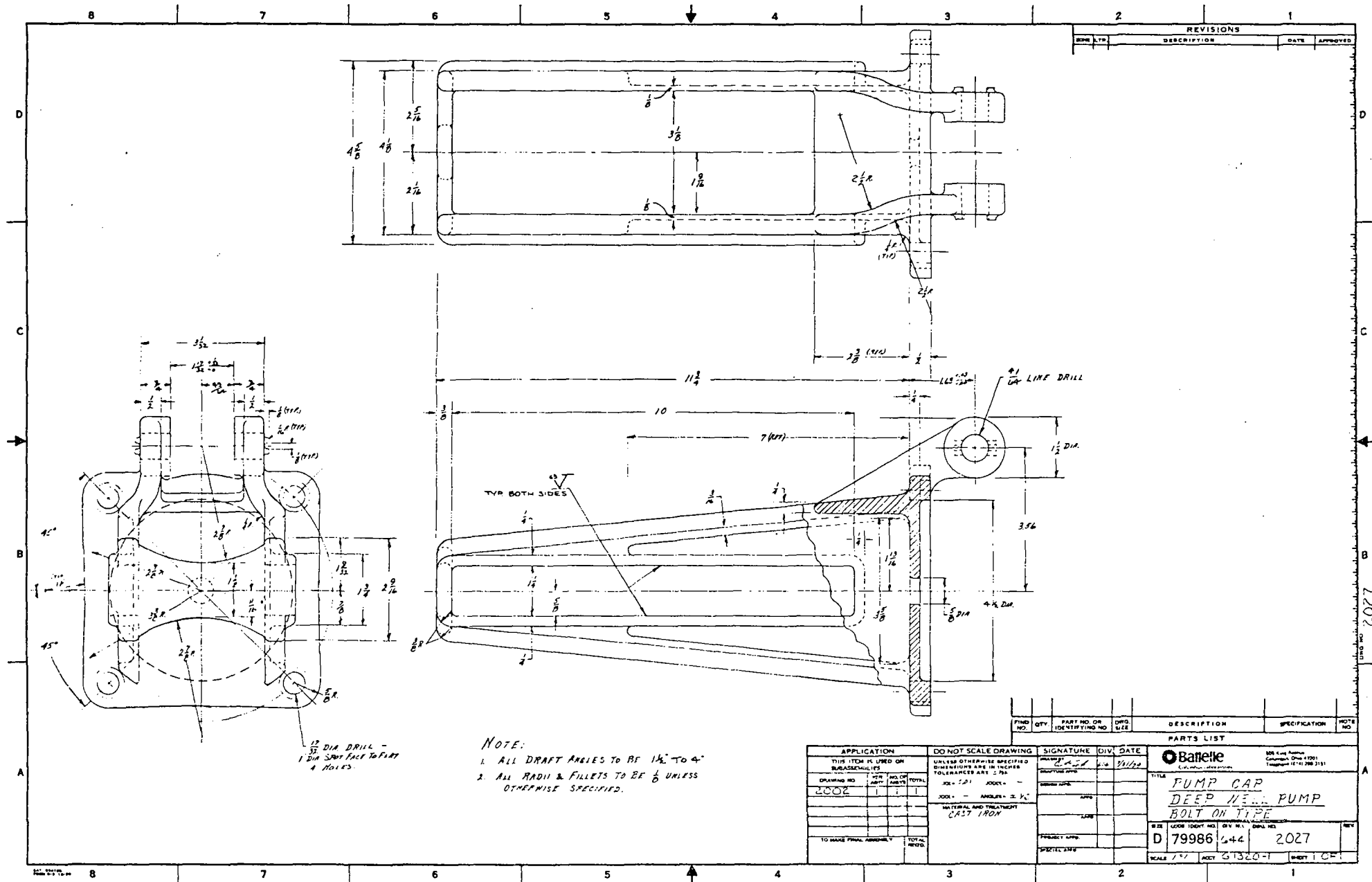
PUMP CAP
SHALLOW WELL PUMP
BOLT ON TYPE

DATE: 2006
 CODE: 79986
 QTY: 444

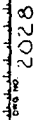


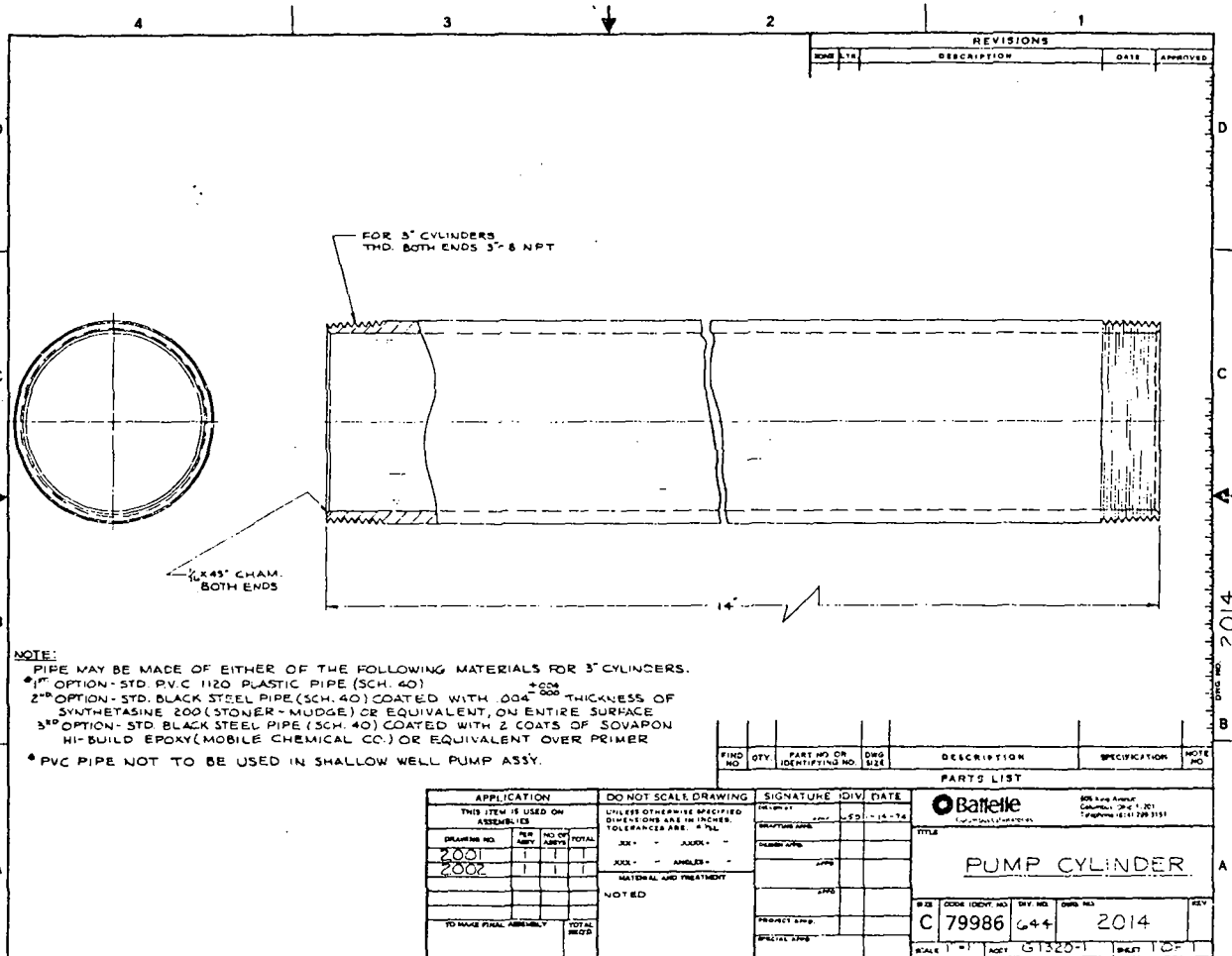




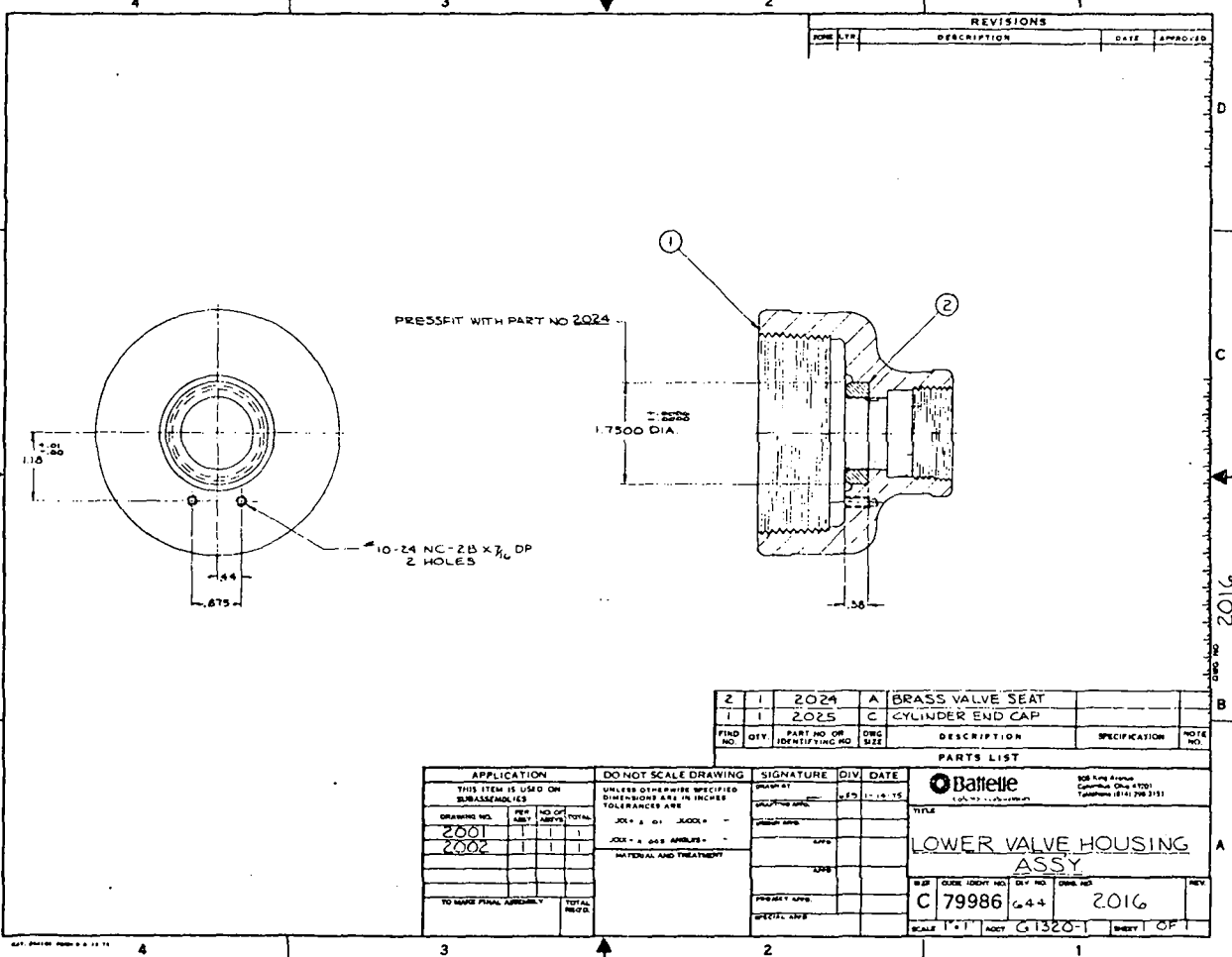


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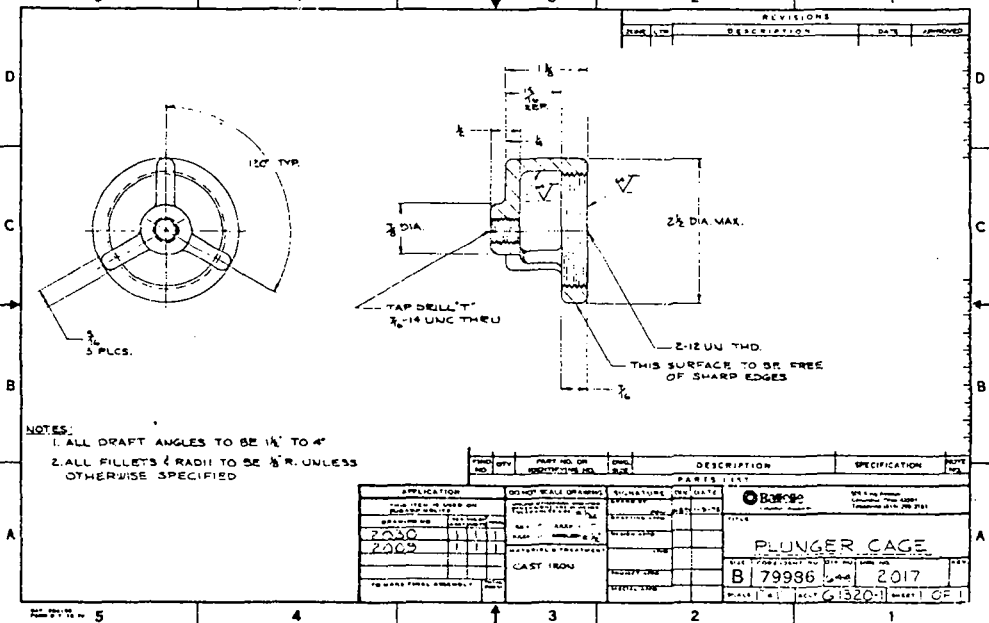
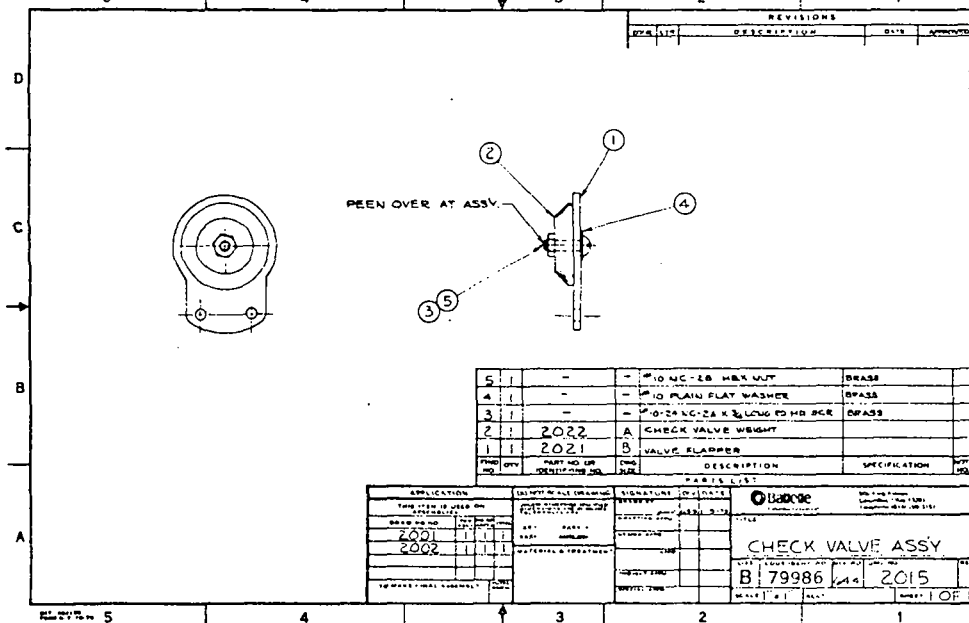
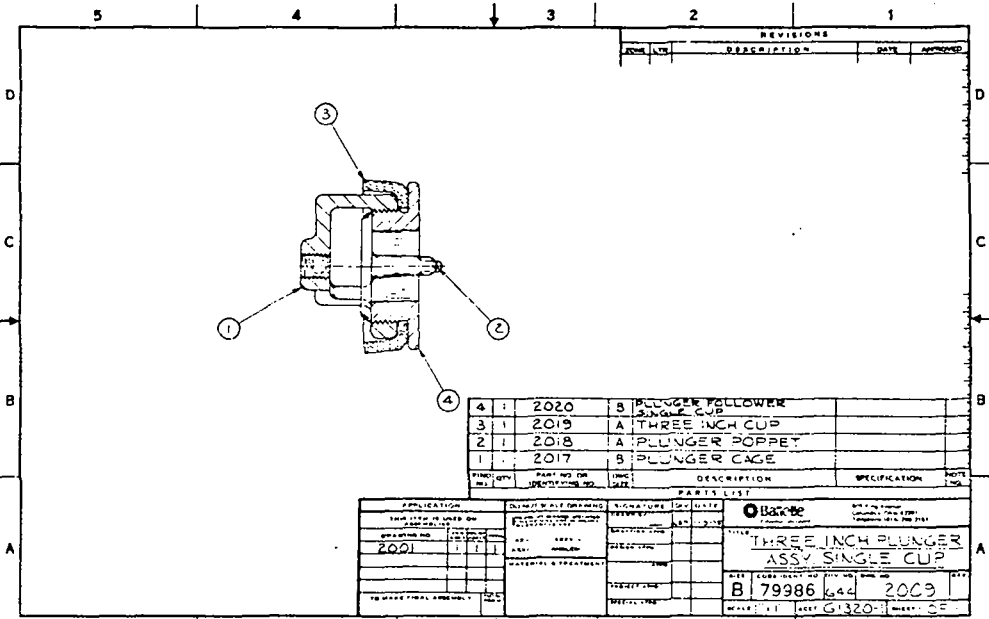
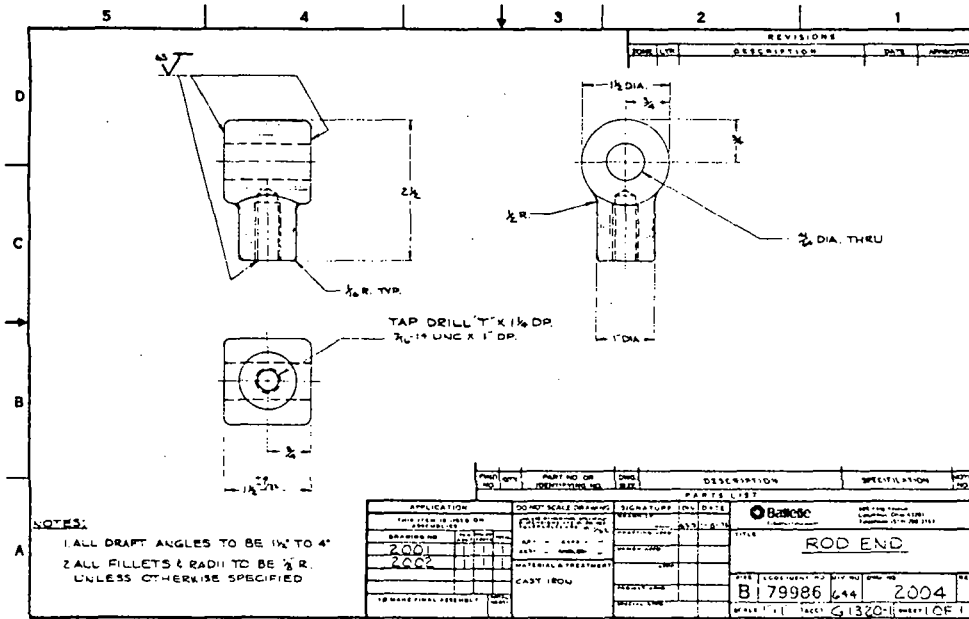




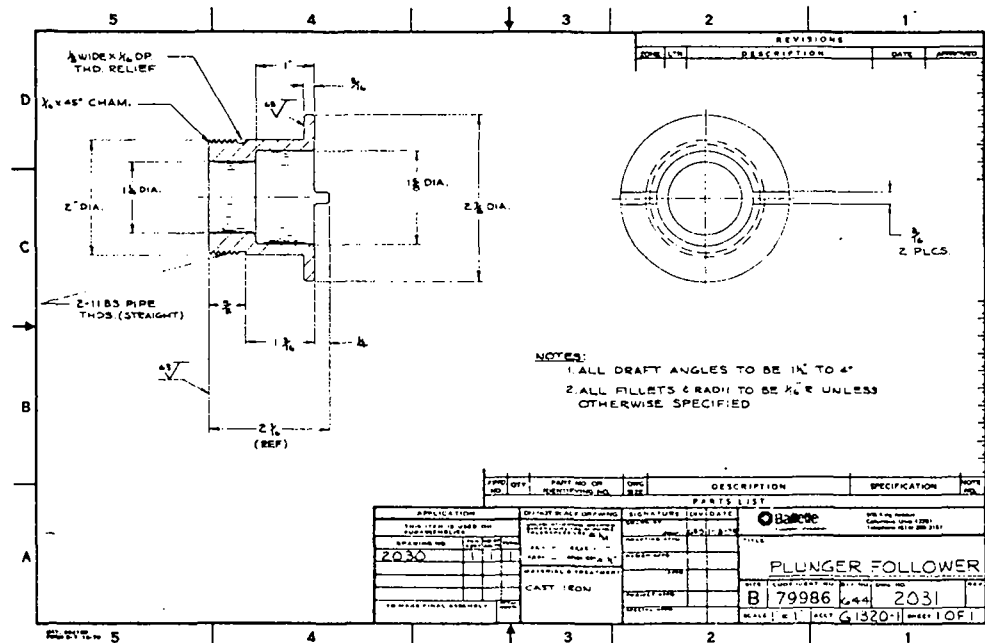
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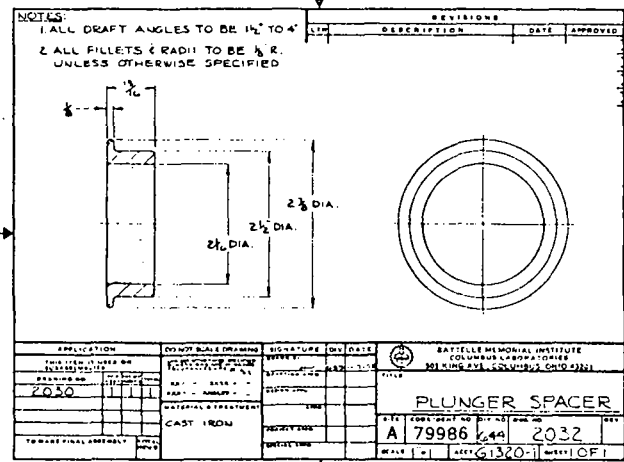
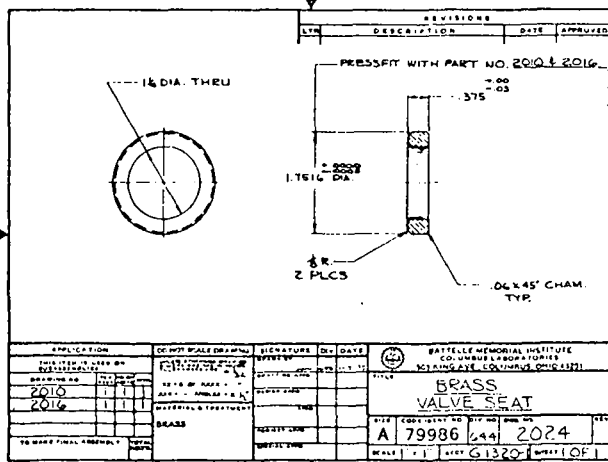
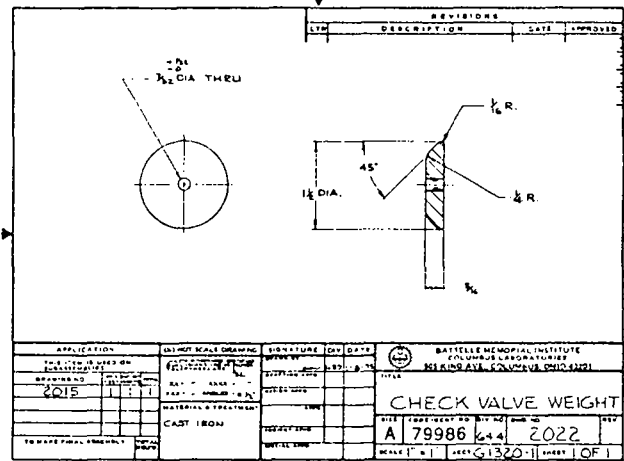
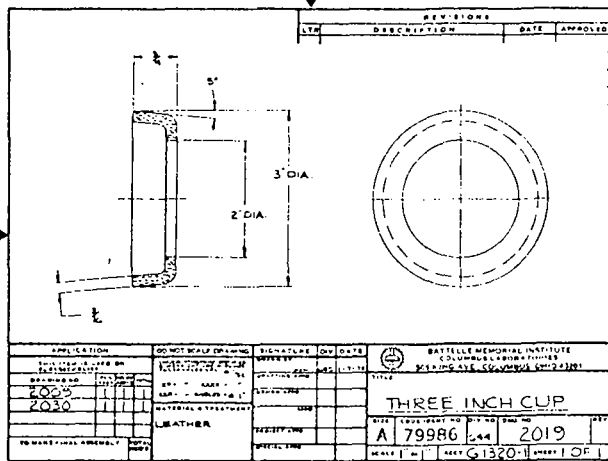
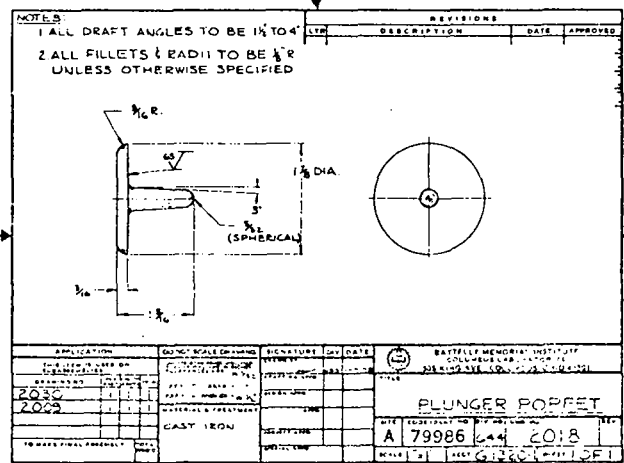
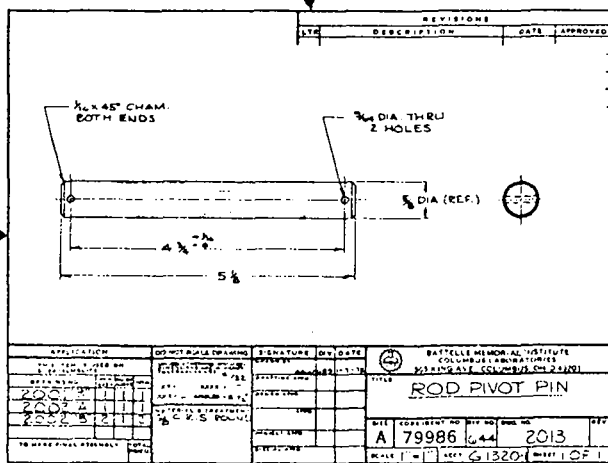
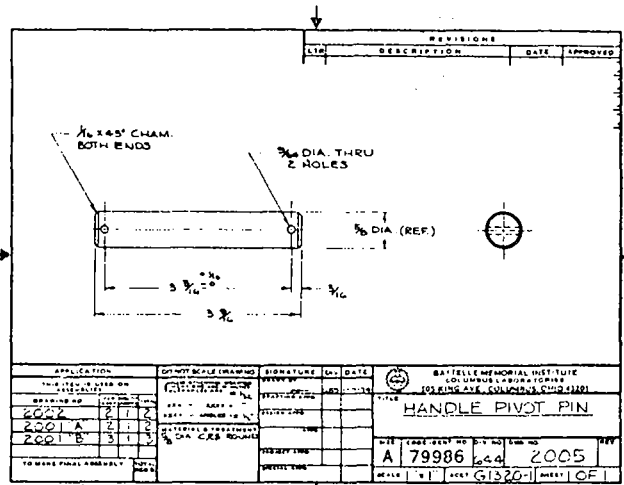
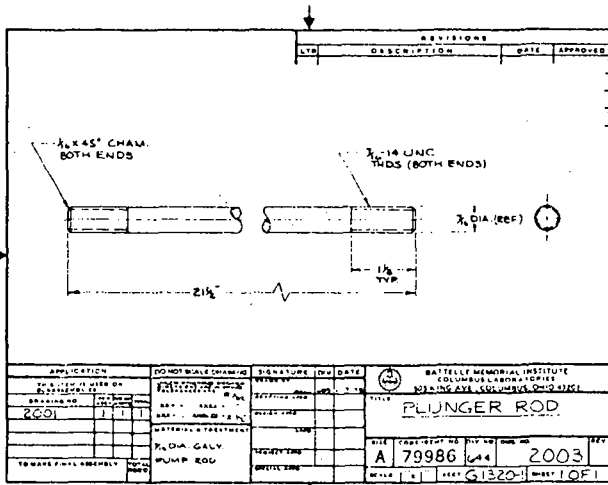


2016









BURMA AND HAND PUMPS

Introduction

Burma is situated between latitudes 10°00'N. and 28°10'N. and longitudes 92°5'E. and 100°35'E. The elevation of the land surface of Burma varies from sea-level along the coastal section to 20,000 feet on the mountainous north. On the west the altitudes of mountains range from 10,000 feet above sea-level. The altitudes of Pegu Yomas, which forms a low range dividing the Irrawaddy and Sittang Valleys in the middle part of Burma, do not exceed 3,000 feet.

The climate of Burma is of monsoonal and the rains fall mainly on the mountainous regions of the west, north and east respectively. The central part of Burma receives very meagre amount of rainfall. The winters and summers are hot and dry, so much so, that the central part of Burma is known as the Dry Zone of Burma.

Prior to 1952, people obtain water from dug wells, rivers, streams and, in dry areas, from dry stream beds by scooping out sand holes to obtain perched water. Utilization of ground water in larger scale had been started in 1952 in villages and in small towns situating in the Dry Zone of Burma. The government of Burma had taken steps in forming an agency known as Environmental Sanitation And Rural Water Supply Board. The Board had employed water jets, cable tools and rotary drill rigs for construction of many tube-wells. As experience in drilling had been gained through some years deeper wells had been bored to obtain more water. At present, depths of wells range from 350 to 700 feet and occasionally a few wells had been put down to 800 feet. Altogether 7839 tube wells had been bored as of March, 1976.

With the provision of safe and clean underground water in the Dry Zone of Burma the demand for more tube-wells by the population have been experienced. The community par-

participation in the development of water resources is keen. Provision of water supply and sanitary facilities to rural health centres and hospitals have been extended recently. The Water Supply Division of Agricultural Mechanization Department under the Ministry of Agriculture and Forests is responsible for development, operation and maintenance of tube-wells, especially in the Dry Zone of Burma.

Recently as of 1973-74 the Government attaches priority to rural water supply in the difficult and scarcity areas. In the development of rural communities the Government of Burma has given the rural water supply as one of the main priorities.

The Water Supply Division of Agricultural Mechanization Department has mainly provided tube wells with either hand pumps or power operated pumps. The programme for providing the tube wells with hand pumps began in 1953. Out of 7839 tube wells drilled or bored, 6807 wells have been successful and provides water resources to 5310 villages and a total population of about 3 million. Power operated pumps had been installed in 230 villages providing water supply for about 0.35 million population in rural areas. The rest of the wells had been installed with hand pumps. About 2.65 million population are presently served by 6,577 hand pumps.

Ground Water Development

The increased use of wholesome tube-wells water on a countrywide basis was first started in 1952 under the Environmental Sanitation Division of the Directorate of Public Health and the Division continued as Environmental Sanitation and Rural Water Supply Board under the Ministry of Social Welfare. Later, the Board was abolished and Rural Sanitation And Water Supply Board was formed in 1954 and work started with force. After the take over of the Revolutionary Government the Board was reorganised under the Agricultural Mecha-

nization Department in 1972 as Rural Water Supply Division.

Under the present Department drilling of tube wells had been continued. Four field stations are presently supervising the drilling works in the Dry Zone of Burma. With 9 rotary drilling rigs, 5 cable tool boring machines and 13 water jets 7839 tube wells had been put down since 1952.

Ground waters in the Dry Zone of Burma varies with the host rocks which contain them. Three main divisions can be made for the quality of ground water. Alluvial valleys yield fresh waters or slightly saline waters, but the majority of the ground-waters met with are fresh. The sedimentary rocks of geologically younger in age such as of Miocene and Pliocene yield mostly slightly saline waters, but in some areas where flushing out of salts containing in the host rocks are present fresh quality water can be obtained. Older sediments of Eocene-Oligocene period yield saline quality waters only. Most of the tube wells are presently put down in Alluvial valleys and some in the younger sedimentary rock formations. Where saline waters are met with the wells are abandoned. Through experience of drillers and through study of rock formations more successful wells had been drilled presently.

Introduction of Hand Pumps

With the introduction of tube wells in Burma hand pumps had been employed since 1953. Provision of hand pumps had been made due to lack of electricity in rural areas. A total of 6,577 hand pumps had already been installed and the Water Supply Division of the Agricultural Mechanization Department is responsible for maintenance. Some people in the rural communities are also being trained by the personnel of the Division to maintain their own hand pumps. Where communication is easier the maintenance crews visit villages regularly. The co-operation of villagers in drilling, as well as

in maintenance have been obtained. Presently, the maximum and minimum number of users for each hand pump are 1,550 and 110 per day respectively.

Three types of hand pumps have been employed by the Division are :

- (1) Semi-Rotary Double Acting Pumps.
- (2) Single Acting lift and force pump.
- (3) Lift and force oil bath pump with fly wheel attached.

The above-mentioned hand pumps are of diverse manufacture, but they are suitable for the tube wells already drilled. The hand pumps have different lifting power and they are installed according to the water levels of tube wells. Where the water levels in tube wells are between 5 to 25 feet semi-rotary hand pumps have been installed, whereas, single acting lift and force pumps are installed where the water levels of tube wells are between 25 to 40 feet below ground level. Most of the hand pumps used are of deep well oil bath type where the water levels in tube wells are below 40 and 90 feet.

The single acting lift and force pumps are operated in up and down motion on a handle, with the yield of 240 gph at about 40 strokes per minute. Various trade names of this kind of hand pumps which have been in use are as follows:

- (a) Orjan
- (b) Beatrice
- (c) Red Jacket
- (d) Lukô
- (e) Myre

Deep well hand pumps such as Godwin with two fly-wheels and Climax with one fly-wheel are being employed. Both hand pumps are provided with oil bath for crank case assembly. Their yield is approximately 300 gph at 30 strokes per minute

for Godwin hand pump and 400 gph at 40 strokes per minute for Climax hand pump. Both types serve the purpose for medium range water levels of 40 to 90 feet below ground level.

For deeper water levels locally invented foot pumps have been employed. These foot pumps draw water from 90 feet to 120 feet below ground level. Power pumps and compressors have been employed where water levels are below 120 and 500 feet below ground level. Altogether 230 power pumps have been provided presently.

In the Dry Zone of Burma there are some areas where the ground water is not potable. In such areas piped water supply has to be provided. Tang Zin water supply work is an example. The water provided in this manner supplies to 35 villages and serving the population of about 25,000. About 6 gallons of water is made available per capita per day. During summer months additional 35 to 40 villages depend upon this system. Pumping in summer has to be increased by about 3 hours, but the supply per capita is reduced.

At present about 0.15 million gallons of water is pumped every day for 10 hours a day. However, plans have been made to increase the pumping time and to serve more population up to about 80,000 in 90 villages. Supply of water per capita per day will also be increased to 8 gallons. No charges are levied by the government for the water supplied.

Conclusion

The Rural Water Supply Division of Agricultural Mechanization Department has its own plans for future ground water development. It plans to increase the momentum in drilling tube wells according to the plans laid down by the government. The Division has plans to increase the number of drilling rigs in order to meet the growing demand for safe and wholesome water for the villages in the Dry Zone of Burma. Since most of the villages have no electricity hand pumps will have to be used for lifting purposes.

* * * * *

Please reply to:

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ITDG'S INTEREST

(Notes for the International Workshop on Handpumps,
The Hague July 12th - 16th, 1976)

The Intermediate Technology Development Group exists to help make concrete some of the ideas set out in Dr. Schumacher's popular book 'Small is Beautiful'. More specifically, the Group was founded 10 years ago to inform users in developing countries of the range of existing technologies in varying fields and to assist in the development of these technologies. The organisation to carry out this complex and specialist task includes:-

- a) Panels of experts from industry and the Universities
- b) Industrial Liaison Unit to link enquiries from the developing world to industry and research institutes
- c) Project Officers who work either in overseas countries on projects that require the long term attention of one or more technologists, or in the UK on a range of research projects
- d) a publications company, whose output is expanding very rapidly
- e) an information/intelligence function
- f) a consultancy company
- g) a hardware company

- 1) With regard to pumps our interest can be clearly stated as the 'total technology of implementation' or the 'systems approach'. That is to say, the pump is only a part of a system in which the most cost effective, or time effective, benefit may be for instance, in keeping dirt and soil from the well or in organising routine maintenance, or in separating drinking water from washing and irrigation water supplies.
- 2) It follows from the above that our interest is not just in pump designs, but even more in whole systems, tried and tested as extensively and repeatedly as possible under field conditions (references: Simon Watt on Ram Pumps, also Chinese Chain and Washer Pumps, and Peter Fraenkel on Food from Windmills, are appropriate).
- 3) Part of our function is to provide information to give the user a choice so HE can select the appropriate pump to manufacture or to purchase; we hope that our publications will enable an isolated user to construct and commission his own equipment.
- 4) Before deciding on a particular pump there needs to be a guide to the range available. We have several forms for such information publications and hope, at this workshop, to identify, if there is a need, the form that an industrial profile of available pumps could take so as to form a useful Buyers Guide.
- 5) The outcome of this pump workshop can be made available to our user contacts through the Journal of Appropriate Technology, through the Overseas Development Ministry contacts, by ITDG Field Officers, and via the ITDG information system which includes the enquiry handling process of the Industrial Liaison Unit.
- 6) Andrew Cowan, the new Head of the Industrial Liaison Unit, has, at this workshop, a full range of ITDG literature, which he will be pleased to show individual delegates for reference, copying, etc.
- 7) It may be that at the end of the workshop it becomes clear that there are some clearly defined pump components required in large quantities. In this event, it would be an interest of the Industrial Liaison Unit to pursue the case with manufacturers.
- 8) Our interest extends to simple basic windpumps through the services of our Project Officers and Panels. Peter Fraenkel's 'Food from Windmills' is an example of this work to extend the range of simple pumps.

INTEGRATING SKILLS, MATERIALS AND EQUIPMENT FOR RURAL
DEVELOPMENT - POSSIBILITIES IN THE SAHEL

S.B.Watt. June 1976.

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4. SELF HELP WELL CONSTRUCTION PROGRAMMES
5. MULTIPLE USE OF MATERIALS AND EQUIPMENT

FIGURES, TABLES, REFERENCES.

Prepared for :- International Workshop on Hand Pumps,
July, 1976.

WHO. IRC. CWS.
N W Havenstraat 6,
Voorburg (The Hague)
HOLLAND.

SUMMARY

One of the resolutions of the recent UN Habitat meeting in Vancouver, urges that just 1% of the annual global arms budget, for instance, will suffice and should be re-allocated to provide safe drinking water for the mass of the world's people who live both in the poor rural areas and the rapidly growing fringe settlements around the towns. As safe drinking water plays such a vital part in the health and well being of the users, this resolution is a very practical one. It shows clearly the relatively minute sums of money that would be needed for the improvements in water supplies compared with the gargantuan level of global military spending. It places the responsibility and the burden of re-allocating resources for this purpose squarely on the shoulders of those who can afford it, and those who control present arms spending.

Improvements to water supplies alone, however, will be unlikely to achieve their potential health benefits in full, unless sanitation, food supplies, housing, clean clothing and soap, hygiene education etc. are improved at the same time. Selecting from a broad range of possibilities the ones that will lead to the best improvement with the most efficient use of resources, is of course the purpose of integrated development plans. Improvements to hand pumps for rural areas should be seen in this broader perspective, as being only one component in a much wider programme.

The purpose of this present paper is to suggest one immediate and practical strategy for rural water supply improvement that integrates and implements at the same time several aspects of rural development by the multiple use of skills, materials and equipment. It also bypasses the immediate pressing search for the elusive, indestructable village hand pump. This paper is based mainly on the experience of programmes in the Sahel region, but the general comments may have some value for other areas of the world.

1. BACKGROUND - SOCIALLY APPROPRIATE TECHNOLOGIES AND SELF HELP

The poet W.H.Auden wrote - 'Art can never be the midwife to society', yet technological development is expected to be the midwife to social development.

Part of the critique that appropriate technologists accept, holds that development in its essential nature consists of what people do, technology is the means and the tools that help them do it; development is therefore the fruit of a successful marriage between techniques and the people who use them. The techniques that are understood and can be managed by the people who use them, or that assist them to contribute to the promotion of their social well being, can be said to be appropriate. This will include both the simple and the highly sophisticated equipment, and patterns of organisation that vary from the strictly local to regional or national. Appropriate technologists argue, however, that an understanding of the range of appropriate choices in technology does not in itself mean that these will be adopted. The decision to do so is essentially the political one of the best allocation of scarce resources to benefit the majority who have the greatest need.

Britain was one of the first countries to industrialise, and even the most cursory examination of its history shows that most of the technological changes during the 'Industrial Revolution' were relatively small and easily understandable by the majority of people. Many of these changes required serious social dislocation and were bitterly opposed by the mass of the people, but others were eagerly welcomed. The steady mechanisation of cotton manufacture needing a tightly disciplined and controlled labour force is an example of the former, the replacement by easily washable cotton of woollen garments an example of the latter. Whether or not development can be seen to take place without gross social disruption depends on the political stance of the observer. The criteria for socially appropriate technologies recognises the essentially political element in technical choice and methods of implementation. They also recognise the competition between the purely economic and the broader social development; that is, between the private and the public good.

The technologies that are appropriate to social development are not all restricted to self help within the social boundaries of the users. There is inevitably a need for skilled local or central government workers to organise finance, know how, and most important to act as a catalyst

between the people and the techniques that bring improvements. This means that a policy of - 'from the bottom up' must balance the more usual structure of - 'from the top down', for self help can only finally come from the users. There must also be a balance between self help and assisted development on the one hand, and the production of goods by independent industries on the other. This balance, as already mentioned, is one of degree, circumstance and ideology.

2. SOME PROBLEMS IN RURAL DEVELOPMENT

There are many real and widely discussed reasons why rural development is so difficult:-

- the migration of active, healthy young people into the towns in search of a better life.
- the consequent impoverishment of social life in rural areas
- the geographically dispersed populations and the greatly increased costs of services, transportation and communications.
- the attraction of development resources to concentrated populations, with the neglect of investment in rural areas.

Developing equipment that can be built and maintained in rural areas is obviously only a part of the answer. Rural development, if it is to be at all successful, must come from a conscious decision by government to direct resources, skills and devolve power back to the rural areas. It is interesting that these same comments are also made by the people living in the relatively poorer regions of Europe.

3. INTEGRATING DEVELOPMENT - FOCUSING ON THE HARDWARE.

The integrated approach to increasing the well being of a rural community makes complementary improvements to a wide range of activities. These improvements are within the ability of the members of the community to understand and manage, and start by tackling the most serious problems first. This approach by planners is a necessary one, and has evolved in

reaction against the tendency to concentrate resources on one activity that can be spectacularly improved by high performance techniques in the short term, but may cause great difficulties in the longer term. Integrated development is essentially a method of economic planning to achieve the best long term results for the smallest investment of capital and skills. It is obvious that this approach to community development also has to take into account the wider strategy at regional or national level. It in no way overcomes the problem of "second class capital" usually directed to rural areas; that is, the rural areas are unlikely to develop whilst power, wealth, and skills continue to flow into the towns at the present rates.

An attempt to understand how techniques and hardware 'fit' into this broader pattern of development is known as a systems approach, and seeks to understand and interrelate the many different factors that determine the successful use of the hardware. On a community, small scale level, the attitudes of the users must be central to this system; this is shown in Fig. 1-2 of the Interim Report for this workshop. Fig. 1. The hand pump system shown however, cannot indicate the confidence of the users and the attitudes of the promoters of the programme - a healthy state of affairs could perhaps be best illustrated by colouring the diagram pink.

The widespread failure of village well pumps has been reported from well construction programmes in many parts of the world. Most of the programmes were planned as emergency relief, when self contained drilling rigs and experienced crews were organised to put down wells and equip them with pumps as fast as possible. The technique of construction and local involvement was not part of a broader plan for longer term development, and the well users were simply recipients of completed wells. In these cases it is of little wonder that the users have often been unable to organise themselves to look after the pumps. This essential difference between emergency relief and development with regard to hand pumps has been examined in detail by other writers.⁽¹⁾

This present workshop has been arranged specifically to consider village scale water pumps, presumably for use in small diameter boreholes. There are, however, many other ways of improving rural water supplies that 'by-pass' the need for hand pumps. Roof and prepared ground catchments feeding water to storage tanks, for instance, can make a major

contribution to water supplies. Fig.2. In areas where ground water is at a depth no greater than 50 metres, wells dug by hand that can be pumped with a rope and bucket, that can be built by self help, and that can fit into a wider pattern of development are a neglected construction technique. (2)

Self help well construction is considered in greater detail in the next section, with examples from the Sahel area.

4. SELF HELP WELL CONSTRUCTION PROGRAMMES

Ground water supplies that are shallow enough to be reached and pumped can provide a large reservoir of naturally replenished water that is usually uncontaminated by disease causing bacteria until a well is sunk into it. The wells may be constructed in a wide variety of ways. The deeper wells over 50m deep, or those penetrating hard rocks, can usually only be drilled by powered rigs and are very costly for reasons already given above. Maintaining the drilling rigs in isolated areas is expensive, and each rig has to have a mechanic amongst the highly trained and highly paid drilling crew; the cost of drilling is such that the machine has to be used to its greatest efficiency to reduce the costs of each well. In addition, a mechanical pump must be fitted. These costly programmes by their very nature cannot involve the well users to any great extent, and as they are sunk so quickly, there is little time for the drilling crew to organise the maintenance and repair of the pump and well head by the users.

Self help well construction programmes are designed to allow the well users to contribute their time and efforts to constructing a cheap well, provided ground conditions are suitable. The techniques chosen are made as simple as possible, and can be used without powered equipment, although this can speed up operations. A list and comparison of these techniques is given in Table 1.

Broadly speaking, self help wells are either dug by hand with a diameter greater than 1m, or are constructed from the surface by a combination of augering and drilling a small diameter well. Fig.3 shows both these methods. Long experience by field works suggests that for most areas hand dug wells are cheaper than the smaller diameter wells of equivalent depth, despite the more laborious work involved, and the greater quantity of materials needed. The reason for this is not at first sight obvious,

and a comparison of two programmes in the Sahel, Table 2 shows that the reason lies in the cost of skilled administration. The same number of organisers can supervise as many as twenty hand dug wells at a time, allowing day to day work to be under the direct control of an artisan who may be a local person; this allows the organisers time to discuss fully with the users how the well will benefit them, and how they can organise themselves to do the work. Small diameter wells, on the other hand, need much more attention to cope with difficult ground, and although they may be drilled during the wet season when the ground water level has risen, the organisers can manage fewer wells each year.

In addition, besides being traditional in many areas, hand dug wells, if they are left open at the top do not need mechanical hand pumps. This allows the criticism that the well water will be open to contamination from the surface, but even then the water will usually be of better quality than the existing sources. At a later date when skills and resources permit the well head can be sealed with a concrete slab and fitted with a hand pump, or other simple water lifting devices Fig. 4. In this case, the hand dug well will give as pure supply of water as a small diameter sealed tubewell.

The hand dug well has a bad reputation as a source of water, but with care and small improvements the risks of contamination can be greatly reduced. Some of these improvements, carried out by local people in Upper Volta, are shown in Fig. 5. The well head is protected and supported by a wall of lateritic blocks, and a lip of concrete is built around the well mouth to prevent spilt water from running back into the well. The ^{total} cost of these improvements will come to less than \$1. The rubber buckets made and sold in the local markets are less than 1/10th of the cost of galvanised iron buckets, and are small enough to be lifted full of water by the women and children who are usually the water carriers. These buckets cannot be set on the ground without spilling their contents, and are therefore at less risk of picking up contaminated matter that will be carried into the well.

There are other good reasons for choosing hand dug wells for self help programmes, especially where the major cost of these is the skilled organisation and delivery of cement and reinforcement for the linings. These materials are simple to work, are permanent and can be used for a myriad of self help projects besides well construction. The availability of these materials in isolated rural areas depends on the level of local development activity. Often they are scarce and correspondingly expensive.

A self help programme, however, is organised to carry these materials and other equipment into the rural areas at the lowest possible cost, usually in bulk with prepared storage. A multiple use of equipment and materials will therefore reduce the unit cost of each item constructed or improved, i.e. the cost of the administration can be shared between them. Local people are often not unaware of these complementary activities, an example of a mortar covered grain bin made locally is shown in Fig.6, with an advanced, unreinforced type also shown; the cement for the granary, and well lip described above, came from a nearby well that was being lined with concrete as part of a programme.

The materials and equipment used to construct small diameter tube-wells by machine or hand power are not so flexible in use.

Some possibilities for using cement and reinforcement by self help as part of an integrated plan are described below. The local people can be instructed and shown how to make these, and taught about their use at the same time as the well is being constructed. The use of each item, especially the granaries, needs of course to be considered from a wider perspective in a similar way to that already described as the systems approach for hand pumps.⁽³⁾ Ideally these activities should be encouraged and if necessary coordinated by an extension or community development worker. Nevertheless, many of these items are permanent and even if neglected on completion will still work satisfactorily when needed.

5. MULTIPLE USE OF MATERIALS AND EQUIPMENT IN RURAL DEVELOPMENT PROGRAMMES.

This final section will consider just a few ways that cementitious materials can be used. There are obviously many more, ranging from housing to bridge construction. The uses described here are ones where the adaption of reinforced concrete will make large incremental improvements to existing activities.

Using the well lining shutters.

Reinforced concrete lined, hand dug wells are built above the water level by pouring concrete behind shutters erected in the excavated well. The shutters, made from welded rolled ^{steel} channel sections and plate, are expensive but make ideal form work for building hand trowelled, wire reinforced cement mortar tanks.⁽⁴⁾ Tanks of this sort have a wide range of uses, for water storage, as granaries, as septic tanks or aqua privies etc. Construction around the shutters by unskilled workers is simple and fool proof, and the tanks are durable and cheap. Cylindrical rings used for

caissoning down the well can also be adapted for road culverts at essential crossings.

These items can be built and installed whilst the well programme organisers are in the area.

Using concrete.

Concrete or any other cementitious material for that matter has innumerable uses in improving basic facilities. It will obviously not be possible to carry out all of these in the short time of the programme but it is not difficult to improve the ones that will bring large and immediate benefits.

These will include providing a washable concrete slab and drain for cattle slaughtering, concrete toilet bowls for the market place, (which is often a major focus of infection), toilets and washrooms for schools, hospitals etc.

Using wire reinforced mortar

Wire reinforced mortar, often called ferro-cement, also has a wide range of uses (See Ref.5). Washing basins with scrubbing boards along side the well are an introduction that will have great benefits for the women of the community.

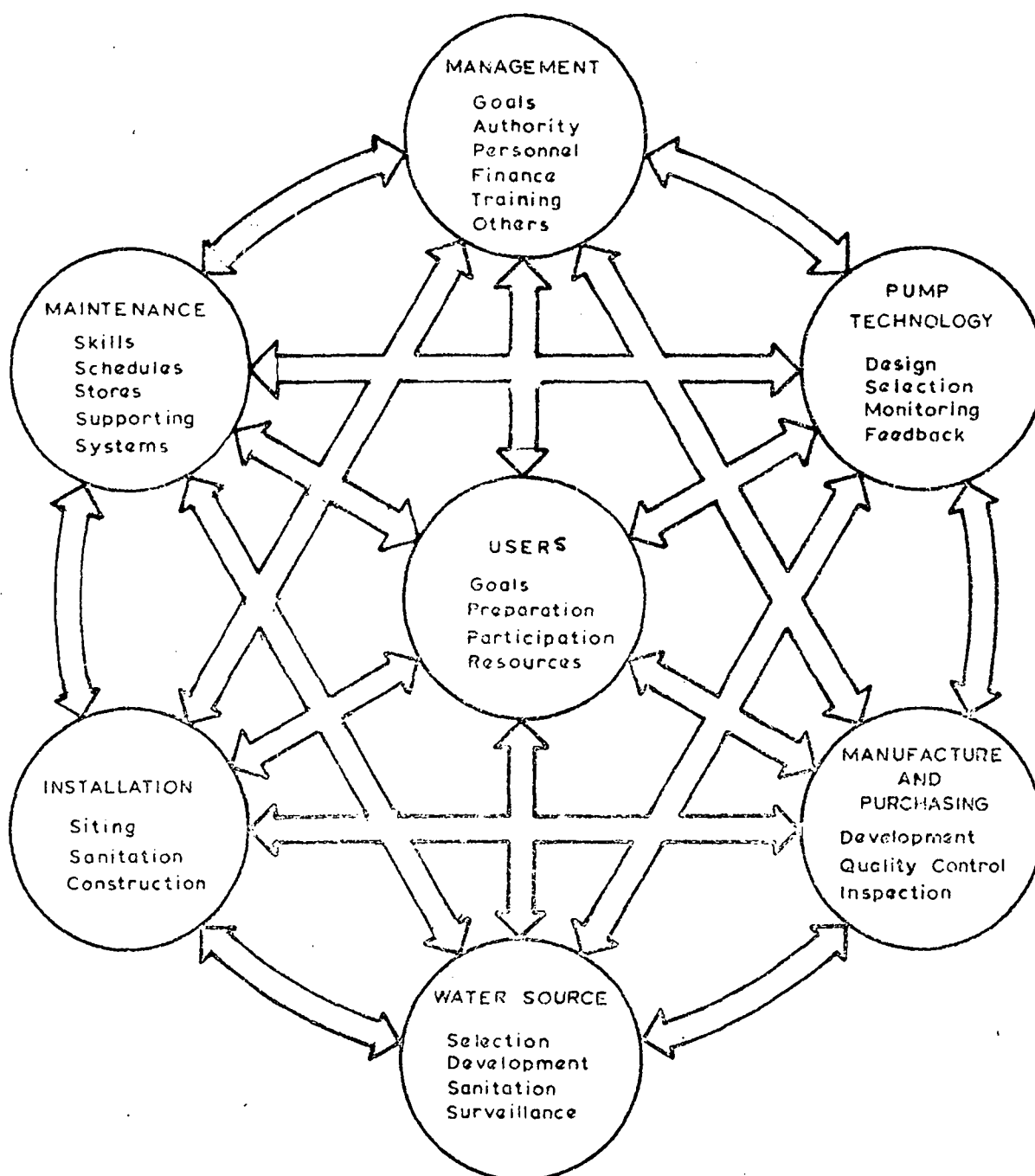
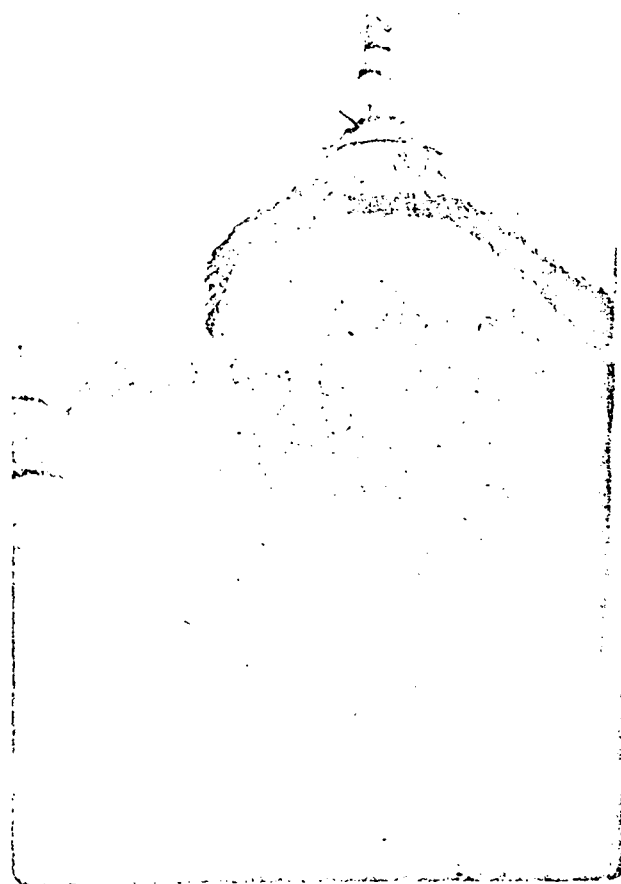


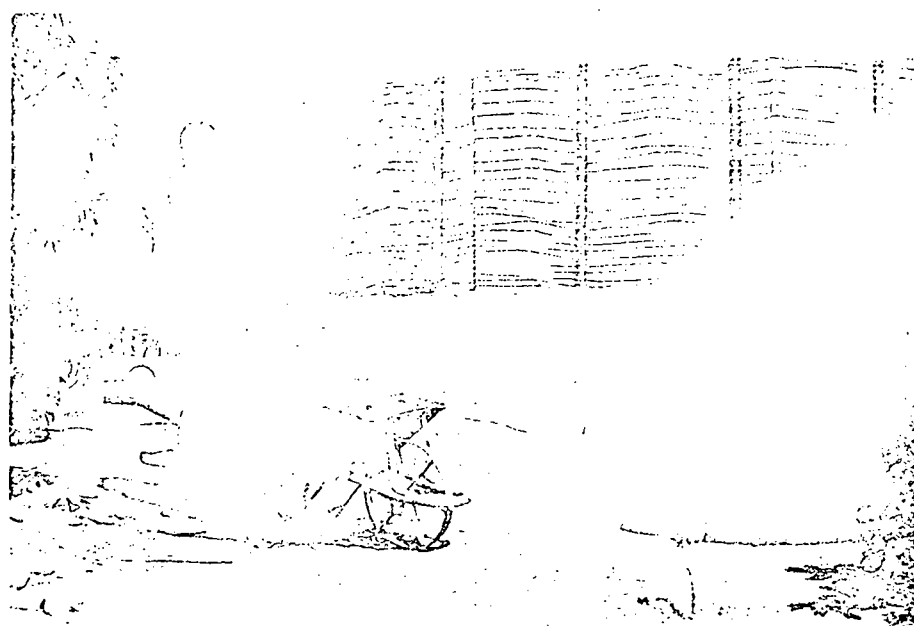
Fig. 1 Diagram showing systems approach for a hand pump.

From - 'Guide lines on Hand Pumps..'

Interim report to WHO, IRC. CWS. Feb.1976.

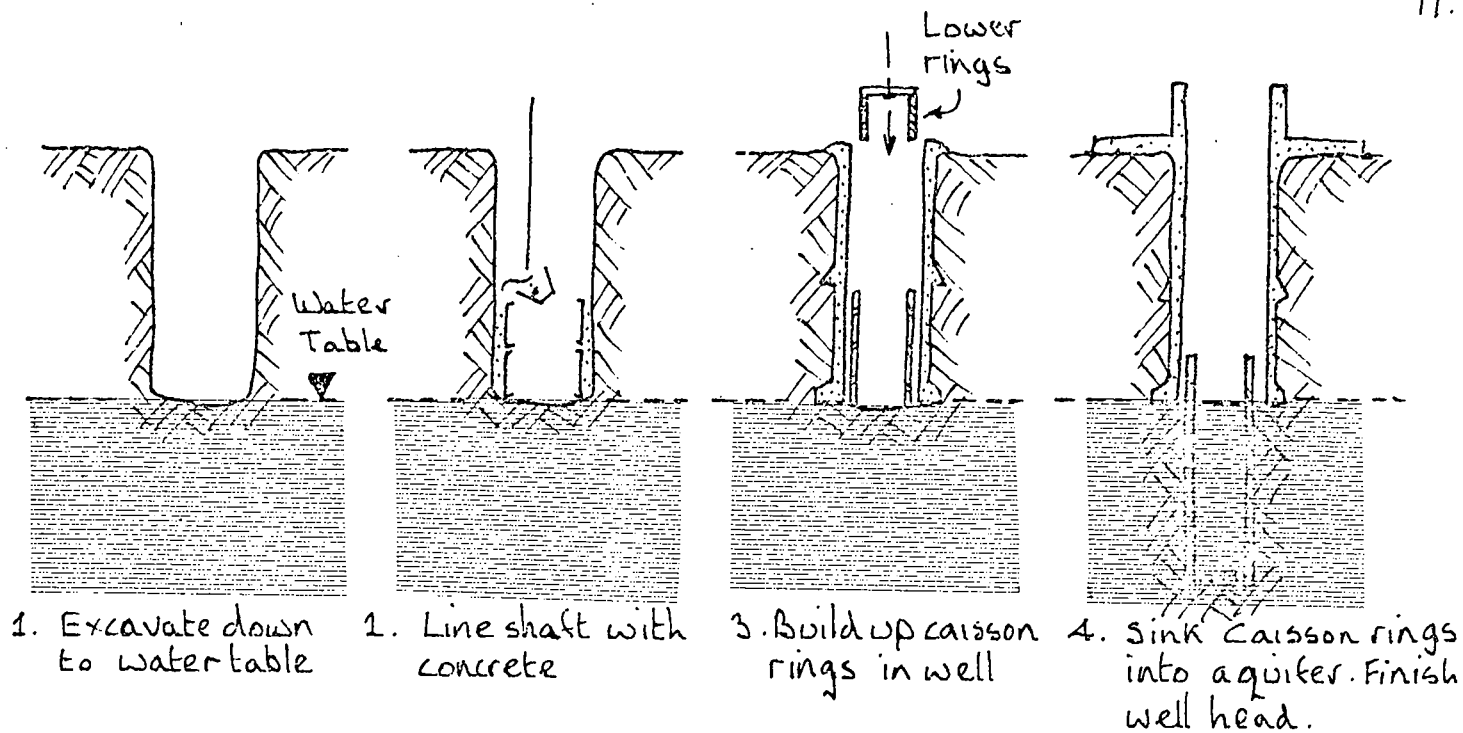


a) Adobe bin lined with ferro-cement, collecting water from the roof. Mali.
From -'Fighting the Drought' Hans Guggenheim NY USA.

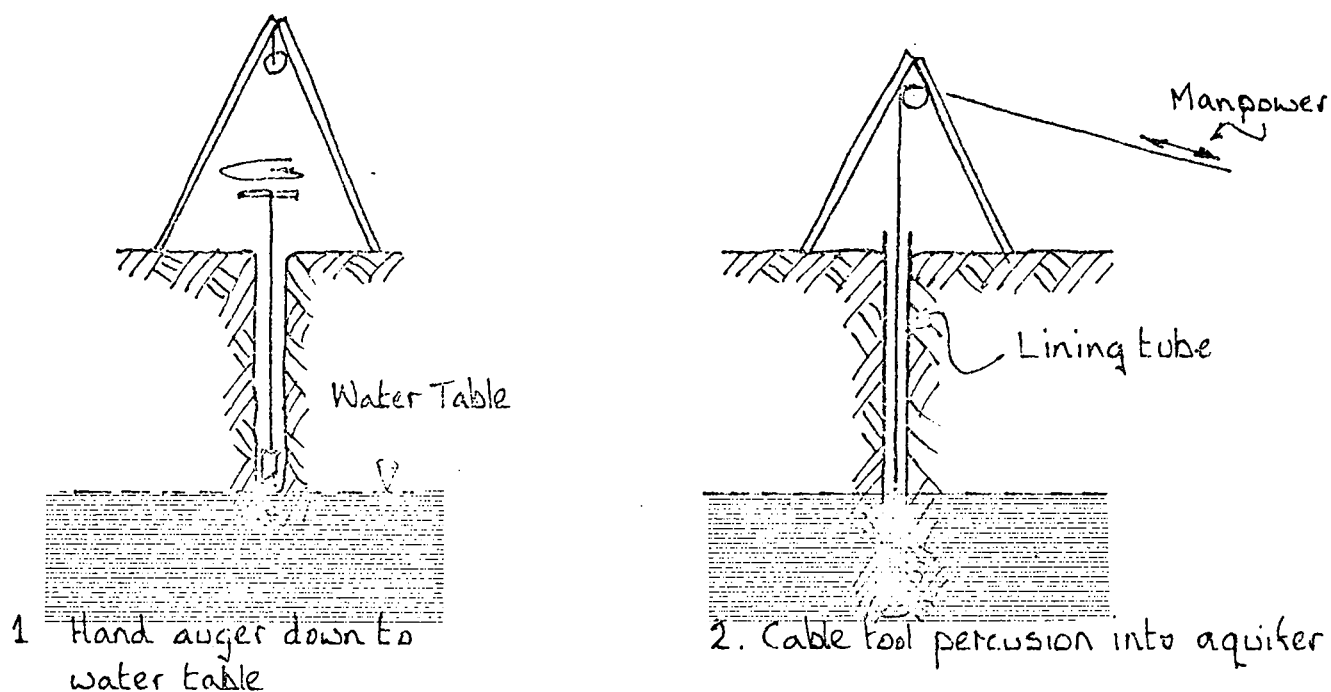


b) Thin walled, wire reinforced concrete water tanks, collecting ground
catchment run off. Rhodesia.

Fig. 2 Roof and ground catchment tanks.

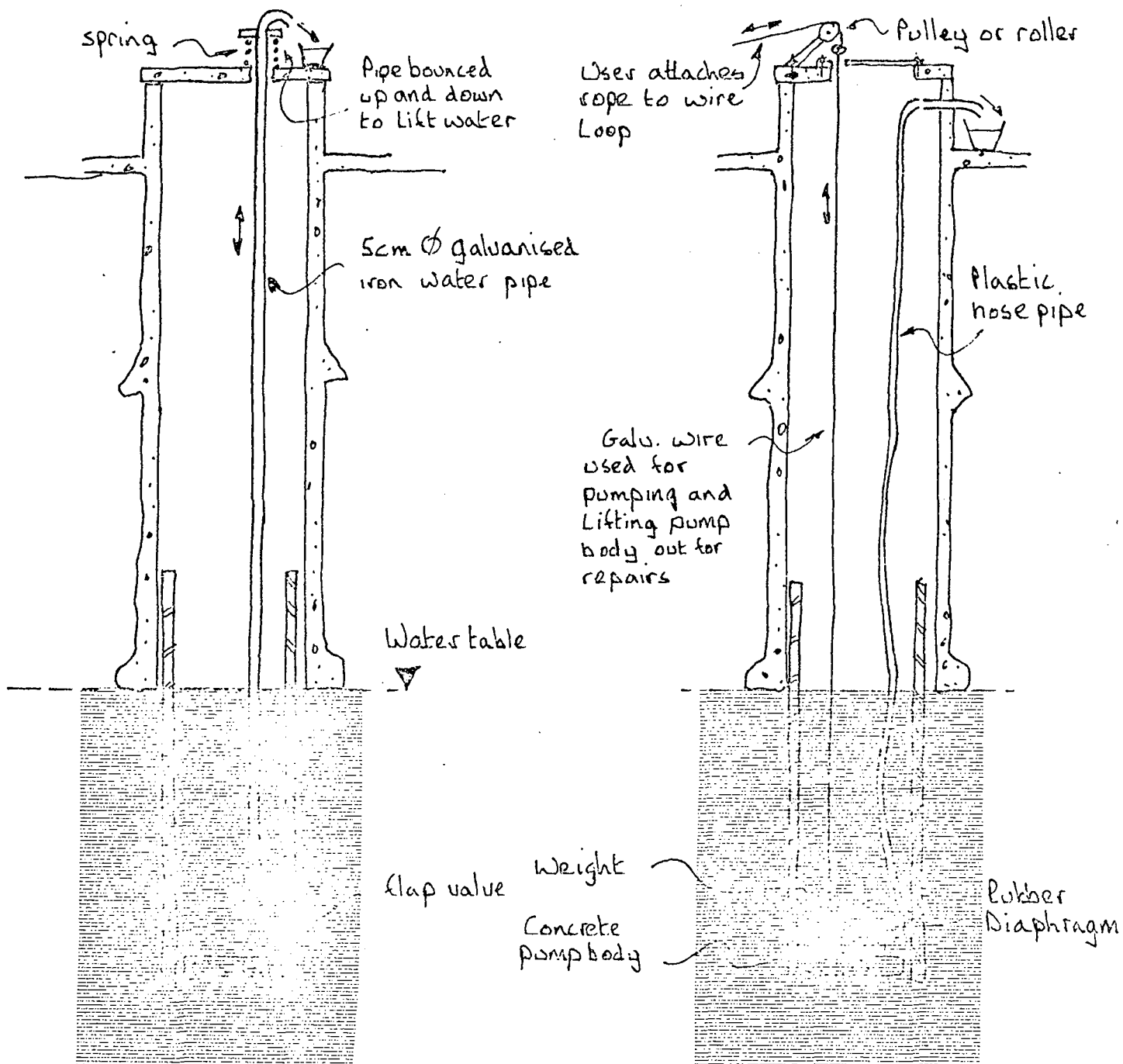


a, Hand dug wells



b, Auger cable tool percussion

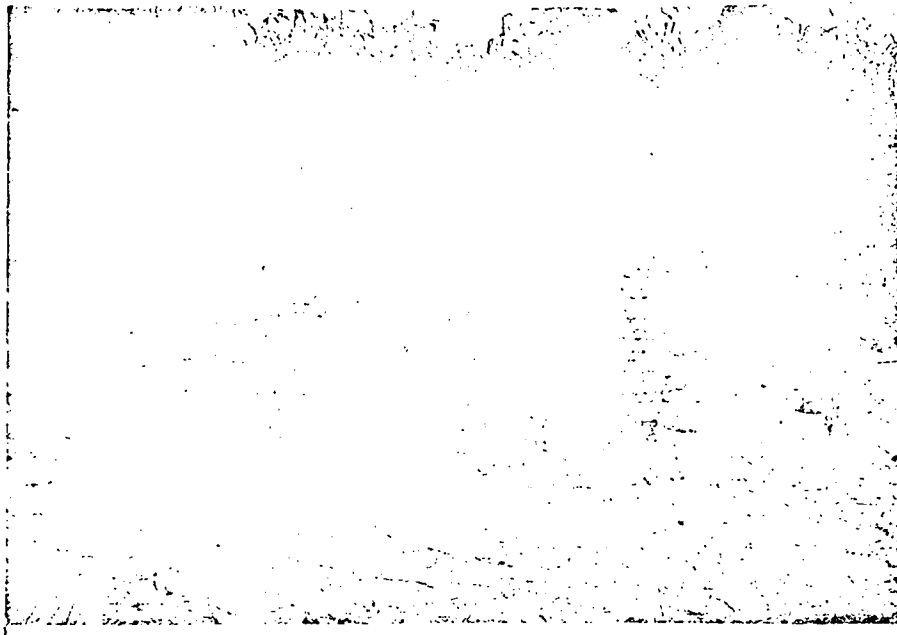
Fig. 3. Typical Self Help Well Construction Methods.



a. Jenson Inertia Pump

b. Diaphragm Pump.

Fig. 4 Simple water lifting devices for sealed hand dug wells.



- a. Protected well head. Lateritic brick head wall to prevent collapse, concrete lip to prevent spilled water draining back into well. The galvanised iron bucket costs 10 times more than the rubber buckets, is heavy when full of water, tips over if it hits the well side during lifting, can be rested on the ground and is more likely to pick up contamination. It can also be used for cooking.

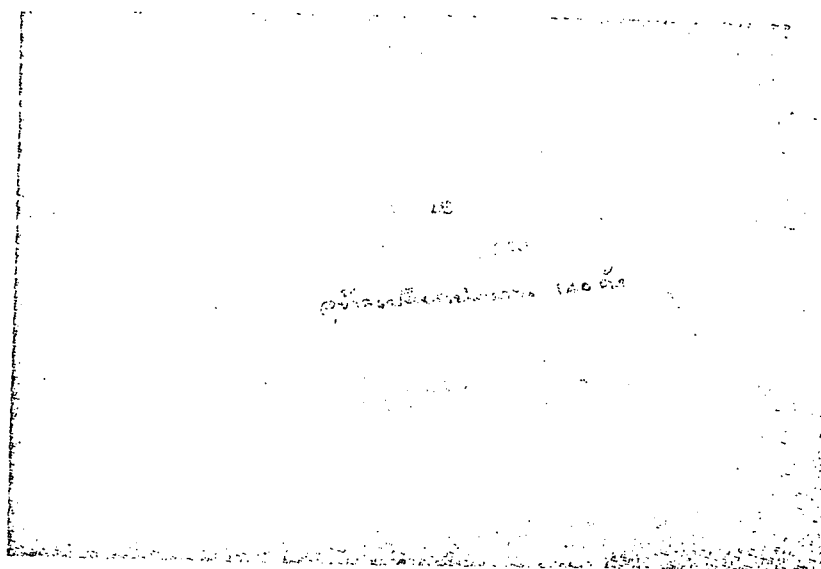


- b. Locally made rubber buckets. Cheap, clean, small volume, can be easily lifted, cannot be stood up on the ground, cannot be used for anything else but water carrying.

Fig. 5 Local improvements in hand dug wells. Upper Volta.



a) Locally made bin, constructed of unreinforced cement mortar trowelled onto brick masonry.



b) Improved, low cost rice bin, Thailand.

Fig. 6 Thin walled mortar grain bins.

TABLE 1. COMPARISON OF WELL CONSTRUCTION TECHNIQUES.

SELF HELP TECHNIQUE	MAXIMUM PRACTICAL DEPTH	DIAMETER	MAIN ATTRACTIONS	MAIN LIMITATIONS
LARGE DIAMETER HAND DUG WELLS	About 30m but can dig to 100metres	Range 1-10 metres	1. Requires minimum of specialised skills 2. Only simple tools and practical skills needed 3. Construction takes place down well and work can be seen at all times. No danger of lost tools. 4. Can use wide range of materials for lining. 5. Wide range of pumps can be used. 6. Large diameter wells are traditional and readily acceptable in many parts of the world. 7. Especially useful in slow flowing aquifers, the large diameter well is often the only way to extract water. 8. Users can substitute their efforts for scarce capital	1. Laborious work giving slow progress moving large amounts of material 2. Cannot dig by hand more than about 5 metres below water table, well therefore liable to seasonal fluctuations in water table. 3. Extra cost in lining materials, shutters, etc.
HAND AUGERED WELLS	30 metres	5-25 cms.	1. Can penetrate further into stable aquifers. 2. Tools relatively cheap to make and use. 3. Uses the minimum of materials.	1. Needs some experience and skills. 2. Cannot penetrate consolidated ground or large gravels. 3. Ground formations must be stable.
DRIVEN WELLS	20 metres	5-10 cms.	1. Simple quick and effective. 2. Needs minimum of equipment 3. Can be used for exploratory work.	1. Cannot penetrate hard soils gravels or rocks. 2. Low water yield.
JETTED WELLS	50 metres	5-30	1. Simple and effective, needs few skills. 2. Can penetrate far into aquifer	1. Requires some special equipment and pumps. 2. Cannot penetrate hard soils or gravels, only loose sand and soils. 3. Needs large source of water. 4. Difficult to know when aquifer is reached.
HYDRAULIC PERCUSSION	75m	5-15cms	1. Simple and effective, needs only few skills 2. Simple equipment 3. Can penetrate aquifer, as well is kept full of water.	1. Cannot penetrate hard soils, rocks and gravels. 2. Diameter of hole limited 3. Difficult to drill through coarse loose materials. 4. Needs good supply of water.
CABLE TOOL PERCUSSION	75m	5-30cms.	1. Very versatile technique, has been widely used and adapted to different materials, and power sources. 2. Can drill through most materials. 3. Can penetrate far into aquifer.	1. Needs some specialist equipment. 2. Technique can handle wide variety of geological conditions but this needs some experience and skills.
MODERN DEVELOPMENTS.				
1. PERCUSSION-LARGE POWER SOURCE	500m	10-30cms	1. Can drill to great depths through almost any rock and soil 2. Equipment and techniques have been highly developed	1. Requires costly, high performance equipment. 2. Needs highly skilled and experienced operators. 3. Equipment bulky, difficult to transport away from good roads.
2. MUD FLUSH ROTARY	500m	10-40cms		
3. ROTARY WITH AIR CIRCULATION	150m	10-35cms		
4. REVERSED CIRCULATION	350m	30-130cms		
5. DOWN THE HOLE HAMMER PERCUSSION DRILLING	200m	10-20cms		
6. CHILLED SHOT ROTARY.	200m	15-100cms		

TABLE 2 A COMPARISON BETWEEN THE COSTS OF LARGE DIAMETER HAND DUG WELLS, AND SMALL DIAMETER WELL PROGRAMMES, WEST AFRICA, 1974.

PROGRAMME	PEACE CORPS. UPPER VOLTA, 1973-4			PEACE CORPS. TOGO, 1973-4		
ITEM.	LARGE DIAMETER, HAND DUG WELLS			SMALL DIAMETER WELLS CONSTRUCTED BY CABLE TOOL PERCUSSION. Aver. depth=10m		
	Aver. depth = 9m					
	DESCRIPTION	COST \$ /Metre	% TOTAL COST	DESCRIPTION	COST \$/metre	% TOTAL COST
A. MATERIALS	Cement, re-rod	15.6	22.3	Well casing, screens, ris- ing main pipes, pumps	20.8	19.3
B. TOOLS AND EQUIPMENT	Hand tools, shutters, carts, etc.	1.9	2.7	Head frame & lifting tackle tools, and re- pairs, etc.	3.8	3.5
C. TRANSPORT MATERIALS & EQUIPMENT TO WELL SITES	Employ local hauliars and storage facilities	3.7	5.3	Use programme vehicle	3.9	3.6
D. WAGES OF LOCAL ARTISANS.	Masons to supervise on- job work	1.5	2.2	} Employ local well diggers for training including transport	13.1	12.1
E. PERSONNEL TRANSPORT FOR ADMINISTRATION.	Pick-up trucks fuels, oils, servicing.	6.2	8.8			
F. ADMINISTRATION & SALARIES OF PROGRAMME SUPERVISORS.	Office over- heads, adminis- tration costs, lodging allow- ance, salaries etc. (1975 figs.)	41.2	58.6	Office over- heads, etc. administration costs, lodging allowance, salaries, etc. (1975 Figures)	66.5	61.6
	TOTAL \$70.1/m 100%			TOTAL \$108/m 100%		
MAN POWER & WORK RATE.	12 Field workers, 1988m of well dug and lined over the year. 165 m of well/field worker/year			1 Field worker to each rig. 120m of well/field worker/ year.		

Source: US Peace Corps. Upper Volta programme. Costs based on total yearly expenditure. Note the higher cost/metre of finished well taken up by administration and supervision for the small diameter wells.

The total costs of self help well construction will depend on a variety of factors, and some of these can be deduced from the Table above. Costs per metre will vary greatly with difficult ground conditions, and the efficiency that the programmes are run. The Table indicates that, all other things being equal, the technically more simple method of hand digging is likely to be the cheapest. Both of these programmes were in areas of hard lateritic soils. In West Africa, hand dug wells can cost as much \$1000/metre (by contractors); machine drilled wells are invariably more expensive than the self help wells - further information can be found from Reference 2. The simple tubewells become cheapest in soft sandy soils with a shallow aquifer.

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WASHINGTON DC 20418
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A free copy will be sent on request.

INTERNATIONAL WORKSHOP ON HAND PUMPS

The Hague, 12 - 16 July, 1976

Well Drilling Programme and Selection of Suitable
Hand Pumps for Use in Ghana

BY

K. OSEI-POKU

REGIONAL MANAGER, VOLTA REGION

This paper discusses briefly programme for drilling of shallow wells equipped with hand pumps and the selection of suitable hand pumps.

PREAMBLE :

Opportunity must be taken here to dilate briefly on the general policy of the Ghana Water and Sewerage Corporation, the Government's Central Agency responsible for promoting and operating the country's drinking water supplies, for the provision of shallow wells equipped with hand pumps for public water supplies in the small rural communities of Ghana.

(2) A study of Ghana's population distribution, according to the 1970 population census, indicates that there are some 46,440 communities with population less than 1,000. This population group numbers 4 million persons. There is a further population group - some 826 communities of populations between 1,000 and 2,000 who number approximately 1 million persons. Ghana's total population (1970 census) is approximately $8\frac{1}{2}$ million. Of this, there are 487 communities of population above 2,000. The total population of these 487 communities is approximately $3\frac{1}{2}$ million.

(3) Where communities are so small and so widely dispersed, any notion of providing them with pipe-borne water would be entirely ruled out, on the grounds of sheer cost. Therefore, for populations below 2,000 the Corporation's policy is to provide the communities with sanitary shallow wells equipped with hand pumps. Shallow wells equipped with hand pumps are provided at the rate of one well per 300 persons or less. (i.e. say three wells for a community of 1,000 persons), it is already well established that village wells, properly designed, sited, constructed and equipped with hand operated pumps of robust construction, are cheap and reliable sources of naturally safe water, and eminently scattered to the innumerable small communities of rural Ghana.

(4) A humble well hand pump can present considerable difficulty in its repair, particularly by virtue of its distant location away from regional and even district centres, and on account of the fact that the entire pump assembly must be lifted from the depths of a well in order to be able to effect a simple repair.

It is therefore an advantage to secure the kind of hand pump that would require attention only after a long period of use, say, one year or longer.

(5) The Corporation has for a long time been faced with the question of standardising upon the hand pumps which are required for installing on the shallow wells. The hand pumps which the Corporation has so far installed have generally proved unsuitable, particularly from the point of view of length of operational life, and the need for a complicated repair system. The Corporation is therefore, suddenly faced with the problem of securing and standardising upon type of hand pumps which would meet Ghanaian conditions and survive for long-term use, particularly in the remote rural areas where access to the pumps is not possible during the wet season.

(6) There are three main hand-pump programmes at various stages of implementation in Ghana.

(i) Shallow Well Drilling Programme in Southern and Central Ghana;

(ii) WHO/UNDP Rural Water Supply Pilot Project; and

(iii) The Upper Region (CIDA) Rural Water Supply Programme.

(i) Shallow Well Drilling Programme in Southern and Central Ghana

(7) In this programme it is intended to drill about 5000 shallow wells equipped with hand-pumps for small rural communities of population below 2000. The programme area covers part of the Brong Ahafo, Ashanti, Western, Central, Eastern and Volta Regions. The West German Government is providing technical assistance and finance to cover the off-shore costs of employing overseas drilling contractors. This project has reached tendering and selection of consulting Engineers stage. The following tasks shall be entrusted to the consulting Engineers :-

(a) Preparation of the programme inclusive of hydrogeological investigations;

(b) Supervision of the implementation of the programme;

(c) Conclusive evaluation of the programme; and

(d) Assistance to the maintenance service.

(8) WHO/UNDP Rural Water Supply Pilot Project

This is a joint project between WHO, UNDP and Ghana Government. The aim of the project is to provide good drinking water in the rural areas of Ghana, including construction of 215 Shallow boreholes equipped with hand-pumps. In this project WHO is to assist G.W.S.C. in the testing and selection of suitable hand-pump of robust construction that can be developed in Ghana for serving adequately the small rural communities. Work under this project has commenced and the hand-pump selection exercise is about to start.

(9) The Upper Region (CEDA) Rural Water Supply Programme

The Upper Region (CEDA) Rural Water Supply Programme envisages the development of a large number of boreholes fitted with hand-pumps to provide safe sources of water to the rural population of the Upper Region. The scope of work envisaged is as follows :-

- (i) Drilling of some 2,300 shallow boreholes, and supply and installation of an equivalent number of hand-pumps.
 - (ii) Locating and clearing of existing wells in communities with population of less than 500 people, (130 communities with 160 wells are involved) including the supply and installation of hand-pumps.
 - (iii) Supply and installation of replacement hand-pumps for existing wells where the hand-pumps are inoperative and beyond repair.
 - (iv) Construction of base maintenance workshop and warehouse at Bolgatanga and district workshops at Wa, Bawku and Tamu; and supply of equipment for these four District Stations including five mobile maintenance units.
- (10) As at the date of writing this paper 1060 shallow wells have already been drilled out of which 1010 wells have been fitted with two types of hand-pumps from Canada, namely the Beatty and Monarch.

(11) The Corporation became very concerned at the rate of failure of these hand-pumps. Out of the first 500 hand pumps installed about 300 failed within 2 to 3 weeks after installation. Various modifications were carried out to make the pumps operative but the failure rate though reduced is still high. In many of the failures analysed it was found that 90% of the failure was on the pump body above ground i.e. the base, column, stuffing box, coupling fulcrum brackets and the handle or lever.

(12) As a result of this high rate of failure it was decided to institute a hand-pump test programme to select suitable types of pumps which will meet Ghanaian conditions and survive for a long-term use.

(13) Test Programme

A test programme involving seven different types of hand-pumps has been set up. The pumps are :-

- | | |
|-----------------|------------|
| (1) Beatty | - Canadian |
| (2) Monarch | - Canadian |
| (3) U.S.T. Pump | - Ghanaian |
| (4) Dempster | - U.S.A. |
| (5) Mono | - British |
| (6) Godwin | - British |
| (7) Kenya Pump | - Kenya |

(14) In order to effectively monitor and control the test programme selected areas of similar subsurface conditions such as static water level, depth of well etc. have been located. The areas chosen will be accessible all the year round. The selected areas are illustrated in Appendices I, II, III, IV, and V, and data recording forms are shown in Appendices VI and VII. The test programme has only just begun and no results are available, and therefore no meaningful conclusions can be drawn at this stage.

(15) It is proposed to carry out the test programme over a 6 months period during which period there will be weekly continuous monitoring of the performance of the various types of hand-pumps.

(16) It is pertinent to mention here that one of the test pumps selected is the U.N.T. pump which is manufactured locally in Ghana. It incorporates many Battelle features and has no pump cylinder. The leather cup seal operates, in a 3 inch diameter plastic pipe (i.e. drop pipe).

(17) Maintenance Programme

Considering the large number of hand-pumps the G.W.S.C. has embarked on installing, the importance of an effective maintenance programme cannot be over-emphasised. In the Upper Region where a large number of hand pumps have already been installed a maintenance programme has just been set up.

(18) The components of the well maintenance function are as follows :-

- (a) Routine inspection and minor repairs to rural hand pumps by Motorcycle.
- (b) Complete field servicing and unit replacements of hand pumps on an "as required" basis by Mobile Servicing Vehicle equipped with tools and spares.

(a) Routine Inspection of Rural Hand Pumps :

Although there is a need to inspect each hand pump four times a year, the actual amount of servicing required is likely to be less frequent. Part of the reason for such frequent inspections is because of the lack of adequate communication facilities. Therefore the routine inspections serve as a reporting system for servicing needs. In addition to being a reporting system, the routine inspections would provide the necessary public relations and training input required in connection with the introduction of groundwater supplies. The users must be acquainted with the proper manner of operating the pumps. Procedures and line of communication for reporting defective units have to be set up. Eventually, the establishment of a limited preventive maintenance capability at the local level should be sought. Proper communication between the GWSC maintenance staff and the rural water consumers is particularly important during the first two or three years of programme implementation.

The main objective of service is to provide the opportunity to fulfill this need. To optimize the efficiency of the inspection activity, it is desirable to combine such inspections with a preventive maintenance and minor repair capability. Even a limited amount of oiling and bolt tightening will extend the life of the parts involved. It is therefore envisioned that during such inspections worn parts can be replaced prior to failure. Typical repairs which could be made as part of the inspection activity are replacement of handle assembly and fulcrum pin, tightening of brace support bolts, and improvising where necessary to keep a pump operational until a major service can be provided.

(b) Complete Field Service of Hand Pumps:

Whereas the inspection function should be carried out as a routine, extensive field servicing should be provided only on an "as required" basis. The frequency of such servicing will depend upon the need as deficiencies and failures are reported by the inspection personnel. It is anticipated that each hand pump will have to be serviced at least once every two years.

Inspection requires a very limited service capability, but the complete field servicing of a hand pump necessitates the availability of at least two men having a service vehicle equipped to remove and replace hand pumps, drop pipes, cylinders, leathers, etc.

SHALLOW WELL INSTALLATION AND MAINTENANCE

Return

R E G I O N :

PARTICULARS OF WELL :

TOWN : DISTRICT : WELL No :
.....

TYPE OF HAND PUMP :

DATE INSTALLED : DEPTH INSTALLED ³ (pt)

DEPTH OF WELL : (pt) YIELD : (GPH)

SWL : (Ft) DWL : (Ft) FINISHED DIA :
..... (Ins.)

SERVICING :

I. MATERIALS USED

ITEM NO.	QTY.	DESCRIPTION	Unit Price		Amount	
			₹	P	₹	P
Total						

II. LABOUR COST

Grade of Employee	Normal Working Time			Overtime Time			N/Allowance			Sub-Total	
	No. of Days	Amount		hrs	Amount		No. of Nights	Amount		₹	P
		₹	P		₹	P		₹	P		
Total											

III. TRANSPORT/RIG COST

TOTAL MILEAGE COST/MILE : ₹ Amt. : ₹

IV. OVERHEADS : ₹

V. TOTAL COST OF SERVICING/REPAIRS: \$

DATE SERVICING/REPAIRS STARTED: Date Completed:

CAUSE OF BREAKDOWN:
.....

NATURE OF WORK/REPAIRS DONE :
.....
.....

REMARKS :
.....
.....

NEXT SERVICING DUE:

OFFICER-IN-CHARGE :

ENGINEER:

UNICEF RURAL WATER SUPPLY WORKSHOP

Bangladesh Rural Water Supply Programme

An Outline of Choices Associated with
Handpump Tubewell Programmes and Handpump Design

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UNICEF, Dacca

DACCA,
BANGLADESH

MAY 1976

OUTLINE

1. Health versus other sectors of development
2. Water versus other elements of health sector
3. Implementing agency choices
4. Funding sources
5. Personnel required : HPTW programmes
6. Sources of specialized personnel
7. Single wells versus piped systems
8. Handpump tubewells versus other wells
9. How to begin
10. Shallow, deep, or multi-purpose handpump
11. Output of pump desired
12. How much to spend?
13. Imported versus local pump
14. If local made pumps - then what?
15. Imported pumps
16. Handpump research and development work : who should do it?
17. Details of pump design
18. Considerations in site selection
19. Installation
20. Maintenance options
21. Continued development
22. Pump production

*

N O T E

This outline may be helpful to UNICEF Programme Officers becoming involved with handpump tubewell programmes for the first time. Perhaps this type of outline could be amplified by others as time permits to include more details, and perhaps cover more topics.

Bangladesh Rural Water Supply Programme

Choices Associated with Handpump Programmes and Design

1. Health versus other sectors of development

- (a) Health and disease as a constraint on economic development.
- (b) Public demand for better health.

2. Water versus other elements of health sector

- (a) Disease patterns affecting children.
- (b) Proportion of water related diseases as percent of total.
- (c) Water resources available to supply safe, potable water.
- (d) Institutional arrangements to instal and maintain public water systems.
- (e) Public demand for and utilization of improved water systems.
- (f) Resources available - material, financial, manpower.

3. Implementing agency choices

- (a) National water authority
- (b) Provincial water authorities
- (c) Local water boards
- (d) Rural development departments
- (e) Cooperatives
- (f) Private sector
- (g) Public works departments
- (h) Health ministries
- (i) Others

4. Funding sources

- (a) UNICEF regular resources
- (b) UNICEF special assistance projects
- (c) Bilateral donors
- (d) Multilateral agencies
- (e) NGO's
- (f) United Nations or UNICEF special emergency appeals
- (g) Self-help, reimbursed payment schemes

5. Personnel required : HPTW programmes

- (a) Ground water engineers
- (b) Tubewell technicians
- (c) Managers
- (d) Logistics: coordinators; procurement; follow up on end use - storage, books.
- (e) Pump technicians - depending on type of pump
- (f) Mechanical engineer, Metalurgical engineer for pump design, production.
- (g) Communications, sociological, educators

6. Sources of specialized personnel

- (a) UNICEF; country office, regional office, other country offices, NYHQ
- (b) UN agencies; UNDP, WHO, FAO, ILO, etc.
- (c) International Consultants: ground water, water resources planning, management
- (d) Local consultants: technical, management, etc.
- (e) Technical faculties of Engineering Universities and Technical Institutions.
- (f) Government agencies, departments, resource centres, technical assistance centres, research organizations.
- (g) Voluntary agencies; within the country, in developed countries but interested in development.
- (h) Specialized personnel and consultants of bilateral donors and multi-lateral funding institutions.
- (i) Foundations
- (j) Retired personnel - especially logistics, retired from armed forces but anxious to work.
- (k) Through advertisement
- (l) Private industry: advice on a wide variety of technical matters related to supplies.

7. Single wells versus piped systems

- (a) Demographic-sociological factors - how people are arranged in settlements. If highly compressed into concentrated settlements, then piped schemes feasible. If dispersed in hamlets, then single well systems preferable.
- (b) State of technology - ability to maintain, operate and finance mechanized piped systems versus single well systems.

(c) Financial and other considerations:

1. Piped systems require relatively higher per capita capital investments, recovered over a long time, if ever.
2. Piped systems often take several years to instal.
3. Financial management/maintenance problems often mean low utilization of piped scheme investments.
4. Single well systems require smaller capital investment, short installation time, relatively easier to maintain and operate.
5. Access to piped water systems often restricted to those able to afford house connections.
6. Piped schemes often become disease distribution systems if contaminated by cross-connections.
7. Piped water system service is often intermittent.

(d) Hydrogeological factors:

1. Single well systems depend on availability of ground-water:
 - a. depth
 - b. quality
 - c. aquifer yield
2. Where safe surface water is abundantly available under gravity pressure, piped systems may be the most practical solution.

8. Handpump tubewells versus other wells

- (a) Handpump systems are relatively sanitary. Open wells are rather easily contaminated, either by the air, or water lifting device -- bucket, rope, etc.
- (b) Handpumps require more maintenance than some simpler, indigenous systems.
- (c) In alluvial formations, HPTWs are easy to install, but require casing and filter.
- (d) In rock, holes are harder to drill, but filter and casing may not be required.

- (e) Handpumps must usually be centrally manufactured, whereas some other systems can be made in the village.

9. How to begin

Whether you are choosing an imported pump, designing a new pump or redesigning an old one, there is only one way to start: start small. Experience by trial and error will then be the most reliable guide for further choices. Believe it or not the handpump choice problem is now very complicated - due to a veritable maze of options of designs, models, materials and assembly processes. To order large quantities of untried designs could lead to disaster.

An equal danger is to do nothing at all. One is apt to bog down in a quagmire of choices. It is necessary to make a start. Not all the factors can be known in advance. By proceeding slowly and cautiously, new factors can be dealt with as they arise. The main point is to avoid over commitment to one design, the performance and production problems of which are not fully known.

Perhaps the starting point should be the observation of available models already in use. Then choose an option which seems appropriate, order a few, field test it, produce a few, redesign, retest, etc., etc., etc., enough times until decision making becomes more refined. The design should gradually begin to converge around an appropriate solution.

10. Shallow, deep, or multi-purpose handpump

- (a) Depends on depth of water table, and uniformity of ground water conditions.
- (b) Where water level is normally 25' or less, shallow well may be used exclusively.
- (c) Where water level is normally more than 30', deep well must be used.
- (d) Where water table varies considerably - say between 10-40 feet within small geographical area, a flexible design, multi-depth setting pump may be used.
- (e) Where water tables are likely to steadily drop, a design which can later be converted from shallow to deep may be worthwhile.

11. Output of pump desired

Designing a handpump tubewell is like designing a water system, because it is a water system - having inlet, rising main, pump, reservoir (the upper part of pump body) and distribution outlet

(spout). Therefore, it is not too surprising that handpump design procedures should take into account criteria also considered in the design of piped water systems, such as mapping of the served area, ground water resources, local usage patterns, calculation of average demands and peak flows, financial status of the executing authority and the users, etc. These are outlined further below.

All these factors taken together will give an indication of the performance desired by the pump. Performance desired is determined by two factors:

- (a) Water per person per day needed to satisfy optimum, minimum, or practical median water requirements.
- (b) Persons per pump.

These two figures can be more clearly determined by consideration of the following:-

(a) Intended water use

- 1. Drinking water only
- 2. Drinking, cooking, washing utensils
- 3. Full domestic use
- 4. Micro-irrigation
- 5. Domestic use plus small garden
- 6. Or other combinations

(b) Intensity of use

- 1. Availability of other wells and/or other water sources.
- 2. Is well to serve 10, 50, 100, 1000 or more people?

Type of site:-

- a) Single family unit
 - b) Extended family, hamlet or small village
 - c) Large village
 - d) Urban fringe area
 - e) Market place, bus station, boat landing, or other high-density public site.
 - f) School, health center or other institution
3. Queue factor: Will people draw water intermittently throughout the day, or will there be peak demands at sunrise, noon, sunset or other periods? If the queue factor is significant, as it is in most traditional societies, then the real test of how well the pump satisfies the performance criteria may well depend upon how well it can meet these periods of peak demands.

(c) Cultural factors

1. Will the pump be used by men, women and children alike?
2. Or will one sub-group predominate in well use? This determines the mechanical leverage desired, and volume of water which can be lifted per stroke.
3. How far are people willing to walk to draw water? Sometimes people will walk a great distance to fetch their minimal drinking water requirements, but will tend to use more convenient surface or other traditional water sources (if they exist) for other needs such as bathing.
4. Health awareness. The degree to which people will expend energy to obtain water from protected sources may depend upon their awareness of the cause-effect relationship between water and health/disease. In the overall equation, this factor is a variable, which may be increased by educational efforts.

(d) Depth of water table and water quality may determine the practical output of a pump, which may be much less than the total desired. That is, the performance of the pump cannot be considered independently of the design and construction of the well. A number of economic considerations influence this choice also. For any given set of ground water conditions, there is a maximum theoretical yield, but the optimum economical yield may be considerably lower. In well design in relation to HPTW programmes, three general levels of output should be defined:

1. Maximum possible
2. Minimum desirable
3. Maximum practical

The practical output would normally fall somewhere between the minimum desired and the maximum possible. Generally it is desired to provide as much water, as conveniently as possible, within economic constraints.

Within these social and economic considerations, the well design is normally determined by the following hydro-geological factors:

1. Depth to water table,
2. Aquifer yield,
3. Degree of development of well, if in unconsolidated formations,
4. Water quality may also be a factor in water use.

The design considerations are as follows:

1. Diameter of filter
2. Diameter of rising pipe

Technical considerations aside, these two choices are largely economic.

3. Filter slot size
4. Gravel packed, shrouded well or naturally developed.

These are largely technical decisions, requiring the expertise of a ground water engineer. They will, however, have a direct bearing on the output performance of the pump.

5. Type, design and configuration of the filter. This is a rather complex interaction of technical and economic considerations. Generally, there are various trade-offs to be considered - largely economic - such as first cost versus yield and/or length of service. Water quality factors, such as encrustation by carbonates, bacterial slimes, or corrosion, acidity, etc. may be overriding considerations.
6. Most suitable aquifer. This is a complicated technical-economical decision. There may be a series of aquifers at different depths having various yields and water quality. It is normally desired to use the shallowest aquifer which will adequately satisfy the needs of the programme. Yield and water quality considerations may lead one to utilize a deeper layer.

However, this is a self limiting process, economic considerations becoming overriding at a certain stated depth. At some point it may be necessary to choose a water quality or yield which is less than desirable, but is the best yield or quality practical within economic limitations.

At this point, adaptability and taste preferences of the local people become critical. Most people are ready to make do with less if that is all which is available. They may also be willing to drink water of less than ideal taste.

- (e) The static water level is an important factor in pump and well design. But equally, if not more important, are

the annual fluctuations of the water table and/or special variations, i.e. the water table depth may vary considerably from place to place within a relatively small geographical area. Implications of these factors on pump design have been mentioned above (10).

12. How much to spend?

How much should be spent on the pump?

The amount should be related to how much has been invested in constructing the well. In Bangladesh, the materials used in constructing a 1½" diameter tubewell 150 deep cost about \$60 - \$70. These wells are easily constructed, and are being installed by the tens of thousands in every village and for every two or three hundred people. The pump is presently costing about \$20 (after the recent devaluation of the Taka). This seems in line with the overall cost.

In other countries, water levels may be several hundred feet deep through solid rock requiring a major capital investment and the use of sophisticated drilling rigs to construct the well. In such cases the well may serve several hundred to a thousand people or more, some of whom may come miles to draw drinking water on which their life depends.

In Bangladesh there are usually many alternative sources of surface water or shallow ground water if the pump fails. But in many places, the UNICEF well may be the only source of water supply. Such wells will be severely stressed by intensive use.

Normally such wells would be constructed in relatively fewer numbers and it is imperative that a very high percentage of them be in good working order at all times. In such circumstances, a considerably higher investment is justified in the pump. The desirability of improving the design as much as possible would be equally great.

Possibly as a general rule of thumb for such deep well situations the amount spent on the pump should not become a major financial constraint significantly reducing the total number of wells. But on the other hand, the amount spent should be sufficient so that the pump is not out of order more than 10% of the time. If there is no existing design which fits within this criteria, then high priority may be given to developing an appropriate design, before mounting a major programme to construct new wells, which will then may be left without a satisfactory pump.

13. Imported versus local pump

a) Ultimate goal of UNICEF assistance?

If the goal is to develop a self-sustaining water programme, local production of pumps may be a high priority.

b) Availability of local pumps : Industrial Base. Some countries have almost no industrial base whatsoever. In such cases, it may not be practical to hope for a locally produced pump. In such case, decision-making is limited to selecting the most appropriate import model.

On the other hand, even in countries with very little industry, it may be possible to develop a water pumping device fabricated out of locally available materials. In such cases, emphasis should be given to developing village level appropriate technology.

c) Foreign exchange position of the country.

d) Volume of demand : For a small number of pumps, it may not be worthwhile setting up local production.

e) Raw materials : Unavailability of raw materials should not necessarily prevent local development of a handpump industry, provided the necessary materials can and will be imported. Japan for example has very few raw materials. Interest, initiative and management are more essential.

14. If local made pumps - then what?

a) Use traditional design? Introduce brand new design? Or modify traditional design? A new or improved design may be needed if:

(1) Existing pumps are out of order more than 30% of the time (shallow wells), or more than 10% of the time (deep wells).

(2) There is no design available which can give 90% trouble-free operation within the price range appropriate for the investment made in constructing the well.

Depending on programme priorities, it may be necessary to begin with local varieties of pumps. Improvements can then be introduced gradually. If at all possible, design development should be separated from programme implementation, so that programmes do not become dependent on unproven designs still in the development stage. On the other hand, traditional pumps originally designed for single family use should either be replaced or reinforced as soon as possible, to prevent the institutionalization of an underdesigned pump.

Experience has shown that successful pump design is more often achieved by starting with an indigenous design and then improving it, rather than by trying to introduce a totally new design. In order to be successful, a design should be capable of being produced locally, and operated and maintained by the beneficiaries. Local acceptance, both by the user and the producer seems to play a key role in good design development.

Similarly, if redesign of an existing pumps is the order of the day, then improvements can be classified according to urgency: I - urgent-immediate; II - as soon as practical; III - for further consideration.

"Urgent-immediate" changes are usually also simple by nature - design aspects which can greatly improve the service life of the pump, but requiring little major changes. Using larger diameter pivots is an example. Enlarging castings for greater bearing surface or to reduce breakage is an example of category II. Redesigned valve systems may be category III.

Establishing such design priorities helps to bring greatest returns on time invested, while at the same time allowing major programmes to get off the ground. Further design work can proceed parallel to programme execution, rather than hold it up. Improved designs can be substituted as they become available.

b) Design objectives

The overall design objective is SIMPLICITY - the simplest, most economical design which will satisfy the functional requirements of the programme.

In general nearly all aspects of pump design fall into four general objectives. These categories can form the basis for the analysis of almost any pump design. They are not necessarily listed in order of priority. In fact, it is difficult to consider anyone aspect completely independently of the others. There is a high degree of interaction among them.

(1) Performance

Does the pump provide water easily enough, adequate to the needs?

(2) Maintainability

Is the design sufficiently robust to provide relatively continuous operation, presuming a basic routine maintenance service?

There is an economic trade off here between first cost and overall service life. In situations where government maintenance systems are weak, and/or the local capacity to maintain and repair pumps is marginal, the long term objectives of the project will probably be better served by increasing first cost, to provide a more robust design which will minimize the maintenance problem over the years.

The performance of a pump from the maintenance point of view may depend significantly on the habits of the people. For example, if they are in the habit of lubricating mechanical equipment, the pump parts may last considerably longer than places where no lubrication is given. Also a conscientious caretaker who really looks after the pump, deterring vandalism, arranging maintenance, etc. will help to improve the service of the pump.

(3) Cost

Is the cost appropriate to the amount of money invested in the well and the degree to which people depend on it for their welfare?

(4) Produceability

Can the pump be produced locally, relatively fast, easily and economically?

Specifically, a pump should be designed as follows:

- (1) Reduce maintenance breakdowns to manageable frequency, so that maintenance system can keep pump in nearly continuous operation. Spare parts should be few in number, simple, easily replaceable.
- (2) Design should be simple, economical, locally reproducible.
- (3) Ease of lifting water may be a key objective.
- (4) Minimize expensive, or imported materials.
- (5) Discharge appropriate for needs in relation to water resources available.

c) Specific design improvements (mainly for shallow wells)

- (1) Increased bearing surfaces (wider, bigger diameter). One practical tip is that in village use, nearly all parts move. A drawing may specify some parts as fixed and others as moving, but usually they all begin to shake loose sooner or later. Therefore, all parts of the design should be reinforced as much as economically practical. Field observations of pumps under very heavy use will reveal the most critical stress points requiring maximum reinforcement.
- (2) Smoother bearing surfaces (round pins, instead of threaded bolts).
- (3) Harder bearing surfaces (heat treatment).
- (4) Lubricated bearing surfaces.
- (5) Reduced number of parts.
- (6) Standardized size fasteners.
- (7) Stronger structural design to resist breakage.
- (8) Reduced weight where possible.
- (9) Use of most appropriate materials.

The design improvements needed may depend greatly upon whether a shallow or deep well pump is being used. Experience has shown that a shallow well pump can be made quite satisfactory by reinforcing bearing surfaces and other basic, common sense improvements of traditional models. However, in deep set well pump installations especially where the water table is particularly deep (say 100 feet or more), simply strengthening the traditional models may not be sufficient to prevent excessive breakdowns caused by the severe stresses on bearing points. For these situations more innovative approaches may be necessary to find a solution. (UNICEF New Delhi has done just this).

Also design objectives may be different if designing for micro-irrigation. Each person may use a public pump as little as five minutes a day. The objective is to have a pump producing 5-10 gallons per minute and which will need parts replaced less than once a year. The situation for a hand operated irrigation pump is quite different. One or two people may operate a pump continuously for 8-12 hours a day.

Therefore greater outputs will be required. Ease of pumping and mechanical leverage will be critical. Replacement of parts will be less of a problem because the pump is owned and maintained by the farmer.

Beware: Beware of new ideas advocated by "experts", but which have not been thoroughly tested under actual field conditions. Field tests almost always result in rougher, more excessive wear patterns than laboratory tests. It has been learned that there is generally no easy instant solution for handpump problems.

d) Design procedures

- (1) Design criteria
- (2) Sketch designs
- (3) Sample prototypes
- (4) Production models
- (5) Analysis of production techniques
- (6) Field test
 - (a) accelerated testing in high density use areas.
 - (b) normal testing in typical village site.
- (7) Analysis of wear patterns.
- (8) Modified-improved design
- (9) Production drawings
- (10) Tolerances
- (11) Raw materials specifications
- (12) Inspection guidelines. Quality control criteria.
- (13) Tender documents
- (14) Contract documents

e) Type of production

- (1) Cast iron
- (2) Fabricated from steel pipe, standard fittings, etc.
- (3) Constructed at site

This decision will depend upon the type of industry in the towns, the raw materials available, and the skill of craftsmen

at village level. A cast iron or pre-fabricated pump requires little engineering at the installation sight. Water pumping devices assembled or constructed in the village are able to utilize local skills and materials thus economizing on materials. The resulting unit is usually locally understood and maintainable.

f) Multipurpose unit versus single design options

It may be necessary to begin a programme with a single multipurpose design pump which will serve a variety of purposes, even if not particularly well. As the programme gains momentum, routine operational problems become reduced, R & D capacities expanded, it may become possible to branch out into several design options - each one appropriate for a single use. For example one pump may be designed specifically for single family use, another for small hamlets of say 50-100 people, and another more robust model for 100-200 people or more.

Also special purpose pumps, such as for micro-irrigation, can be designed as the need arises. Here again there is scope for variety. The aim may be to water a small vegetable garden plot with the household pumps, or micro-irrigate a small field crop of wheat, potatoes, sorghum, etc. with a special pump designed for that purpose.

15. Imported pumps

- a) OLGA* may be helpful. But there are other pumps under development which are not yet in OLGA, particularly shallow well pumps in Bangladesh and Deep Well Pumps in India which may be more suitable. HQ may be able to give advice on the most appropriate model. Martin Beyer and Hans Lotje should be the best sources of information.
- b) If local production is the ultimate project goal and import is a temporary expedient, then a simple design such as is being produced in a nearby developing country may be the most suitable design to begin developing local capacity.

16. Handpump research and development work : Who should do it?

- a) International Consultants. Tend to be expensive, and take a long time getting from the drawing board to prototype. Difficulties in communicating complex technical questions over long distances. May develop solutions which are

* UNICEF GUIDE LIST (OSU-6400 May 1975, UNICEF HQ, NY)

neither technically, socially or economically appropriate. (But usually do have highly qualified engineers. Good for initial studies).

- b) Government Agencies. Ideal to involve government in developing its own pumps. But often there is insufficient motivation or technical skill.
- c) Local Industry. Usually has technical skill, but lacks initiative in developing improved, better--cheaper technology. Existing technology tends to become institutionalized, even though it may be more expensive, inefficient or both.
- d) Beneficiary. For drinking water pumps, technical skills, motivation and resources are not usually available at village level. However, farmers in a famine situation often develop an uncommon ingenuity for developing appropriate means of getting water to the land.
- e) UN Specialized Agencies. Do not normally purchase large quantities of final design units, and may have difficulty getting their ideas into production.
- f) UNICEF Office. Normally does not have technical staff to initiate technical innovations and follow through into production.
- g) OPTIMUM combination for success = purchaser + designer + manufacturer + beneficiary. That is, successful designs develop through continuous interaction between the agency responsible for purchasing the improved design, the designer, the manufacturer, and user of the pump in the field. It is sometimes most effective if the designer and purchaser are one in the same.

Another formula for SUCCESS = 90% perspiration and 10% inspiration. There does not seem to be any substitute for people. People willing to work closely with local manufacturers, make frequent visits to field sites, back to the drawing board, back to the workshops, back to the field, etc., etc., repeated enough times until an appropriate design is evolved. There is no easy solution to long range development.

Another way of saying this is that nothing happens automatically. An idea needs to be pushed and prodded, revised and pushed again every step of the way until it actually reaches the field and produces results.

17. Details of pump design

A. Dimensions

1. Cylinder size. Along with stroke length, determines the volume of water per stroke. The volume determines the weight of water lifted per stroke. $2\frac{1}{2}$ " , 3" and $3\frac{1}{2}$ " are common pump cylinder diameters.

A rather small increase in cylinder diameter may give a relatively large increase in discharge, since discharge per stroke depends on the cross-sectional area, which increases as the square of the radius.

Combinations of diameters and stroke lengths are listed below. These discharges are not theoretical, but are general performance levels from existing designs operating under field conditions:

<u>Cylinder dia.</u>	<u>Cross sectional area</u>	<u>Stroke length</u>	<u>Typical* discharge</u>	<u>Pump type</u>
$2\frac{1}{2}$ "	5.0 sq.in	4"-5"	4 - 5 gpm	Pak. G.I.
3"	7.1 sq.in	4"-5"	4 - 6 "	B'desh No.4
$3\frac{1}{2}$ "	9.6 sq.in	6"-7"	6 -10 "	B'desh No.6

* depends considerably on well.

2. Stroke length. A longer/stroke length gives a greater discharge per stroke for a given cylinder diameter. A given unit of discharge may be achieved by either a fewer number of longer strokes, or a greater number of shorter strokes. From the operational point of view, the optimum configuration will have much to do with the size, strength and work habits of the users. From the maintenance point of view, it is thought that a smoother pumping action results in less wear on the moving parts.
3. Discharge. A combination of cylinder diameter, stroke length, number of strokes per minute, and number of cylinders.

Note: The discharge of the pump can not be considered apart from the design characteristics of the well. These factors include:-

- a) Diameter of filter and rising pipe
- b) Slot size and open area of filter
- c) Transmissibility of aquifer
- d) Development of aquifer
- e) Depth to water level
- f) Fluctuations of static water level

4. Handle length. Determines the mechanical advantage, which, along with cylinder dia., and depth to water table, determines how hard it is to work the pump. Generally, the longer the better. The configuration of the handle also seems to be important in the overall use of the pump.
5. Overall size. Depends upon the size of the people using the pump, and the type of installation.
6. Thickness of bearing surfaces. $1\frac{1}{2}$ " usually recommended as total breadth of C.I. bearing surfaces around pivot points.
7. Diameter of pivot pins. $\frac{5}{8}$ " - $\frac{3}{4}$ ".

B. Materials

- | | | |
|-------------------|---|--|
| 1. Cast iron |) | |
| 2. Plastics |) | |
| 3. Mild steel |) | |
| 4. Brass - Bronze |) | |
| 5. Wood |) | |
- These all relate to the particular local economy/technology, and the particular engineering function which each is to perform.

C. Assembly

- | | | |
|-------------------------|---|--|
| 1. Foundry |) | |
| 2. Workshop |) | |
| 3. At site construction |) | |
- Depends upon local technology, both in towns and at village level.

D. Security

1. "You can't pump the pump because the vandal took the handle".* Security problems vary from place to place, but are likely to be increased in exposed public places where there is no responsible caretaker. Lock and key arrangements can be devised locally.
2. Stones, pebbles, etc. There seems to be a human impulse to drop pebbles, etc. down a tube sticking up out of the ground. A wire mesh barrier placed in the pump cylinder, or sheet metal cowl over the top may be solutions. This problem is more critical for deep set well pumps where the cylinder mechanism is down the hole.

* Song by R. Dylan

18. Considerations in site selection

- a) Maximizing the number of beneficiaries
- b) Responsible caretaker
- c) Suitable drainage arrangement
- d) Ground not too high to go beyond suction lift (for shallow pumps).
- e) Site not too low to become flooded.
- f) Far enough away from sources of pollution.
- g) Maximizing possibilities of good ground water. (salt or iron concentrations may be localized).

19. Installation

- a) A good concrete foundation and surrounding platform helps maintain a sanitary seal and healthy conditions around the pump, thereby increasing well use.
- b) Details of design depend on local use patterns, available materials and skills.

20. Maintenance options

- a) By caretaker: May be possible depending on skills, tools, spares available in village.
- b) By local or union boards: May be able to manage finances and coordination, but may have difficulty arranging spares.
- c) Centralized agency.
 - Advantages : Bulk purchase of spares
 - Disadvantages : Cumbersome, inefficient administration, financial burden on government.

21. Continued development

No design represents the "final" solution. The conscientious designer will restlessly be agitated by the questions.

Can we do it better ?

Can we do it cheaper ?

Nearly always the answer is, "yes". Improved solutions are developed the same way as original designs : continuous interaction between designer - user - producer, as well as a restless look out on the horizon for better/cheaper materials, techniques, designs.

22. Pump production

- a) One supplier or many?
- b) Centralized production or regional dispersion?

This of course depends on the quantities needed by the programme against any one supplier's capacity to produce them. Dealing with one supplier may be preferable at the beginning since supervision and supply of raw materials and subcomponents is simpler. However having several producers improves UNICEF's bargaining position for price, frees programme of dependence on one source of supply, and helps to institutionalize the design. Possibly, production could start with a single supplier, centrally located and grow to include regional points as the demands of the programme and UNICEF's capacity to manage contracts increase.

RP/psb
26.5.76

HAND PUMP MAINTENANCE AND THE OBJECTIVE OF COMMUNITY

by ARNOLD PACEY

PART ONE: analysis

1. The size of the problem

Many governments, with the assistance of official agencies, and some voluntary agencies, have tackled the water supply problems of rural communities in the Third World by drilling tubewells and boreholes, either to provide a new water supply where other sources were inadequate (as in the Maharashtra drought area), or to tap clean water at a depth in circumstances where more accessible sources nearer the surface are polluted, or at least suspect (as often in Bangladesh). The size of some of these programmes is vast:

Philippines, 1970 :	19,000 drinking water wells completed, 56,000 planned. (USAID)
Bangladesh, 1976 :	~~450,000 drinking water wells completed out of~~ ~~320,000 planned (UNICEF assistance).~~ 320,000 public drinking water wells and about 350,000 private wells in existence (UNICEF survey); another 100,000 planned.
India, 1974 :	150,000 drinking water wells completed, (UNICEF assistance).

Although the agencies named have been mainly responsible for assisting governments with these programmes, funds have come from many sources, and it should not be assumed that UNICEF and USAID have carried the whole financial load.

Inevitably, Oxfam's contribution looks modest by these standards. Drilling rigs provided by Oxfam have possibly sunk up to 10,000 drinking water wells plus many irrigation wells in India during the ten years since 1966, often with state governments paying the running costs through drilling contracts. And because of the complicated arrangements which exist between agencies, some of these 10,000 wells may be included in the UNICEF total, which in any case should be regarded as very approximate.

In Africa, Oxfam's largest well and pump project has been in Tanzania, with the Community Development Trust Fund (TAN 6). By the end of 1974, 673 hand-dug well had been completed.

Despite this apparently impressive record of work completed or in hand, many of these wells are useless in practice, because the pumps used to draw water have broken down and have not been repaired or replaced. The New Internationalist in February 1975 claimed that up to 90,000 wells in India are idle, basing this on a UNICEF statement that 60% of pumps at their wells are not working. In fact, this may be a conservative estimate, since elsewhere, UNICEF has said that only 20% of some thousands of hand pumps are working efficiently.

Oxfam experience in India has been similar. In one part of south India, when 61 drinking water bores were inspected (TN 3), 20 were found with pumps in working order, 23 had pump breakdowns which were relatively simply repaired, and 18 pumps were beyond repair with the wells effectively abandoned. At another project (TN 12), when 44 pumps were inspected three years after their initial installation, 17 were still functioning.

In contrast to these problems with deep well pumps in India, UNICEF has achieved a far more impressive result in Bangladesh. A survey of 2,400 villages made in 1975 showed that 83% of well were operative, i.e. only 17% were out of action because of pump breakdowns or otherwise. Although these are tubewells, often drilled to a considerable depth to secure a clean supply, water tables are generally near the surface and low-lift, shallow well pumps are used. It seems probable that in Bangladesh, people value their pumps more highly than in some other countries - this is indicated by the number of private individuals who have invested in a private pump in their own household. Also, the government has organised an effective maintenance service, and UNICEF has provided this service with a free supply of spare parts. It is also true that maintenance of shallow well pumps presents fewer problems than do - deep well pumps because the parts requiring attention are much more accessible. This paper is therefore concerned primarily with deep well pumps, where the most intractable problems are encountered, though much of what is said will be applicable to shallow well pumps also.

2. Approaches to the problem

The conventional way of looking at this problem is to assume that what we need is a new design of hand pump, which will be more robust and reliable than the ones which break down on such a spectacular scale. Several organisations have therefore put a lot of effort into the re-design of conventional pumps, notably the AFAM agencies in Maharashtra (MAH 4, MAH 31), the Battelle Memorial Institute (commissioned by USAID and later by UNICEF), UNICEF and WHO. The aim of most of this work has been to produce a pump which will work with minimum maintenance in the harsh conditions of Africa and India, where heat, dust, poor lubrication and poor materials inevitably add to the problem.

There have undoubtedly been benefits from this work, but one must beg leave to doubt whether the key problems have yet been faced or tackled. It is one of the great illusions in the appropriate technology movement that seemingly technological problems can be solved purely by attention to hardware. In this instance, the problem has at least four or five dimensions:

1. the communities using the wells and pumps.
2. the agencies administering well programmes.
3. the objectives for which the wells were provided.
4. the type of pump used.
5. the environment - climate and hydrology.

3. The communities using the wells

One comes across some very depressing statements about the communities using wells. We are told that there is "a lack of community spirit towards water supplies, even to the extent of vandalism". Some villagers are said to show "little concern for putting the pumps in order - they will not even oil the moving parts". And it is observed that privately-owned pumps which are used only by the owner's family are usually well maintained, even in villages where the public pump is neglected. So it is very obvious that the problem of getting communities to work together and take collective responsibility for their wells is not being effectively tackled.

In some villages, when the pump breaks down, the people may remove it from the well. In Tanzania, this happens because the people can then let buckets down into the wide hand-dug wells. In India, where a pump has broken at a borehole, it has been known for the people to hand-dig a new well alongside it, so that they can get at the water without being dependent on the pump.

On the other hand, some villages do take great pains to take care of their pump. In one south Indian village where a wire cable transmission system on the pump was a constant source of trouble, they very ingeniously replaced it with a length of bicycle chain.

If one village can do this, why not others? The answers seem to fall into two categories:

1. the well and the pump may not be providing an adequate service through being too far from the village; through being on Hindu upper caste land in India when intended for Harijan people; or because water is insufficient in quantity (i.e. there is excessive draw-down in the well), or because it is brackish in taste. These subjects are often not investigated sufficiently before the pumps are installed, and the views of villagers are often not sought.

2. the people may not feel that the pump is theirs, because of their lack of involvement in its installation, and because no specific responsibilities for its maintenance have been defined. The New Internationalist (February 1975) commented: "The villager often does not know how the drilling rig and pump work, where they have come from, why they have come to this particular village, what advantages they offer. He has not contributed anything in the planning, money, labour or time." Therefore he feels that the well and its pump do not belong to the village; he does not feel responsible for them, and he is perhaps uncertain whether he should try and tinker with the pump if it goes wrong.

The latter statement is certainly unfair to most projects, but it is equally certainly true in part for many projects - it is a caricature one ought to take to heart.

4. The agencies administering well projects

One reason why agencies have been slow to recognise the difficulties mentioned in the previous paragraph has been that construction and maintenance of wells have been thought of as quite separate operations, to be carried out by different agencies. Construction is often in the hands of a specialised well-drilling team, sometimes run by a voluntary agency, sometimes by a government. But completed wells are usually handed over to a local authority for maintenance (e.g. in India, to a Panchayat Union). This division of responsibility means that well drillers can remain blissfully unaware of the ways in which the construction phase of the work can permanently influence villager's attitudes to the completed well with its pump.

This situation arises because the agencies which drill wells have had to put great effort into running sophisticated drilling machines in difficult conditions, and this has often had to be done as part of a crash programme during drought conditions. It is very understandable, then, that community development, follow-up and maintenance planning have all been neglected. Nor has there always been sufficient check on incorrect or incompetent installation of pumps.

The local authorities who take over responsibility for pump maintenance are sometimes conscientious, but more often fall down on the job. It often takes

Three months before an effort is made to repair a broken pump. Private mechanics sometimes take advantage of the delay to repair pumps for exorbitant charges. The particular ways in which local authorities are most deficient in their organisation of pump maintenance are apparently as follows:

1. The idea of maintenance as a means of preventing breakdowns is lacking. Administrators confuse maintenance with repair.
2. Records of how often each pump is visited by a technician and what is done to it each time are rarely kept, so there is little chance that maintenance will be regular or that faulty pumps which need replacing will be identified.
3. Officials are so desk-bound that they are isolated from practical problems. It makes all the difference if a local official's family is actually dependent on one of the pumps for its water.
4. Officials are moved from post to post too often.
5. Pumps are not standardised and it is difficult to keep adequate stocks of spare parts for all the types used.
6. Skilled manpower is short and transport costs for technicians visiting pumps are high.

5. The objectives of well projects

It is evident that the use of drilling rigs has been a factor in limiting the participation of local people in well projects, and in distracting agencies away from longer term problems. But of course, drilling rigs offer vital advantages in terms of speed of working and the depth to which wells can be sunk - and they can, if the effort is made, be fitted into community development programmes.

If, to keep people alive in a drought situation, it is necessary for a water supply to be created as rapidly as possible, then one is justified in taking short cuts which neglect long-term considerations. But one must be clear that such wells are a form of humanitarian or emergency relief - they are to be classified as "welfare" and not "development", and one must not be surprised if few long-term benefits emerge.

A great many well and pump projects would have been more successful if those responsible for planning them had faced up to this distinction between welfare and development, and having clarified which was their objective, had designed the project with that end consistently in view. If a well is supposed to help stimulate development, then the drilling equipment must be subservient to a community development programme in which villagers first decide whether they want the well; then, where among geologically feasible sites it should be located; what they should contribute in cash or labour for site clearance; and finally, who among them will take care of the completed installation.

6. The type of pump used

The choice of a pump for a well or borehole itself depends on whether the objective of the project is welfare or development, as will be shown below.

However, an even more basic consideration is to avoid pumps which are obviously defective in design or construction. Many of the problems which have arisen with well projects in South Asian countries are due to the very poor quality of some of the pumps manufactured there. In India especially, reputable manufacturers do exist, whose products can be relied on, notably Kirloskar Brothers Ltd, Water Supply Specialists of Bombay and Gujarat Small Industries. But many pumps in South Asia suffer from some or all of the following defects:

- (a) poor quality cast iron (very widespread, often due to high phosphorus content).
- (b) roughly finished cylinders; cylinder bore uneven.
- (c) use of cast iron for cylinders instead of brass (brass is more expensive, but can be given a much better finish; to use cast iron is a false economy).
- (d) no protection from rust; parts often badly corroded before the pumps are even installed.
- (e) excessive wear on leather washers because of (b), (c) and (d).
- (f) poor screw threads; nuts and bolts will not stay together.
- (g) roughly drilled pivot holes.
- (h) no provision for lubrication.

On top of all these difficulties, the size of pump components is not standardised to a sufficient degree of accuracy, so when a pump needs a spare part, there is no guarantee that the new part will fit - indeed, nuts and bolts sometimes arrive with incompatible threads.

Pumps with these defects frequently break down within two or three weeks of installation. They may then be almost impossible to repair, or they may demand attention so often that even highly motivated villagers or maintenance organisations become discouraged.

Obviously, one form of appropriate technology development which is urgently needed is a programme which would upgrade the quality of work done by these small manufacturers. There is an obvious need for better foundry practice, and also for training in better machine shop practice, including the use of jigs and fixtures which will make it possible to produce interchangeable parts. As it is, the trend is for the major drilling agencies to manufacture their own pumps, and their custom is therefore lost to the existing local industry.

7. Hydrological considerations

The hand-pump problem has become widespread and notorious partly because so many rural drinking water schemes depend on wells or boreholes, even when alternative forms of water supply are possible. Again one needs to be clear on the welfare/development issue. Where long-term development is intended, the solution of water supply problems will often require the conservation and use of surface water resources - in all areas, even in semi-deserts without permanent streams, there is some surface water at some seasons of the year. But to create a good drinking water supply from such sources is often a more time-consuming and difficult matter than the routine sinking of a well, so the latter course may be best for an emergency or welfare project - even when over-exploitation of groundwater and lack of

conservation measures give the well a predictably short life.

On the more immediately practical level, a well and its pump is sometimes neglected because it is sited at the point where hydrologists think the likelihood of finding water is best - and this sometimes a very inconvenient site for the villagers. Hydrologists are so often wrong in areas where geological surveys are incomplete that their views should not be given so much importance. Wells should be sited as near as possible to where villagers want them. Wells for Harijan people should always be on Harijan land.

A final point related to hydrology is that people will inevitably and quite logically neglect pumps if the wells they draw from are unsatisfactory, either because the water tastes bad, or because there is not enough water. Bores which seem unpromising from either point of view should be capped, with no pump installed. In particular, the sufficiency of supply should be checked by means of a pumping test. A hand-pump, not a motorised pump, should be used for this, because if sufficient water is available, but only with large draw-down, hand-pump performance may fall off so much that villagers give up using it. Tests with a motorised pump could disguise this entirely. Part of the pumping test should be a check on hand-pump performance at various draw-down levels. This should help in deciding the best depth for the pump cylinder in the final installation.

PART TWO: strategies

8. Three packages

Because most western-trained engineers have been taught to think of technology as being exclusively to do with hardware and other material practicalities, and have not been trained to deal with its human and social component, their response to stories about pump breakdowns in India is usually to start thinking of re-designing or modifying the pumps. Because so many very bad pumps are in use, quite a lot can be achieved this way.

But the re-design of pumps can only go part of the way towards a solution, because, as we have seen, so much else in the realm of social and administrative structures contributes to the failure of so many hand pumps. It is possible to relate this wide range of factors which lead to hand-pump failures by studying them as a systems problem, in which the pump hardware is only one component in the total system. Other components are the organisations which construct and maintain wells, the people who use wells, and the communities to which they belong. It is, of course, true that all applications of technology involve people, and therefore involve systems which have social components, and it is common experience in Oxfam projects to find that the social components of technological systems are more significant, or more difficult to understand, than the hardware components.

Because the hand-pump problem was seen as not just a matter of the pump, but also of the system to which the pump belongs, the problem was discussed with the Systems Department of Lancaster University, two members of which visited Oxfam House during the summer of 1975. Systems theory has not often been explicitly applied in the field of rural development, but rural development

workers do have in their own jargon a number of words which imply systems concepts. One of these is the word "package", and it may be more acceptable in the present context to use that. So instead of saying that we wish to investigate systems which will achieve the satisfactory functioning of village wells and pumps, we can equally and alternatively say that we wish to look at various packages of measures which will improve the performance of well/pump projects.

The remainder of this report will examine three possible "systems" or "packages" which offer different solutions to the problem of chronic pump breakdowns. The three packages are distinguished from one another mainly by different degrees of involvement of local people and communities, and are as follows:

- (a) Total village self-reliance in the manufacture and maintenance of pumps.
- (b) Community development linked to partial village self-reliance using pumps made by factory methods, but with a back-up service for spare parts, technicians, etc.
- (c) Systems involving little or no village-level responsibility, including some welfare projects where the over-riding priority is to provide a reliable water supply quickly.

9. Package for Total Village Self-reliance

Some people have argued that if a pump could be designed capable of being made by a village craftsman using simple tools and local materials, then the maker of the pump would always be on hand to repair it when necessary and the village would be entirely self-sufficient in its pump requirements.

This argument has considerable validity for low-lift pumps, and particularly for irrigation pumps, because in many parts of India, China and S.E. Asia, there are traditional designs for such pumps which have been built by village craftsmen from time immemorial. Persian wheels in India and the dragon spine pumps in countless Chinese rice-fields are obvious examples. Many people have attempted to extend this approach by using widely-available but modern materials such as PVC piping, and among those who have attempted to develop deep well pumps which could be made in villages are members of the VITA organisation and the World Council of Churches. One such pump has been successfully built in Ethiopia by Oxfam's Duncan Allsebrook (ETH 11). But while such pumps operate successfully in the hands of their inventors, there have been very few instances of such designs ~~be~~ accepted into the general use and practice of village craftsmen.

One reason for this is that operating conditions for borehole pumps in wells deeper than about 20 metres are too demanding for the regular use of pumps made mainly from wood and plastic with additional parts variously improvised from metal pipe, scrap bicycles, reinforcing rods and so on. High water pressures make leaky valves less acceptable than in low-lift pumps; forces on pump rods and handle pivots are greater; and much of the

pump is too inaccessible within the borehole for regular tinkering and adjustment. Anybody with a deep well (though obviously not a borehole) who cannot afford or cannot maintain a pump is generally better advised to resort to a bucket on a rope, with a simple windlass for raising or lowering, rather than tackle these problems. All possible precautions should be taken, though, to prevent the bucket from transferring polluting material from the ground surface to the water in the well - e.g., the bucket should not be placed on the ground, nor carried from the well to people's homes.

A second reason why pumps capable of being constructed within villages have not caught on is that most of the designs proposed have more in common with the Western do-it-yourself approach than with the style of work done by real village craftsmen. There is a gap between cultures in concept and in detail - e.g. in the use of screws, the way joints are made, and so on.

Except for certain low-lift pumps which can be successfully made in the village, one must therefore think of pump manufacture in terms of adequately equipped workshops capable of turning out pumps built of durable materials (usually metal), with the high standards of finish (e.g. machining of cylinders) required for reliable operation. Workshops with this capability can be ~~successful~~ on a relatively small scale, but rank as small industries rather than localised village industries, often serving counties, districts or whole states. The problem of pump maintenance is therefore a problem about manufacturing pumps made by factory methods and to factory standards.

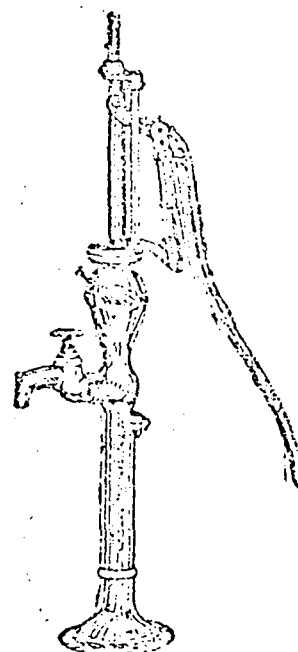
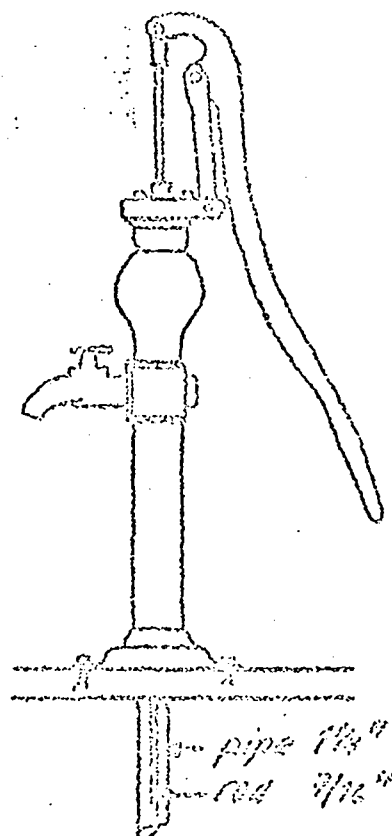
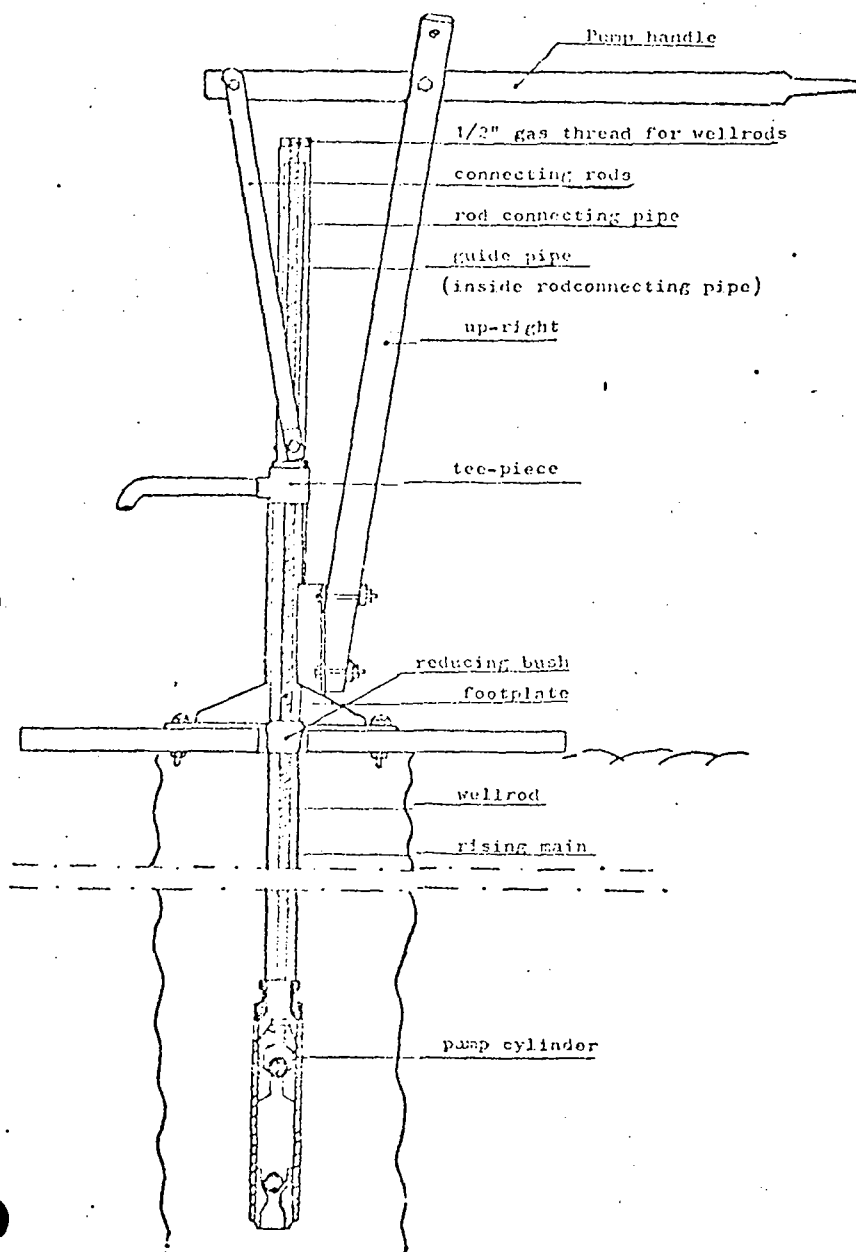
The local production of pumps may vary from the work of a general workshop making agricultural implements which occasionally turns out a pump, to small but specialised workshops capable of turning out 200 or more pumps per year. The latter are likely to be more effective in the long run than the former, but a good example of a general workshop turning out pumps occasionally is to be found at the Family Farms project in Zambia (ZAM 17). Several of the more specialist type of workshop are to be found in India (MAH 31, TN 3), and as an example of what equipment is required for pump manufacture on this scale, it is worth quoting the workshop at Jalna (MAH 4). In 1970, this employed nine men to make 200 pumps. The major items of equipment used were as follows:

- 3 lathes
- 2 arc welding units
- 1 gas cutting and welding set
- 2 drills
- small-scale foundry and moulding equipment.

With pumps of more traditional design, welding facilities would not be needed, but a larger and more complete foundry would be required.

10. Package for partial self-reliance with factory-made pumps

The simpler types of borehole pump can be fairly easily maintained by people with relatively few skills, so the possibility arises of villages being substantially self-reliant with respect to the maintenance of their pumps. But pumps of this kind all require regular attention, particularly with



Pumps appropriate for the
"partial self-reliance" package.

above: the Craelius pump made
in Kenya; model for
hand-dug wells.

top right:
the Dempster model 23 F.

right: the Wasp deep-well pump,
made by Water Supply
Specialists, Bombay.

regard to greasing or oiling moving parts and countering dirt and rust. So any package which includes such pumps must also include a considerable community development effort aimed at impressing upon the villagers the need for regular pump maintenance, establishing responsibilities for this work, and giving some training in care of the well and its pump. If adequately carried out, such a programme would stimulate more frequent oiling, cleaning and adjustment of other mechanical equipment in the village - implements, ox-carts, mills or bicycles. Although regular basic maintenance can be carried out by villagers in this way, the "package" must also include some form of back-up service which would supply spare parts and make technicians available for a regular inspection of all pumps in the area.

Deep well pumps suitable for programmes of this kind include the Craelius pump made in Kenya; the Wasp, Kirti and Kaveri pumps made in India, and the Dempster model 23F made in the United States (see illustration).

The three Indian pumps have all made their appearance on Oxfam projects in the sub-continent, and Craelius pumps have been used under Oxfam auspices in several East African countries. Dempster and Craelius pumps have both been widely used in Africa by UNICEF, and the Swiss Association for Technical Assistance (SATA) have also used the Dempster in their well-known water projects in Cameroun - though Oxfam bought Godwin pumps for one small well project there which SATA helped with (CAM 12).

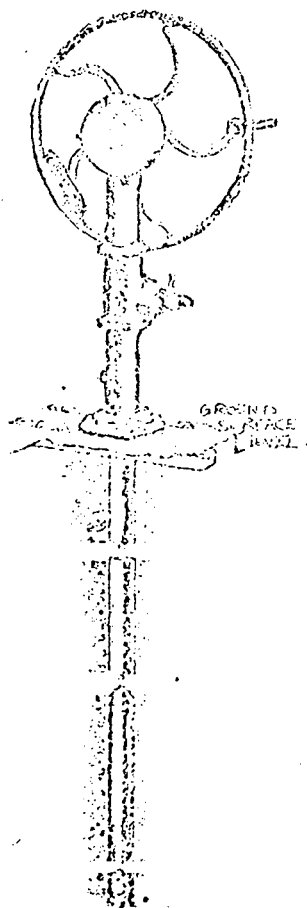
The Craelius is the most distinctive of these pumps; it has an arrangement of pipes sliding over each other to carry out the same function as the rather complex guide rods on the Wasp, and on the almost identical Kirti. The Craelius system offers some advantages in terms of simplified maintenance, and Craelius pumps have a long record of reliable service in East Africa. Unfortunately, though, they are two or three times as expensive as the Dempster. The relative simplicity of the Dempster (and the very similar Kaveri) as compared with the other pumps is due to its lack of guide rods above the top end. Experiments have shown that these guide rods offer an advantage mainly in very deep wells where better control of the pump rods leads to reduced wear on all bearing surfaces, and particularly on the leather washers. The guide rod system on the Wasp is also adjustable so that the leverage can be set for pumping water from greater depths without excessive effort.

So although the Wasp and Craelius pumps have advantages for deep wells, for most projects, where water has to be raised 20 metres or less, pumps of the Dempster/Kaveri type are an adequate and economical choice. In research commissioned by USAID, the Battelle Memorial Institute designed an improved version of this type, which is easier to maintain by virtue of having fewer components and needing fewer tools for maintenance. It is also less vulnerable to damage, being of heavier and more rugged construction, and having more protection against rust. But so far as is known, this design is not yet in regular production anywhere.

The pumps described in this section may be regarded as almost the norm for Oxfam projects, so it is important that the social component of this level of technology be fully understood. Appropriate forms of participation by the local community and suitable technical back-up arrangements are discussed at length in section 13 below.

11. Packages involving little or no village-level responsibility

Several decades ago, certain pumps were designed in Britain for use in "the Colonies" and in regions where normal maintenance could not be guaranteed. Almost all of these were heavily built machines in which a handle attached to a large fly-wheel had to be turned in order to work the pump. This fly-wheel drove a normal pump mechanism by means of a small



crank shaft. The great advantage of this design was that all bearings and other mechanical parts could be totally enclosed, protected from dirt and other interference, and self-lubricating bearings could be arranged. The wheel and crank-shaft also controlled the length of the stroke, thereby averting another cause of failure in conventional lever-arm pumps, where considerable damage often arises from people working the pump with excessively long strokes and banging the handle against the stops. Such pumps have successfully worked for long periods without maintenance. Many are still in use, though few are now being installed because of their high initial cost.

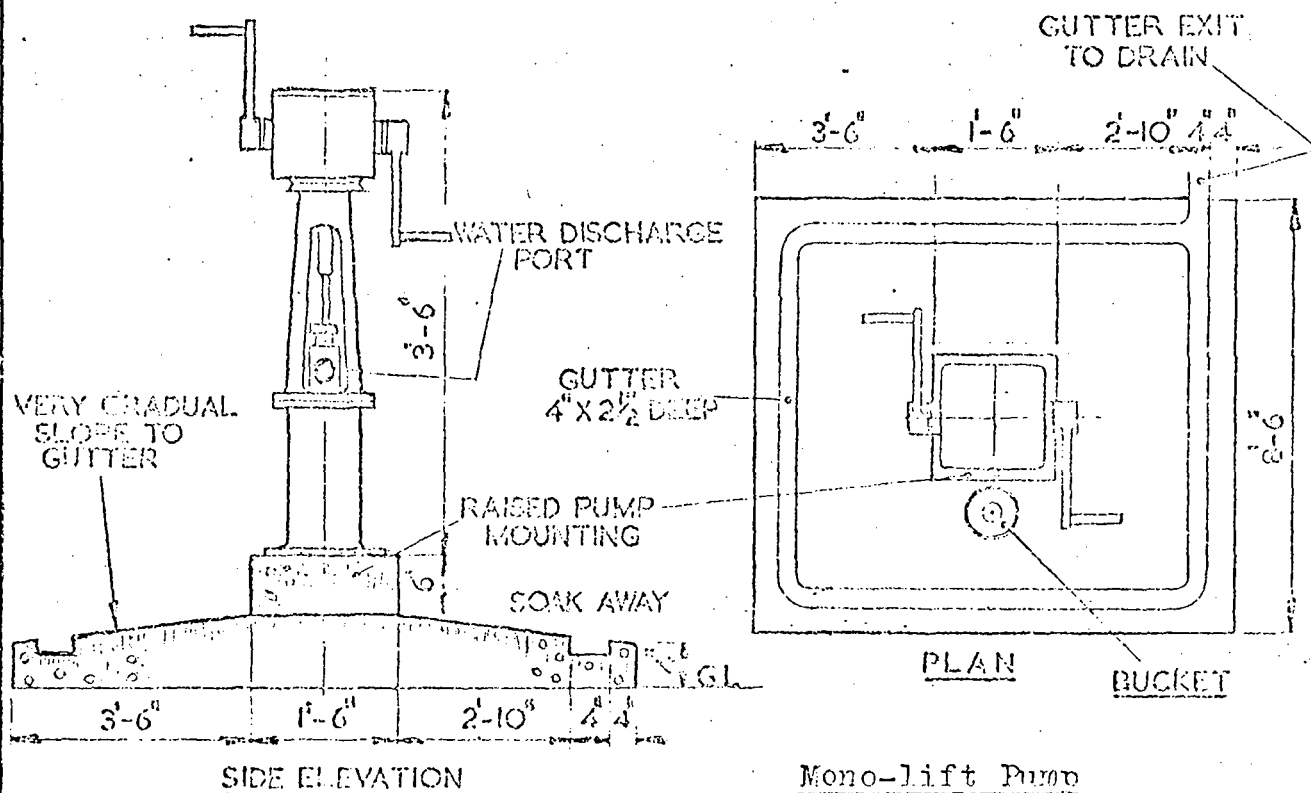
A more modern type of pump which can also operate for long periods without maintenance is the hand-driven Monolift pump. This works on a different principle from all the pumps discussed so far; it has a helical or screw-type metal rotor turning inside a fixed sleeve. The internal shape of the sleeve is also helical, but with half as many windings in a given length as the rotor. Gearing from the crank handles at the well head to a vertical shaft inside the well which turns the rotor can be very simple, and is again totally enclosed and self-lubricating.

Like the fly-wheel drive pump, the Mono pump is relatively very expensive. However, in Malawi, where both types are used on government boreholes, it is felt that the very low maintenance costs of the Mono, in particular, fully justify its high capital cost.

UNICEF is also using hand-driven Mono pumps in parts of Africa, e.g. in Sudan, in conjunction with Oxfam (SUD 12). However, the most widespread use of these pumps has been in Nigeria, where over 1200 are now installed. The Rivers State has issued a special booklet about the pump for villagers. The accompanying diagram from the booklet shows the two crank handles at the head of the pump, and also illustrates that even a pump which is nearly maintenance-free does impose some responsibilities on the local community. The Rivers State authorities tested other pumps but found that without exception, the Monolift hand-pump was the only unit which stood up to the arduous duties called for in remote villages where little maintenance was possible. Similarly, UNICEF believes that the Mono pump is the only type which could stand up to Indian village conditions.

RIVERS STATE RURAL WATER SUPPLY SCHEME

MONO ROTARY HAND PUMP SOAK AWAY



SIDE ELEVATION

Mono-lift Pump
in Nigeria.

- detail of top end.

NOT TO SCALE

IMPORTANT

1. IT IS THE DUTY OF THE VILLAGE/TOWN PLANNING COMMITTEE TO ENSURE THAT ALL PEOPLE KNOW HOW TO USE THE PUMP CORRECTLY.
2. DO NOT TRY TO FORCE OR JERK THE HANDLES ROUND OR APPLY ANY MECHANICAL MEANS IF STIFFNESS IS ENCOUNTERED
REMEMBER THIS IS A HAND OPERATED PUMP
3. A SLOW EASY ROTARY MOVEMENT IS REQUIRED TO OPERATE THE PUMP-- CONSTANT USE WILL RELIEVE ANY STIFFNESS.
4. DO NOT LET CHILDREN PLAY WITH THE PUMP-- IT IS NOT A TOY.
5. REMEMBER THIS PUMP IS YOUR GATEWAY TO A BETTER HEALTHIER LIFE: ITS WORKING LIFE WILL BE DETERMINED BY THE WAY YOU LOOK AFTER IT.

MONO PUMPS ENG. LTD.
DRAWN BY B. KELLY
DATE 24-1-73
DRG. No. RDD 5526

It is difficult to quote precise costs for fly-wheel drive and Mono pumps, not only because there is considerable variation from one country to another in the present inflationary climate, but also because the cost of the pump after installation depends so much on the depth of the well and the remoteness of its location. However, it was earlier said that the Craelius pump was two or three times as expensive as the simplest type of deep-well hand-pump. We can now add that the cheapest fly-wheel drive pumps cost about twice as much as Craelius pumps after installation, and Mono pumps are somewhat more expensive still. So the two types which circumvent so many of the maintenance problems may cost six or eight or even ten times as much as the simplest pumps available to do the job.

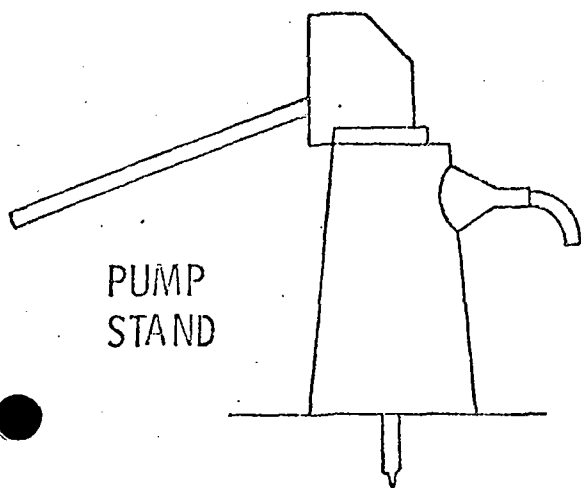
In India, neither of these rather costly pumps has been much used. Instead, efforts to create a pump with similar low maintenance needs have resulted in the Jalna type. This is a conventional borehole pump with lever-arm handle, but it uses a length of motor-cycle chain to connect the pump rod to the handle. This means that there is need for only one bearing, and roller bearings in an oil bath can be provided for this. The rest of the mechanism is sufficiently compact for it to be totally enclosed, again avoiding problems with dirt. In the design of this pump, effort was concentrated on the head-gear because it was found that 80% of pump breakdowns in India were dependent on this. It is claimed that Jalna-type pumps will function satisfactorily for up to two years without any maintenance.

This pump was developed at the former Church of Scotland Mission at Jalna in Maharashtra during the late 1960s, backed by some Oxfam finance (MAH 4). It was later taken up by the other Maharashtra agencies which are linked together by AFAEM, and most notably, by the Sholapur Well Service (MAH 31). Sholapur improved the design somewhat and took out a patent which they use to prevent sub-standard pumps being made by other agencies or commercial firms. The Jalna type pump is now manufactured by SANKO Industries and by the Coimbatore Water and Agricultural Development Project (TN 3), both at Coimbatore in south India, as well as in Maharashtra, and UNICEF have adopted it as standard for their pump and well projects in India.

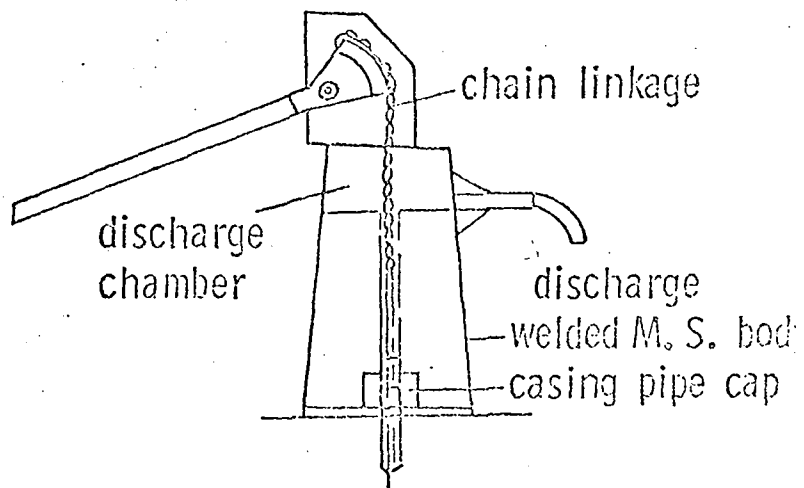
Jalna, Mono and Fly-wheel drive pumps all make minimal demands on the communities they serve and place few responsibilities on villagers. They work successfully for long periods without maintenance, and as UNICEF points out, if a pump requires maintenance only once a year, a well-equipped maintenance team becomes possible which can offer a much better service than a lone fitter coming round once a month, which is what many other pumps seem to require. So as means of providing rural communities with water, these are very good pumps; and with its basis of localised, small-scale manufacture, the Jalna pump in particular is an immense success story.

But as catalysts for development, encouraging villagers to take charge of their own futures, these pumps contribute little - they leave the villagers purely as clients of the local authority, or of the water resources agency which carries out the annual servicing. On these grounds, one Oxfam project

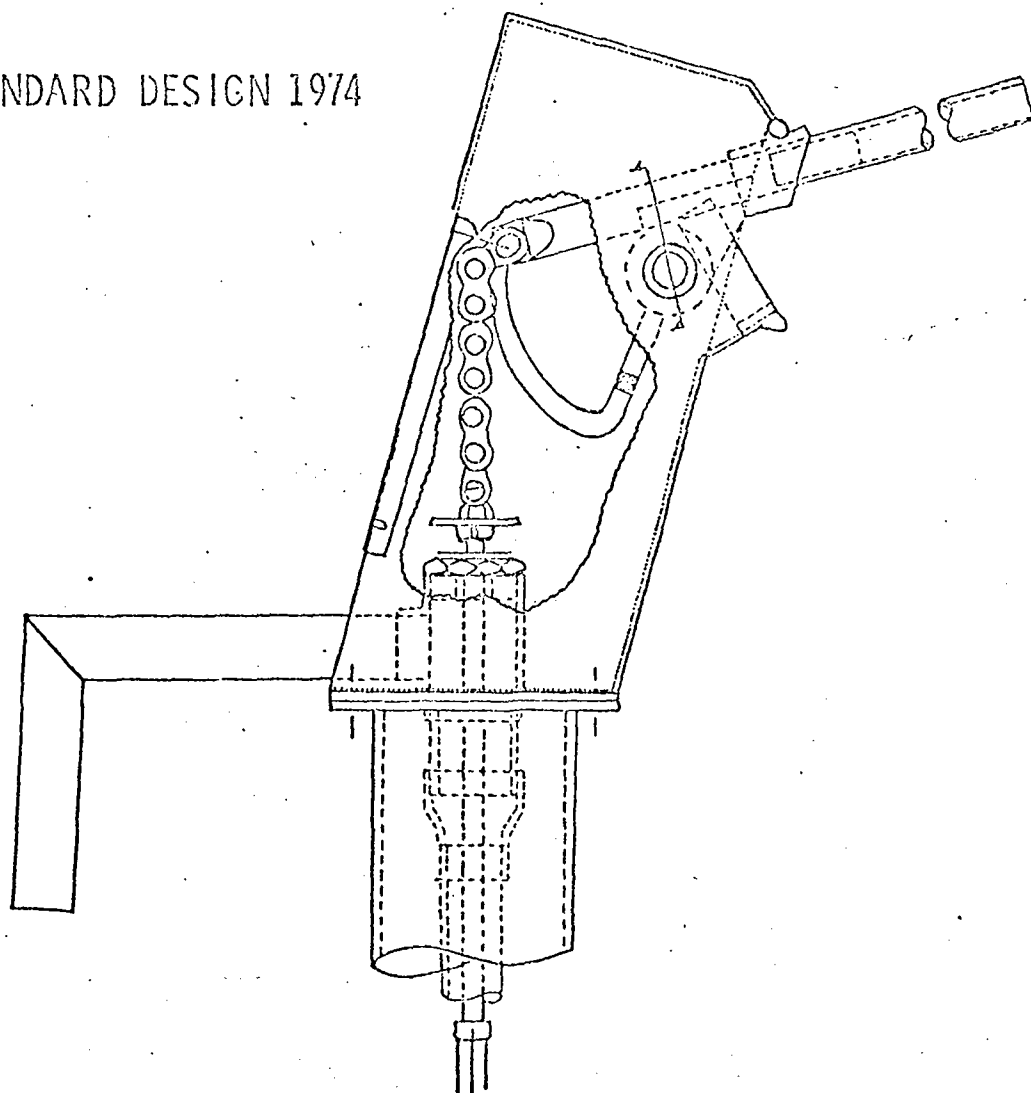
Figure 1 Jalna -type pump



TOP END MECHANISM 1972



STANDARD DESIGN 1974



holder in south India has become very critical of the Jalna pump and the philosophy which has caused UNICEF to adopt it. He feels that the low maintenance concept is an illusion, and that it would be better to use a simpler pump and squarely face up to the social-cum-organisational problems of effective maintenance.

12. Oxfam and UNICEF philosophies

Oxfam has come to see water supply projects, along with others involving house-building, roads and other community-based activities, as being potential catalysts for other kinds of development. Such projects encourage the people within communities to work together, and allow people to demonstrate to themselves how much they can achieve by their own efforts - how they can manage their own development. Used in this way, water supply projects can become a very effective means of social education or community development.

Oxfam's best experience of this has probably been in some water projects in Lesotho (IES 16), where the possibility of constructing piped water supplies very easily made it possible for villagers to participate to the maximum in planning and building their own water system. The value of this in terms of social education, and as a catalyst for further development projects, has been very great - people have gone on to build a road, construct soil conservation works, and develop small irrigated gardens.

Similar results have rarely been achieved with well schemes, especially where large drilling machines have been used, and it is clear that well/pump packages of the last of the three kinds discussed above are incompatible with this philosophy. The concept of minimum maintenance and slight community responsibility is clearly the antithesis of any social education approach. It would be only too easy, therefore, to portray UNICEF and Oxfam as having entirely different and quite opposite approaches. Oxfam, it might be claimed, is interested only in development which makes rural people more self-reliant and socially aware, while UNICEF's well and pump policy in India is purely concerned with supplying water on a relief or welfare basis, with no component of social development.

Such a statement would be untrue of Oxfam, which is very much concerned with welfare in practice if not in theory, and it would be unfair to UNICEF, whose successful well/pump projects in Bangladesh probably owe a lot to a sensitive approach to community development and training. The truth is that both organisations encompass a philosophy of development alongside a compassionate concern for those in need. Where people are suffering through lack of water, both organisations have often been right to short-cut the processes of social education and development to provide water quickly. What matters is not so much which philosophy is adopted, but that we are honest with ourselves, and are quite clear whether the objective is "development" or "welfare". To claim that the sinking of a well is a development project, but then to neglect the educational, social and administrative inputs which will ensure that development results is not only to kid ourselves, but it raises false hopes, and expectations which can never be met.

Although Oxfam has had a number of water projects which have been conspicuously successful in terms of social development, a much larger proportion of projects than we care to admit have been conducted purely on a welfare basis. In the context of these, UNICEF's vast experience, and the pump packages they recommend can only be beneficial to Oxfam's work. Oxfam is therefore right to continue with the Jalna pump programmes in India, and with the Sudan projects which use UNICEF Mono pumps. But at the same time, Oxfam field staff should be alert to the possibility of well projects in which social education or community development is possible. In these cases, a pump package involving community participation is desirable, and it is with this subject that the rest of the present paper is concerned.

13. Community development approach to well projects using simple factory-made pumps

Ideally, community development related to the provision of a new water supply, be it a well, borehole or surface source, should begin long before any drilling or digging is started. Either through village meetings, or by formation of a committee, or by other types of discussion, the villagers should have taken the following steps:

1. They should have formulated a request for help in installing their new water supply.
2. They should have discussed what sort of supply they need, and where they would like the well or other water points located.
3. They should have discussed their own contributions, which should usually include some physical contribution as well as cash, e.g. clearing the site before the drilling rig comes.
4. They should have decided which members of the village should be deputed to take up any special responsibilities - who should collect the cash, who should organise the work gangs, and who should be in charge of the pump when it is erected.

Carried out under village leadership, though often with the encouragement of community development workers, these procedures immediately place the drilling rigs and their crews in a less dominant position. Under this scheme, they wait for the villagers to request the well, and then co-operate with them in siting it and in construction. In areas where hand-dug wells are feasible, the drilling rigs should perhaps be confined to drilling pilot bores for groundwater exploration. Then the most important contribution of the big machines would be to save people the all too common, heart-breaking experience of devoting weeks to digging a well and then finding no water. The work involved in digging is only an intolerable burden if it finally proves to be futile.

If a project is begun in this way and followed through in the same spirit with full participation by the villagers, many of the problems encountered in well/pump schemes will not crop up at all. If a wrecked pump on an existing boreholes has to be replaced, the opportunity can be taken of introducing a degree of participation even at that stage, by forming a village committee to allocate responsibilities for the new pump, and to organise labour for cleaning up the well site.

Exactly how responsibilities for looking after pumps are allocated depends partly on the kind of back-up service which is available, and on the type of pump. It may be appropriate to ask villagers only to deal with the more basic maintenance tasks and those which have to be carried out most frequently. The back-up service would then need to provide a well-trained and well-equipped technician who could visit the pumps at regular intervals (e.g. every three months) to give them a thorough servicing. This system is commonly found in India, and an appropriate division of responsibilities between villagers and technicians is described below.

The alternative is to give certain villagers a thorough training in pump maintenance and leave virtually all responsibility in these villagers' hands. This approach is being tried in Tanzania, where: "Each village will be required to nominate a person before the well is sunk who will go to the District Office for two weeks to learn about shallow well construction and maintenance, particularly of the pump. He will then be responsible for the well once it is sunk, and will carry a small stock of leather washers and other spare parts in his house. If a major breakdown occurs he will go back to the District Water Office and either get the parts needed to do the repairs himself, or else get the district Water Engineer's fitters to do the job." (TAN 6)

In order to ensure that the villager responsible for maintaining the pump remains highly motivated, it may help to give him duties which add to his responsibility and status in the village. For example, if the pump is locked with a padlock and chain between certain hours, the maintenance man can be given charge of the key. This invests him with a certain status and at the same time imposes a degree of discipline in the use of the pump. If the maintenance man is involved in any expenses, e.g. through taking a bus to pick up a spare part, he should be able to approach the village committee which organised the well scheme and arrange through them for the community to re-imburse him.

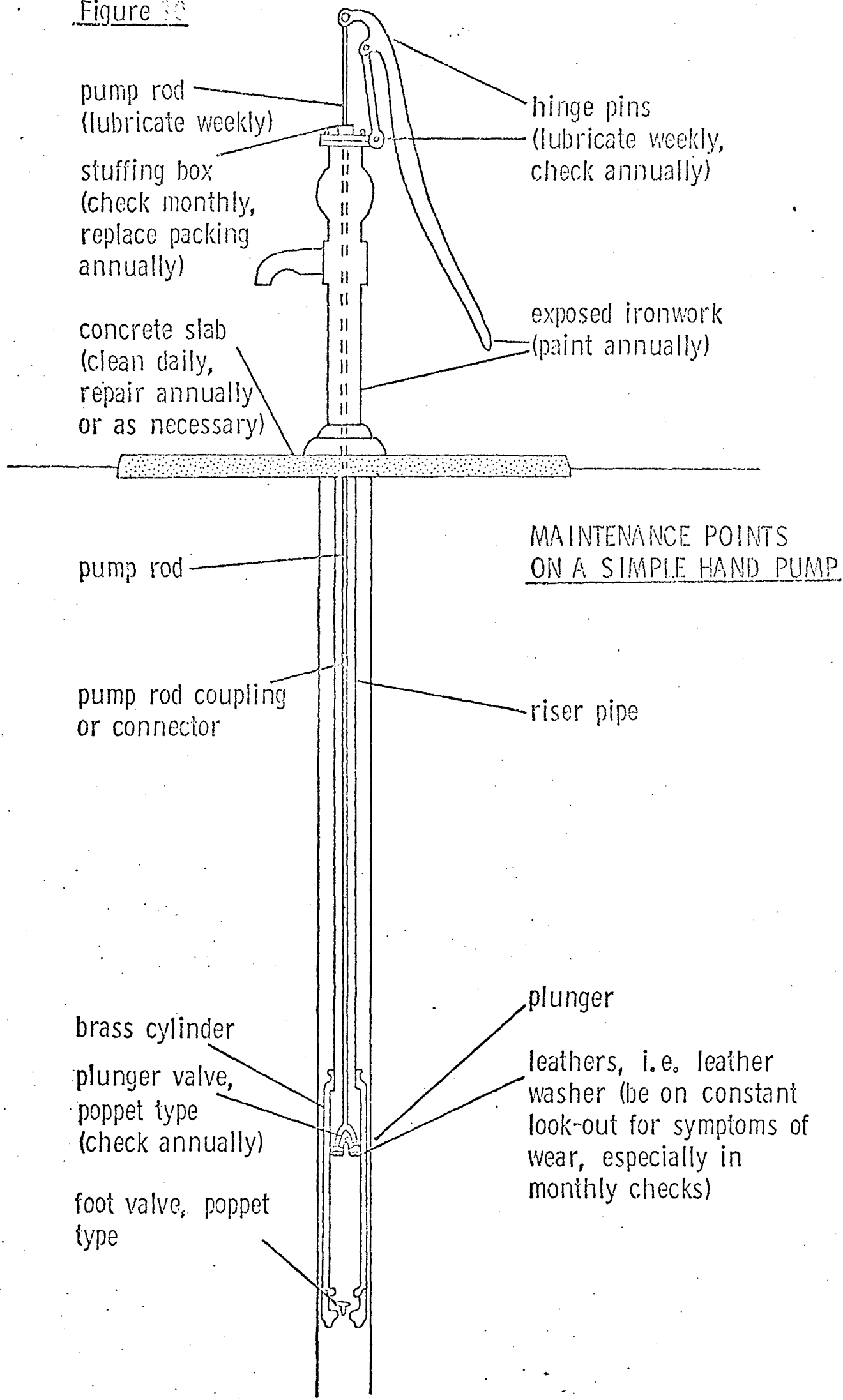
Yet another community development activity which may motivate villagers to take full care of their pump and at the same time take proper advantage of its benefits is health education. This should stress the importance of hygiene, and in discussing the importance of clean water, should explain how to guard against pollution of the well.

14. Maintenance tasks for the simpler types of bore-hole pump

Before one can define in detail the parts of the pump package which have to do with maintenance one must know more about the vulnerability of pumps to breakdowns and other troubles. Experience in a variety of countries suggests that the following points need most attention:

The most common cause of pump breakdowns is usually said to be failure in the top end - the hinge pins on which the handle pivots (see diagram), breakages of the handle, of nuts and bolts and other parts. Lack of lubrication and clumsy use (banging the handle against the stops) are the usual reasons for trouble. The Jalna-type and Fly-wheel drive pumps avoid most of these problems.

Figure 3C



The second most common cause of pump breakdowns is wear of the leather washers in the cylinder - and in Thailand and some other countries, this is said to be the most common problem of all. This problem is reduced by using brass cylinders instead of cast iron ones, or by using oil-impregnated leathers as developed, for example, by the Lee Howl firm. (No synthetic material is yet as good as leather for this purpose though). Pump maintenance men always need a stock of spare leathers. The problem is, of course, eliminated by pumps whose operation does not depend on the use of leather washers, such as the Mono pump or the new Godwin type (see below).

The next most significant cause of pump failures is trouble with valves in the cylinder. Ball valves are normally very simple and trouble-free, but suffer from the defect that pounding of the ball deforms the metal seat. Poppet valves with rubber cushioning have some times been more effective in the long term for this reason.

One other common problem with hand pumps is breakage of pump rods or pump rod couplings and trouble with rod bushings.

Although a wise choice of pump avoids some of these difficulties, regular maintenance is still the key factor. The table provided on the next page sets out in detail the maintenance needed on the simpler kinds of hand-pump. It refers specifically to the Dempster model 23F, to the Craelius pump, and to comparable pumps made in India (WASP, Kirti and Kaveri) and in Britain (Godwin and Lee Howl). The table is based on advice obtained from manufacturers, and on the maintenance schedule recommended by SAMA in Cameroun. Where other makes of pumps are used, this table should be amended in the light of the makers' instructions.

Village pumps are often used very intensively, and the table recommends a correspondingly high level of maintenance. In some instances, it would lead to pumps being over-maintained, but that is obviously preferable to the present state of neglect which is found in most areas. Frequency of maintenance can be adjusted for lightly used pumps.

A key decision which must be taken is which of these tasks is to be carried out by a responsible villager, and which by a professional maintenance team. Current policy in the Oxfam/CUTP Tanzania project (TAN 6) is to give a high degree of training to the villager concerned, and make him responsible for virtually all these tasks - with the possible exception of some of the annual ones. In most cases, however, it will be wise to have a professional maintenance team visit the pump every two or three months. In these instances, the daily, weekly and monthly tasks must be carried out by villagers except in the months when the professional team comes. Since it will almost never be practicable for the team to visit more often than once a month, daily and weekly tasks must obviously always be the responsibility of the village.

If they include a small degree of training, the activities of the maintenance team can also help to strengthen the villagers' ability to cope with their own problems. The team should re-train villagers in any maintenance tasks which appear to be neglected.

SCHEDULE FOR MAINTENANCEof SIMPLE BOREHOLE PUMPS

- daily
1. lock and unlock the pump at hours agreed by the village.
 2. clean the well-head.
- weekly
1. thorough clean-up of pump, well-head and surroundings.
 2. oil or grease all hinge pins, bearings, and sliding parts, after checking the no rust has developed on them.
 3. record any comments from users about irregularities in working (tightness of parts, leaks from stuffing box, fall-off in water raised). Correct these where possible.
- monthly
1. if necessary, adjust the stuffing box or gland (this does not apply to the Craelius pump). Usually this is done by tightening the packing nut. This should not be too tight - there should be a slight leak when the adjustment is correct.
 2. check that all nuts and bolts are tight, and check that there is no evidence of loose connections on the pump rods.
 3. check for symptoms of wear at the leathers, noting any comments from users about any falling off in the water raised. If the pump fails to raise water when worked slowly (e.g. at 10 strokes per minute), replace the leathers.
 4. carry out all weekly maintenance tasks.
- annually
1. paint all exposed parts to prevent development of rust.
 2. repair any cracked concrete in the well-head and surrounds.
 3. check wear at handle bearings and replace parts as necessary. On the Craelius pump, worn bushes can be replaced by short sections of pipe of suitable diameter.
 4. check plunger valve and foot valve; replace if found leaking.
 5. check the pump rod and replace any defective lengths or connectors.
 6. replace packing at the stuffing box or gland (does not apply to the Craelius pump).
 7. carry out all monthly maintenance tasks.

The maintenance team should also consult villagers about any difficulties encountered in operating the pump. A pump will usually show symptoms of malfunctioning before it actually stops working, and villagers may notice a slight falling off in the amount of water pumped which might not be obvious to a visitor. Another important function of the maintenance team should be to keep records of how often each pump is visited and what faults it develops. This allows the regularity of maintenance to be checked and shows up any pumps which need replacing. The villager responsible for maintenance should also be encouraged to keep a log, to show that all tasks are regularly carried out, and also to record the onset of any symptoms of malfunctioning.

Spare parts kept by the maintenance team or by the responsible villager will usually include plungers (also called buckets or pistons), leathers, valves, nuts and bolts, handles, pump rods and connectors. The team will need transport, or a single maintenance man just a motor bike.

If pumps are maintained on this basis, breakdowns will be very rare. However, some projects have provided villagers with stamped and addressed postcards which they can use to summon an emergency repair team when this is necessary, and this or some other arrangement for dealing quickly with breakdowns will always be necessary.

15. Some pumps currently under development

Although the foregoing completes all that need be said in general about pump packages, specific mention needs to be made of two potentially important pumps which are still at an early stage of development - the new Godwin model and the pedal-operated Vergnet pump. In neither case is it possible to specify maintenance requirements precisely, so it is not possible to present either pump in the context of a package.

The new Godwin pump is still at the design stage, and few details have yet been released. However, it promises very considerable economies in the initial cost of a pump and its associated pipework and in the cost of transport to site. It could, in fact, become one of the cheapest available pumps, with a much reduced weight of metal or plastic needed for its construction. The plunger assembly in the cylinder is also completely re-designed to allow for very free movement, and much less effort should be needed to work the pump. The top end design for the new Godwin pump has not yet been finalised, but the design is entirely compatible with the Jalna-type top end. In this case, the pump would have similar maintenance characteristics to the Jalna pump, except that less maintenance would probably be needed in the cylinder.

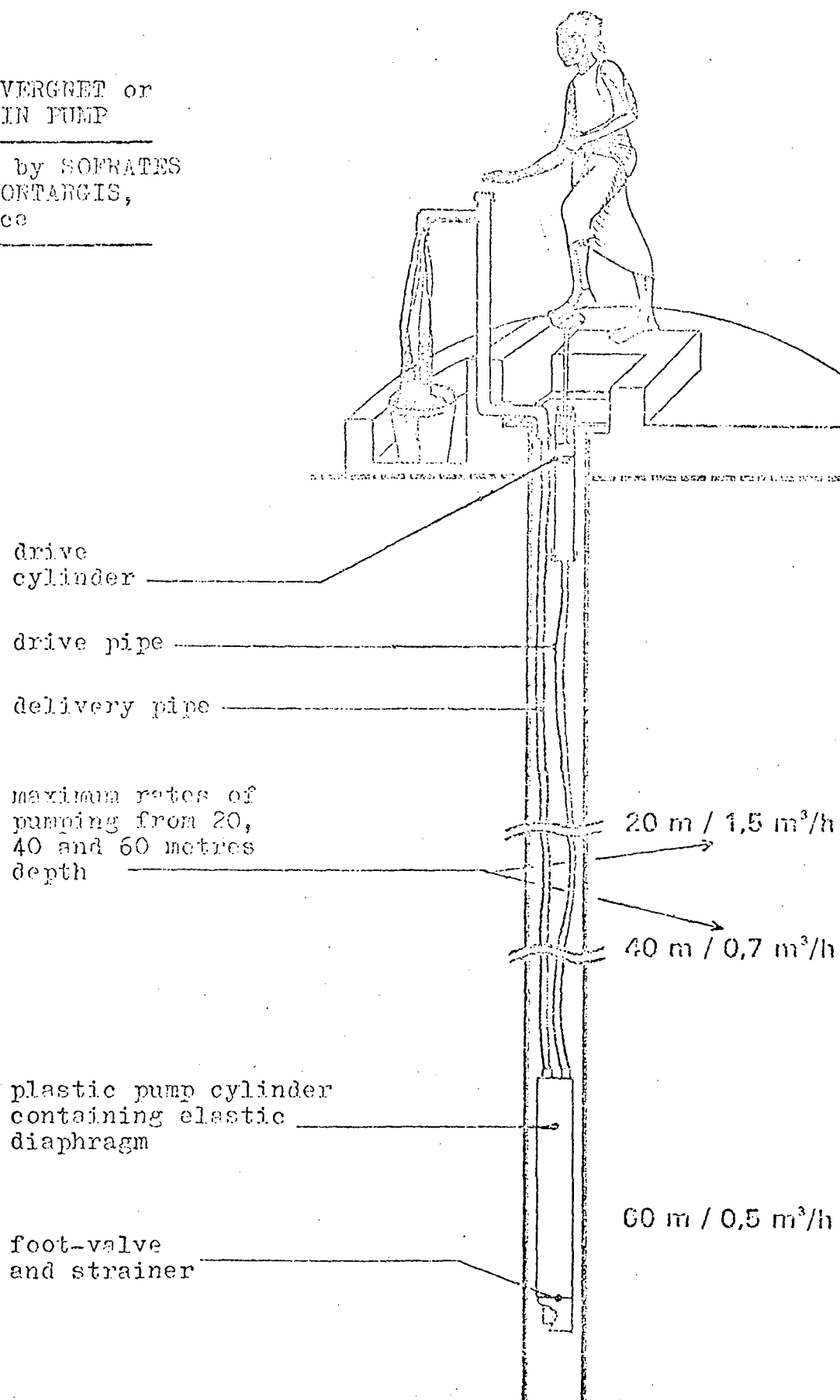
The Vergnet pump, now undergoing field trials with UNICEF in Upper Volta, works on a principle completely different from that of all other manually operated deep well pumps. It is effectively a diaphragm pump, with a diaphragm in the cylinder operated by hydraulic action.

The pump cylinder, located as usual within the well, is made of PVC plastic. It is linked to the surface by two pipes, one a driving pipe connected to a

10A

The VERGNET or
MENGIN PUMP

made by SOPRATES
of MONTARGIS,
France



pedal; the other a delivery pipe through which the pumped water emerges. The whole system is filled with water, the plunger when at rest being in the raised position. The operator presses on the pedal with his foot, and so pushes water through the drive pipe and into the pump cylinder. This has an elastic lining or diaphragm which replaces the plunger or piston in an ordinary pump. So when the pedal is pushed down, the elastic lining expands and pushes water from the cylinder and up the delivery pipe to the surface. But at the end of the stroke, when the operator removes his foot from the pedal, the elastic lining pulls back to its original shape, pushing water up the drive pipe and restoring the pedal to its original position. The cylinder has a conventional foot valve and also a delivery valve at the entry to the delivery pipe. So as the elastic lining pulls back, water flows through the foot valve, from the well into the cylinder.

There is no connection between the drive and delivery systems, except for a check valve, which replaces any water lost by leakage from the delivery pipe.

16. Conclusion

It has seemed useful in this paper to draw a contrast between three design philosophies for pumps, and to show how each is related to a different package of measures. Which package and which design philosophy one adopts depends very much on the objectives of the project in relation to such concepts as "development" and "welfare"; "self-reliance" and "dependence". In this way, engineering is always related to social ideals and objectives. The product being designed always forms part of a system which includes a large social component. A "systems map" which illustrates this appears as the final diagram.

So the solution to the problems experienced with hand pumps by Oxfam, UNICEF and numerous other agencies cannot be solved wholly, or even mainly by re-designing pumps or improving the quality of manufacture. Quite as important is the need to clarify objectives and to pay much more attention than hitherto usual to the social components of the well/pump package.

In some countries, it is participation by the local community which can be identified as the social component most crucially neglected. Therefore, an increased emphasis on community development will lead to better pump maintenance as well as stimulating development on a broader front. In other countries, however, the missing social component lies with the local government organs which are responsible for maintaining pumps. A correspondent in south India writes: "I do not believe that providing maintenance instructions and training strike at the problem. There is no lack of know-how, and the mechanisms are very simple... There is no lack of organisation. Panchayat Unions have an engineer and staff under him who are responsible for maintenance and repairs and who promised to look after the pumps. They don't even know the score... technicians lack incentive, they expect tips and bribes, they fleece people. They do not consider it any reflection on themselves if the pumps in their custody don't work. The hurdles are all human. It is a cultural or psychological problem."

Some of these problems may be quite intractable and may lead to the view that a minimum maintenance philosophy based on Mono pumps or something similar is all that remains. However, it is important to be clear about this just as it is important to be clear about objectives, and the final conclusions of this report can be summarised as follows:

1. Any organisation planning to implement a project involving wells and pumps should first clarify its objectives, and decide not only what is desirable, but also what is feasible.

2a. If the objective is primarily to provide a drinking water supply and to do this without delay, an appropriate strategy will be to adopt the package described in section 11 above, and to choose pumps which require a minimum of maintenance.

2b. If, however, the objective of the project is development on a broad front, and the water supply is intended to play a catalytic and educational role in the development process, it will be more suitable to adopt either of the packages described in sections 9 and 10. Of these, the second (section 10), which involves partial village self-reliance, will be most generally applicable. The key element in this package is the social or community development inputs, and the village-level activities to which they lead. This is illustrated by the systems map diagram, which indicates four separate activities in which a village committee or other group could participate in the construction phase, and two activities in the operating phase.

3. Any agency involved in well and pump projects should ensure that the whole of the relevant package is adopted, including the training of villagers responsible for maintenance and the organisation of a professional back-up service with adequate transport, spare parts and management (including record-keeping - section 14).

4. Any agency wishing to promote the local manufacture of hand pumps for deep wells should be prepared to equip a workshop with suitable machine tools and train workers with the necessary skills - simple tools and traditional skills are rarely adequate, though the introduction of the appropriate workshop technology is a worthwhile form of development (section 9).

Acknowledgements

I am indebted to the following for answering queries, providing information or for corresponding with me about hand-pumps:

Martin G. Beyer of UNICEF New York, Charles Heineman of Madurai, A.P. Mangalam of Coimbatore, R.K. Stoelzel of UNICEF New Delhi and many members of Oxfam staff; also Craslius Terratest Ltd of Nairobi, Dempster Industries Inc of Beatrice, Nebraska, H.J. Godwin Ltd of Quenington Gloucestershire, Lee Howl and Co Ltd of Tipton, and Mono Pumps Engineering Ltd of London.

I also recall the co-operation of David M. Farrar of Manchester in earlier reports on hand-pumps (the first written in 1969), some details from which are incorporated here. Thanks are also due to Wimal Gunawardena and T.R. Barnett of Lancaster University.

A PVC HAND PUMP #2 low in cost, dependable, easily repaired.

Cast iron has become increasingly expensive, and in the deep well pump the heavy cylinder suspended on a galvanized iron discharge pipe with the rod inside is difficult for the villager to remove and repair.

If a Governmental agency establishes mobile repair crews, as more wells are installed with hand pumps the maintenance cost increases rapidly. For many years it will not be feasible or economic in most countries to put small piped systems in villages of less than 500 people. There is a great need for a low cost, dependable, easily repaired hand pump. Such a pump is now available using PVC pipe as the cylinder. This pump was described in a VITA publication and the shallow well suction pump has been fabricated and tested by the Thailand Dept. of Agriculture. The test pump was shown on the cover of their monthly Journal with a report on its performance.

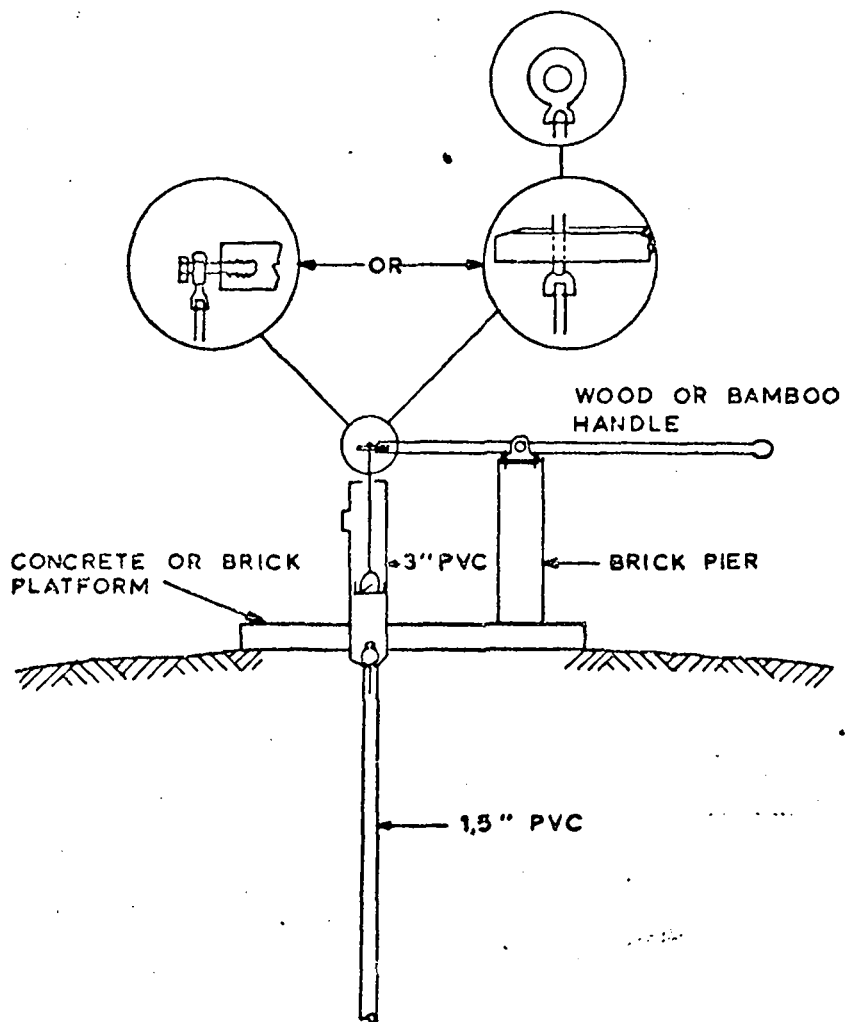
The cylinder was a section of 3" PVC pipe above the platform with a 1½" suction pipe extending into the well. The pump rod was 3/8" diameter steel with a small yoke at the top to fit on both sides of the wooden handle. A standard piston with poppet valve was attached to the lower end of the rod. A foot valve was placed on the bottom of the 1½" suction pipe. The handle was supported by a 5"x5" wood post set firmly into the ground. The handle was of hard wood 2"x1½"x70" long. A round, flat cover of wood with a small slot to permit free movement of the rod was used to close the top of the 3" PVC pipe. The pump had a maximum lift of 23 feet and the discharge was between 10 and 15 gallons a minute with an 8-10 inch stroke, depending upon the suction lift. The cost was about US \$20.00. The PVC foot valve alone was US \$5.00. Using a simpler lower valve and making the pump in quantity, the cost could be reduced to about US \$15.00 compared to US\$100.00--150.00 for a cast iron pump.

The deep well version is based upon the use of PVC pipe as the well casing in small diameter driven, jetted or drilled wells. The PVC casing becomes the cylinder and the casing is extended above the platform to act as the channel for the water. The handle and support post is similar to the suction pump. If the casing is considered part of the cost of the well, the pump cost only includes the handle, support post, pump rod, piston and lower valve. The lower valve seat can be fixed in a length of PVC casing at the shop. The PVC pipe should be supported from the bottom as it is lowered into the well with a trip to release the support when the casing is in place. The deep well pump has not yet been field tested. The suction pump has been run 200-300 hours with only very slight wear on the leather "bucket". The handle should be of such a length that the end of the handle attached to the rod will, in sweeping a small arc, pass through the vertical position for the rod. This will minimize wear of the leather "bucket". A rubber bucket is used in Korea and should give a superior performance when used in a PVC pipe cylinder.

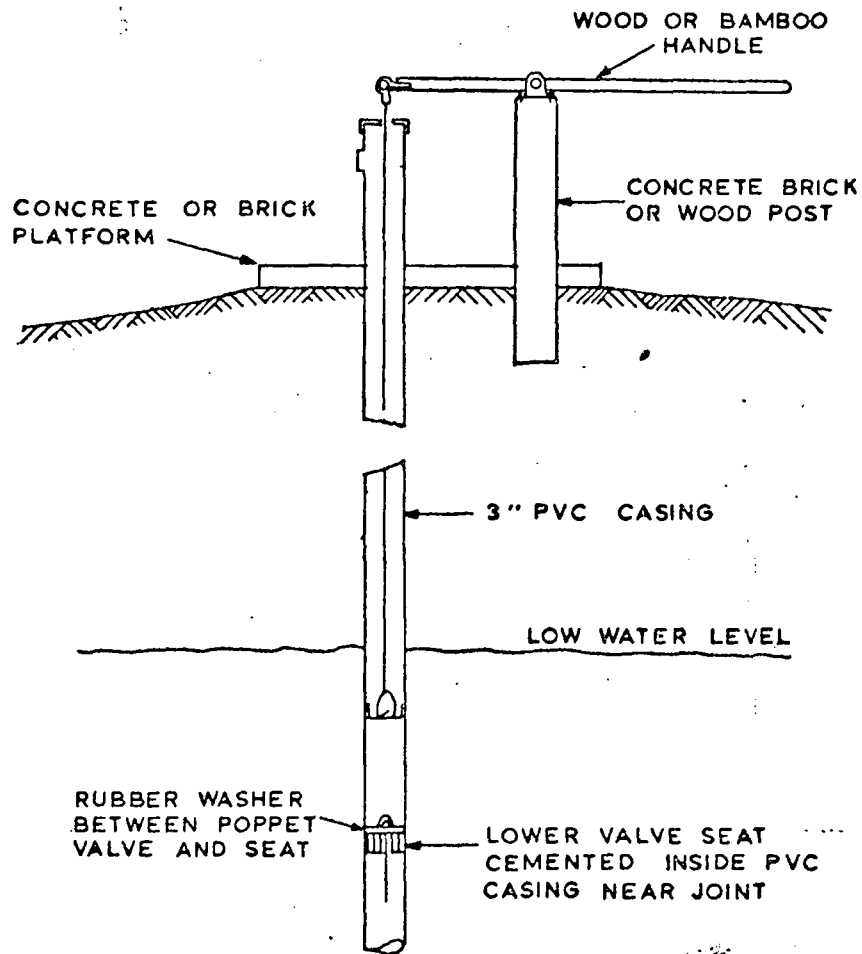
This dependable, low cost, easily repaired pump should make wide spread use of hand pump wells feasible and economic.

C. D. Spangler
April 1976

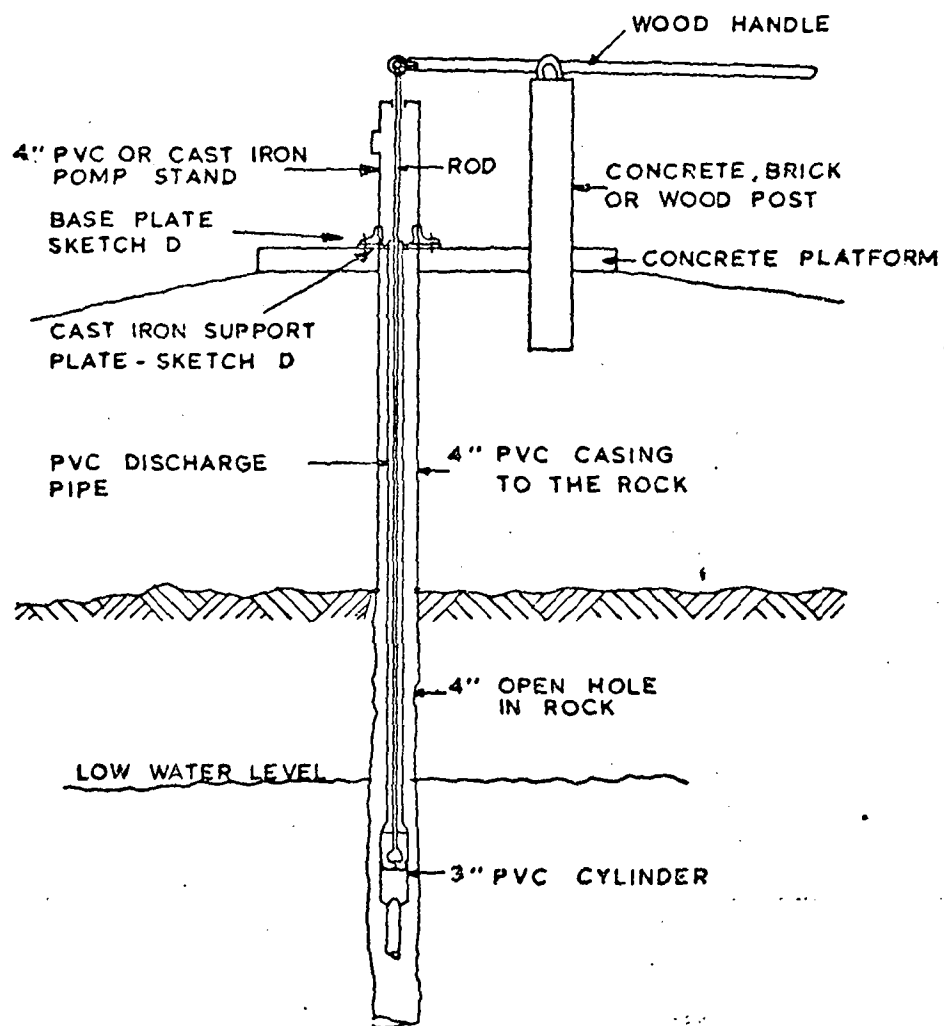
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SWEL ENCIS.	NR. _____ DATE _____



SKETCH A SHALLOW WELL PUMP

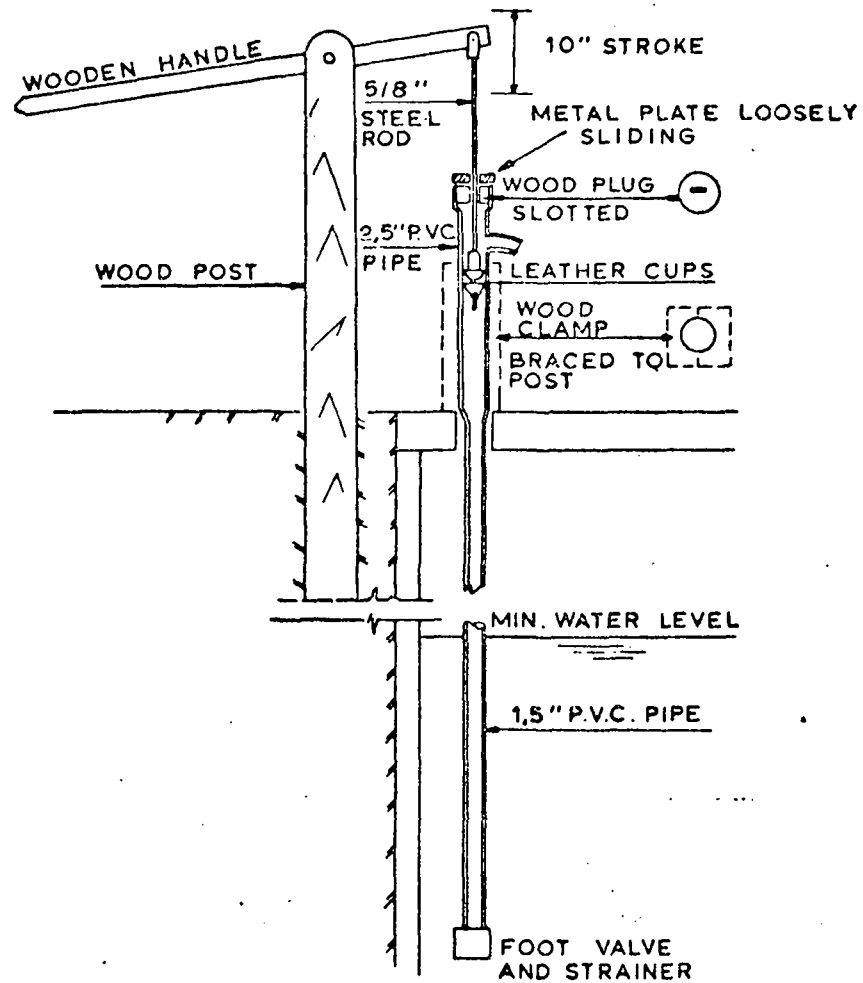


SKETCH B DEEP WELL PUMP

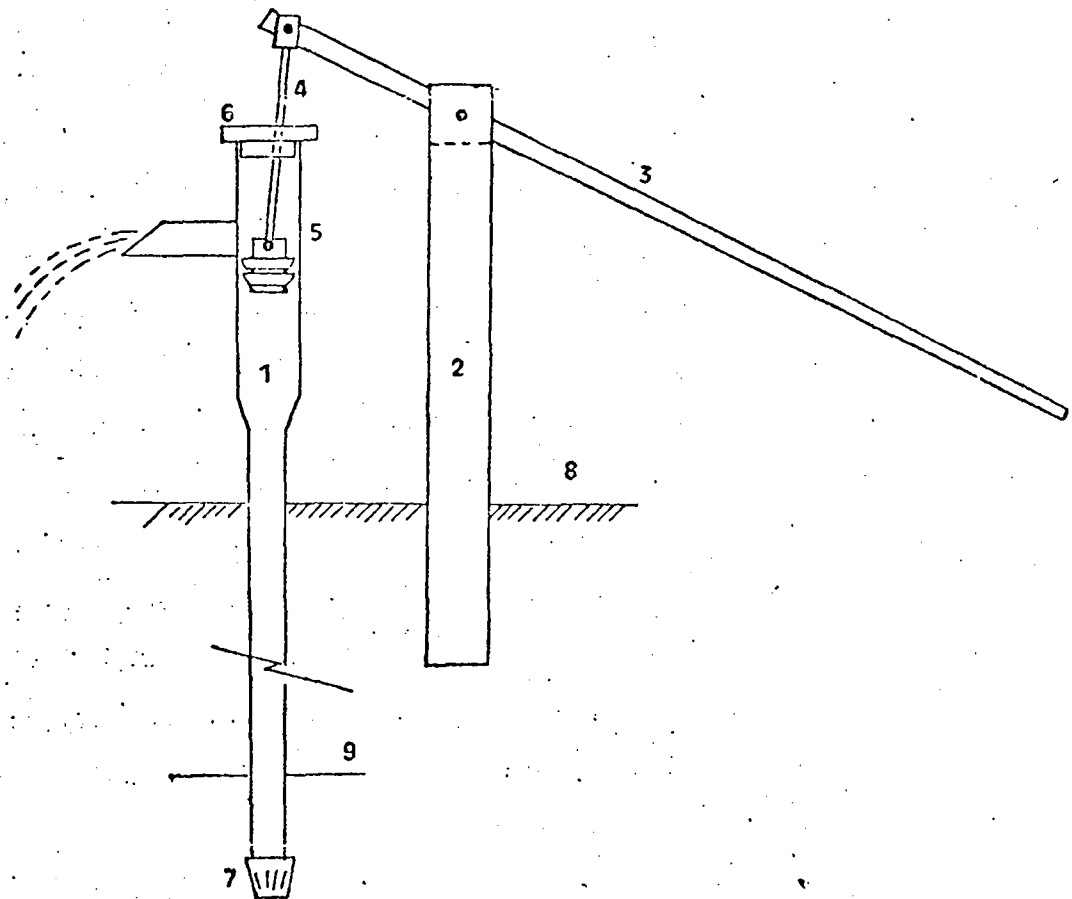


SKETCH C

DEEP WELL PUMP-UNCASED
HOLE IN ROCK



P.V.C. HAND PUMP FOR SHALLOW
VILLAGE WELLS , THAILAND



PUMPS, SMALL HAND AND POWER DRIVEN: Standard Industrial Classification 3561

A. PRODUCT DESCRIPTION

Conventional hand and power driven pumps with cast iron casings. The production requirements in section D are based on half the production being hand operated and the other half power-driven. The proportion can, however, be varied to suit demand.

B. GENERAL EVALUATION

This plant requires a fairly large capital. Not much skilled labor is needed, but good management and supervision are necessary to assure maintenance of quality standards. Such pumps are increasingly in demand for rural and industrial development, and there should be quite a number of developing areas where a plant of this kind could operate successfully.

C. MARKET ASPECTS

1. USERS. Farmers, construction contractors, certain industries, etc.
2. SALES CHANNELS AND METHODS. Sales would generally be made to machinery and equipment distributors, though some might be made direct to industrial enterprises.
3. GEOGRAPHICAL EXTENT OF MARKET. These pumps are easily handled and are often transported long distances. They are a common export item.
4. COMPETITION. If the pumps are well made and costs are reasonable, it should be possible to compete with imported pumps. Some sales to neighboring countries might be possible, but the operation is on too small a scale to enter into general international trade.
5. MARKET NEEDED FOR PLANT DESCRIBED. The market is likely to be extensive and variegated. Demand will depend on the degree of prosperity in rural areas and the extent to which user industries are developing in the area.

D. PRODUCTION REQUIREMENTS

ANNUAL CAPACITY - ONE-SHIFT OPERATION: 9,000 Hand Pumps, 9,000 Motor Driven Pumps

1. CAPITAL REQUIREMENTS

a. <u>FIXED CAPITAL</u>	<u>Cost</u>
Land.	\$ --
Building. One story, 60'x100'.	36,000
Equipment, Furniture & Fixtures.	
Prodn. tools & equipmt. \$46,000	
Other tools & equipmt. 1,200	
Furniture & fixtures 800	
Transportation equipmt. 5,000	53,000
Total (excl. Land)	\$ 89,000
<u>Principal Items.</u> Pedestal grinder, lathe, arbor press, milling machine, drill press, boring machine, hacksaw, welding equipment, wet grinder, turret lathe, pipe threaders, pipe threading dies.	

b. WORKING CAPITAL

	No. of Days	
Direct Materials, Direct Labor, Mfg. Overhead(a)	60	\$ 87,300
Admin. Costs(b), Contingencies, Sales Costs(c)	30	3,900
Training Costs		4,800
Total Working Capital		\$ 96,000
c. <u>TOTAL CAPITAL (EXCL. LAND)</u>		<u>\$185,000</u>

2. MATERIALS AND SUPPLIES

	Annual Requirements	Annual Cost
a. <u>Direct Materials</u>		
Castings	450 tons	\$ 87,700
Steel shapes	50 tons	12,500
Wood handles	9,000	1,800
Gaskets, fittings	18,000 sets	6,300
Nuts, washers, bolts	18,000 sets	7,200
Belts	9,000	4,500
Fractional hp. motors	9,000	225,000
Total		<u>\$345,000</u>

b. Supplies

Lubricants & hand tools	\$ 400
Cutting tools & abrasives	3,800
Maintenance & spare parts	1,200
Patterns	900
Office supplies	300
Total	<u>\$ 6,600</u>

3. POWER, FUEL AND WATER

	Annual Cost
a. <u>Electric Power.</u> 200 hp. connected load.	\$ 3,000
b. <u>Fuel.</u> About 10,000 gals. oil annually.	\$ 1,200
c. <u>Water.</u> About 9 million gals. annually.	\$ 2,200

4. TRANSPORTATION

	Annual Operating Cost
a. <u>Own Transport Equipment.</u> Truck for local deliveries.	\$ 1,000
b. <u>External Transport Facilities.</u> In & out shipments about 3 tons a day. Good highways desirable.	

5. MANPOWER

	Number	Annual Cost
a. <u>Direct Labor</u>		
Skilled	3	\$ 18,000
Semi-skilled	10	50,000
Unskilled	12	48,000
Total	25	<u>\$116,000</u>
b. <u>Indirect Labor</u>		
Manager & supervisors	3	\$ 27,000
Office	1	5,000
Maintenance & driver	3	16,000
Total	7	<u>\$ 48,000</u>

c. Training Needs. Manager & supervisors must be experienced. With 2 skilled workers, they should be able to train other workers & reach full production in about 1 month.

6. TOTAL ANNUAL COSTS AND SALES REVENUE

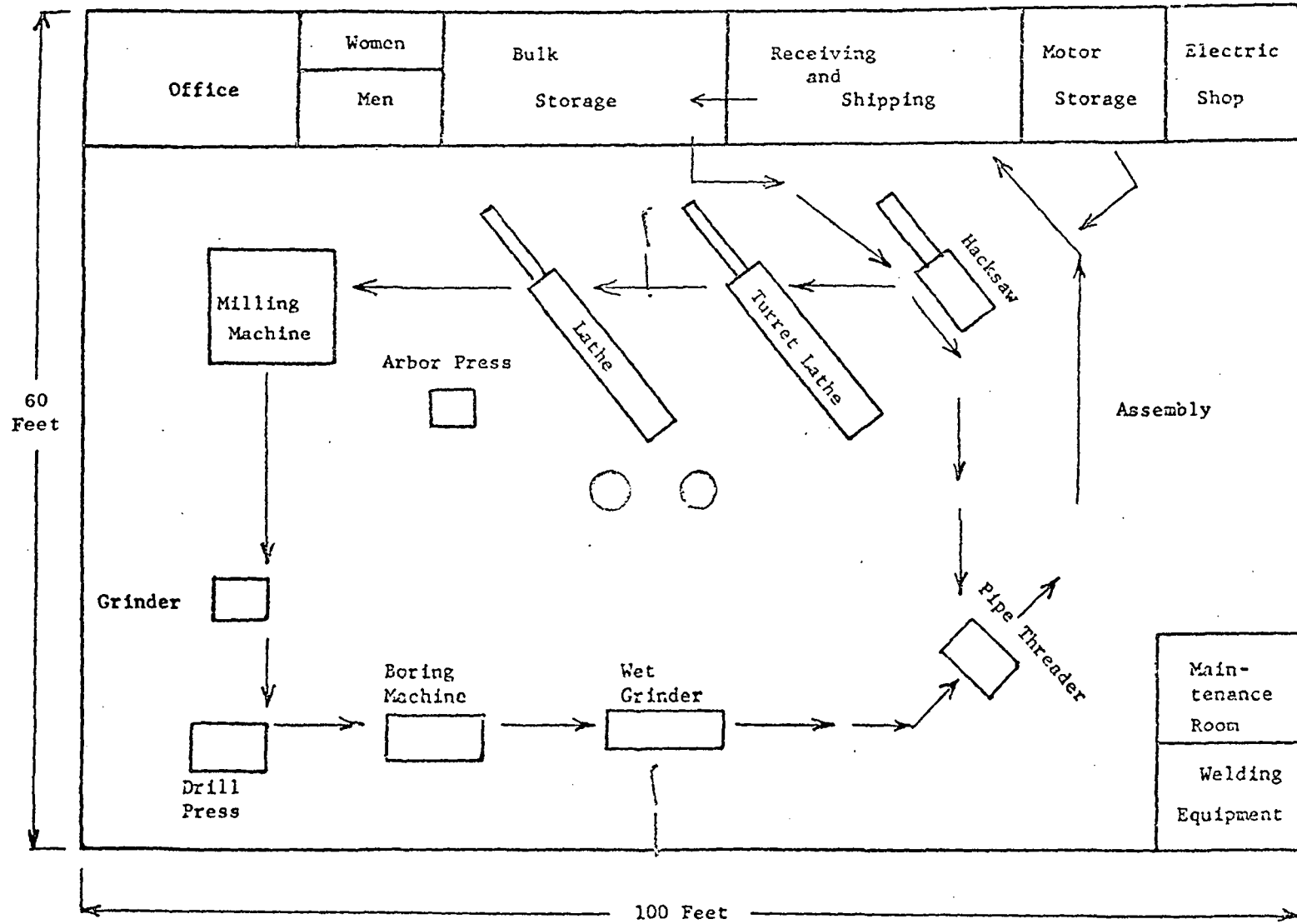
a. <u>Annual Costs</u>	
Direct Materials	\$345,000
Direct Labor	116,000
Manufacturing Overhead(a)	62,000
Admin. Costs(b), Contingencies	21,000
Sales Costs(c), Bad Debts	30,000
Depreciation on Fixed Capital	8,000
	<u>\$582,000</u>
b. <u>Annual Sales Revenue</u>	<u>\$650,000</u>

NOTES. (a) Includes Supplies, Power, Fuel, Water, Transportation, Indirect Labor. (b) Includes Interest, Insurance, Legal & Audit Charges. (c) Includes Sales Commissions, Freight Out, Travel.

PUMPS, SMALL HAND AND POWER DRIVEN: S. I. C. 3561

PUMPS, SMALL HAND AND POWER DRIVEN: S. I. C. 3561

PLANT LAYOUT AND WORKFLOW



PUMPS, SMALL HAND AND POWER DRIVEN: S.I.C. 3561

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I. TEXTBOOKS

- A. Pumps: Types, Selection, Installation, Operations, and Maintenance. F. A. Kristal and F. A. Annett, 1953. 373 p. Illus. \$10.00. McGraw-Hill Book Company, Inc.
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New York, N.Y. 10036
- B. ASME Handbook of Metals Engineering Design. O. J. Horger, editor. 2nd edition, 1965. \$22.50. McGraw-Hill Book Company, Inc.
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New York, N.Y. 10036

II. U. S. GOVERNMENT PUBLICATION

- A. Manufacture of Hand Pumps. IR-30634. Gratis. Agency for International Development
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III. PERIODICALS

- A. Materials in Design Engineering. Monthly. \$15.00/year. Reinhold Publishing Corporation
430 Park Avenue
New York, N.Y. 10022
- B. Machinery. Monthly. \$7.00/year. Industrial Press
93 Worth Street
New York, N.Y. 10013

IV. U. S. PATENTS

- Available U. S. Patent Office
Washington, D.C. 20231 \$.25 each.
- A. Patent No. 2,954,736. 1960. 4 p.
A low lift pump for liquids.
 - B. Patent No. 2,910,008. 1959. 5 p.
Fluid pump of the piston type.
 - C. Patent No. 2,627,816. 1953. 8 p.
An electrically driven pump.

SELECTED REFERENCES (Continued)

V. TRADE ASSOCIATION

- A. Sump-Pump Manufacturers Association
Mills Building, N.W.,
Washington, D.C. 20006

VI. ENGINEERING COMPANY

- A. Fulflo Specialties Company, Inc.
410 Fancy Avenue
Blanchester, Ohio 45107
Pump engineers.

VII. DIRECTORY

- A. American Foundrymen's Society Buyers' Guide. Biennial. \$10.00.
American Foundrymen's Society
Golf and Wolf Roads
Des Plaines, Ill. 60018
Lists major suppliers of products sold to foundries.

PUMPS, SMALL HAND AND POWER DRIVEN: S.I.C. 3561

SHALLOW WELL HAND PUMPS: Standard Industrial Classification 3561

A. PRODUCT DESCRIPTION

Simple hand pump, made of gray cast iron. bore 2-5/16", piston movement 6", obtained by hand lever. Bottom casing tapped for 1-1/4" inside diameter pipe. Pump will deliver approximately 200 gallons per hour, with about 30 to 35 strokes a minute, from maximum depth of 22 feet.

B. GENERAL EVALUATION

Capital and skilled labor requirements in this industry are modest. The plant consists essentially of a foundry, with a tool room in which castings are machined. Such a plant can make other cast iron articles, e.g. pipes, valves, wheels, stands, troughs, plows. Thus, if the demand for pumps is insufficient, the plant can use some of its capacity to make other articles. A plant of this type appears to have good prospects for profitable business and growth in many developing areas.

C. MARKET ASPECTS

1. USERS. Farmers; and urban property owners, where piped water does not exist.
2. SALES CHANNELS AND METHODS. Sales will generally be made to wholesale and retail distributors.
3. GEOGRAPHICAL EXTENT OF MARKET. These products are fairly easily handled, and transport costs are unlikely to restrict the market area very severely. Where there is a reasonably well developed transport network, plant may send shipments over a wide area. There is a moderate volume of export business in equipment of this kind.
4. COMPETITION. a. Domestic Market. Unless costs are unusually high, local product should be able to compete with imports. b. Export Market. This plant would be too small to engage in general export business, but some sales to nearby areas of neighboring countries might be possible.
5. MARKET NEEDED FOR PLANT DESCRIBED. In the less developed areas pumps of the kind produced by this plant are often widely used both in urban and rural areas. With extension of modern systems of water supply in urban areas demand will of course tend to decline. Where pumps of this type are in general use, a population of the order of 4 million should provide an outlet for production of this plant.

D. PRODUCTION REQUIREMENTS

ANNUAL CAPACITY - ONE-SHIFT OPERATION: 30,000 Units

1. CAPITAL REQUIREMENTS

a. <u>FIXED CAPITAL</u>	Cost
Land. About 10,000 sq. ft.	\$ --
Building. One story, 40'x75'.	18,000
Equipment, Furniture & Fixtures.	
Prodn. tools & equipmt. \$12,800	
Other tools & equipmt. 5,500	
Furniture & fixtures 700	19,000
<u>Total (excl. Land)</u>	<u>\$ 37,000</u>

Principal Items. Cupola complete, turbo compressor, sand screener, sand mixer, optical pyrometer, flasks, core oven, grinder on stand, portable grinder, 2 lathes, thread cutter, drill press, band saw.

b. WORKING CAPITAL

	No. of Days	
Direct Materials, Direct Labor, Mfg. Overhead(a)	60	\$ 17,400
Admin. Costs(b), Contingencies, Sales Costs(c)	30	1,400
Training Costs		5,000
<u>Total Working Capital</u>		<u>\$ 23,800</u>

c. TOTAL CAPITAL (EXCL. LAND) \$ 60,800

2. MATERIALS AND SUPPLIES

a. <u>Direct Materials</u>	Annual Requirements	Annual Cost
Pig iron & scrap	750 tons	\$ 30,000
Coke & flux	225 tons	8,000
Sand, core sand, nails, patterns		3,000
Valves, bolts, nuts, washers		1,000
<u>Total</u>		<u>\$ 42,000</u>

b. Supplies

Lubricants & hand tools	\$ 100
Grinding wheels & cutting tools	400
Maintenance & spare parts	1,300
Office supplies	200
<u>Total</u>	<u>\$ 2,000</u>

3. POWER, FUEL AND WATER

	Annual Cost
a. <u>Electric Power</u> . Connected load about 25 hp.	\$ 800
b. <u>Fuel</u> . About 3,000 gals. oil annually.	\$ 400
c. <u>Water</u> . About 400,000 gals. annually.	\$ 100

4. TRANSPORTATION

- a. Own Transport Equipment. None necessary.
- b. External Transport Facilities. Total in & out shipments about 120 tons a month. Plant should be located on good highway, and, if possible, near railroad.

5. MANPOWER

	Number	Annual Cost
a. <u>Direct Labor</u>		
Skilled	2	\$ 12,000
Semi-skilled	4	20,000
Unskilled	3	12,000
<u>Total</u>	<u>9</u>	<u>\$ 44,000</u>

b. Indirect Labor

Manager	1	\$ 10,000
Office	1	5,000
<u>Total</u>	<u>2</u>	<u>\$ 15,000</u>

- c. Training Needs. Manager should be fully experienced. With aid of 2 skilled workers, he should be able to do all necessary labor training. Plant should reach full production in 2 months.

6. TOTAL ANNUAL COSTS AND SALES REVENUE

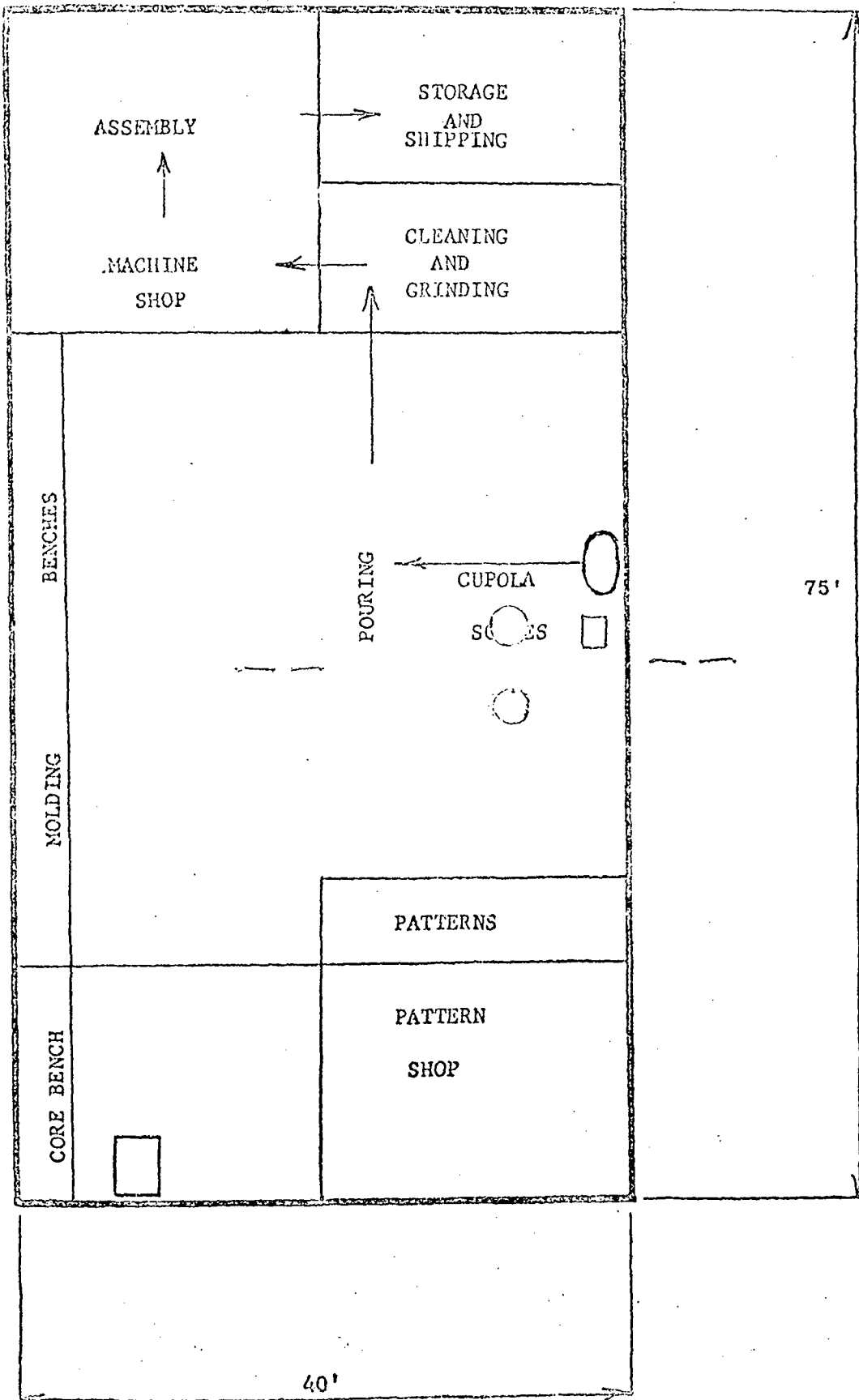
a. <u>Annual Costs</u>	
Direct Materials	\$ 42,000
Direct Labor	44,000
Manufacturing Overhead(a)	18,300
Admin. Costs(b), Contingencies	6,500
Sales Costs(c), Bad Debts	10,500
Depreciation on Fixed Capital	3,400
<u>Total</u>	<u>\$124,700</u>
b. <u>Annual Sales Revenue</u>	<u>\$150,000</u>

NOTES. (a) Includes Supplies, Power, Fuel, Water, Indirect Labor. (b) Includes Interest, Insurance, Legal & Audit Charges. (c) Includes Sales Commissions, Freight Out, Travel.

SHALLOW WELL HAND PUMPS: S. I. C. 3561

PLANT LAYOUT

ARROWS INDICATE FLOW OF WORK



SHALLOW WELL HAND PUMPS: S.I.C. 3561

SHALLOW WELL HAND PUMPS: S.I.C. 3561

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- B. Foseco Foundryman's Handbook. 1965. \$3.50.
Pergamon Press
44-01 Twenty-first Street
Long Island City, N. Y. 11101
- C. Metallurgical Principles of Founding. V. Kondic. 1965.
American Elsevier Publishing Co. Inc.
52 Vanderbilt Avenue
New York, N. Y. 10017
- D. Introduction to Foundry Technology. D. C. Ekey and W. P. Winter. 1958.
296 p. illus. \$7.00.
McGraw-Hill Book Company, Inc.
330 West 42nd Street
New York, N. Y. 10036

II. U. S. GOVERNMENT PUBLICATIONS

- A. Foundry Practices. IR-27681. Gratis.
Office of Technical Cooperation and Research
Agency for International Development
Washington, D. C. 20523
- B. Pumps. IR-23519. Gratis.
Office of Technical Cooperation and Research
Agency for International Development
Washington, D. C. 20523

III. PERIODICAL

- A. Foundry. Monthly. \$20.00/year.
Penton Publishing Company
Penton Building
Cleveland, Ohio 44103
Foundry news and information primarily for management, production,
technical, and purchasing personnel in foundries.

SELECTED REFERENCES (Continued)

IV. U. S. PATENTS

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Washington, D. C. \$.25 each.

- A. Patent No. 2,164,103. 1939. 3p.
Hand pump for lifting water.
- B. Patent No. 1,738,734. 1929. 6p.
Construction of a small reciprocating pump.
- C. Patent No. 1,699,726. 1929. 4p.
Piston pump for shallow wells.
- D. Patent No. 1,670,798. 1929. 8 p.
Simple pump of the piston type.

V. TRADE ASSOCIATION

- A. Gray Iron Founders Society
National City-East Sixth Building
Cleveland, Ohio 44114

VI. ENGINEERING COMPANIES

- A. National Engineering Company
610 Machinery Hall Building
Chicago, Ill. 60606
- B. Jeffery Manufacturing Company
956 North 4th Street
Columbus, Ohio 43201
Sand handling and mold conveying and crushing.

VII. DIRECTORY

- A. Standard Metal Directory. Biennial. \$15.00.
National Business Press, Inc.
425 West 25th Street
New York, N. Y. 10001
Lists United States metal plants, including foundries.

SHALLOW WELL HAND PUMPS: S. I. C. 3561

INDUSTRY PROFILES

SHALLOW WELL HAND PUMPS

I. P. NO. 66169

This Industry Profile is one of a series. Each Profile gives basic information on a small or medium-sized plant in a specific industry. It discusses succinctly the features of the industry and its marketing problems, shows the approximate amount of capital needed to establish a plant of specified capacity, and gives an estimate of the annual costs, by categories, of running the plant at full capacity. It also provides a plant lay-out and supplementary reference information on technical journals, articles, books, patents and the like.

Potential investors can, by examining the Profiles for the industries in which they are interested, take the initial step in the process of deciding whether to embark on particular projects. In some cases the next steps may be simple, in others they may be complicated, requiring full-scale feasibility studies by experts. But whatever the situation, it should be remembered that the Profiles are not a substitute for the specific studies, whether simple or elaborate, that should precede the actual establishment of new plants. The Profiles indicate the major factors to be considered in making such studies and provide a systematic guide for making cost estimates applicable to local conditions. Conditions in different areas vary and may affect the optimum plant size, the type of plant and equipment, the kinds of materials used, utilization of power, organization of transport, etc. Local costs may also vary for raw materials, labor, plant and equipment. Thus, specific studies may provide somewhat different estimates from those shown in the relevant Industry Profile. But the Industry Profiles provide an order of magnitude of costs, point the way to making proper assessments of actual situations, and help to precipitate investment decisions.

PRE-INVESTMENT FEASIBILITY SURVEY NEEDS

Before an investment is made in a plant, a feasibility study should be conducted. This may require skilled economic and engineering experience. The following illustrates the range of questions to which answers must be obtained: What is the extent of the present demand for the product, and how is it now being satisfied? Will the market absorb the production of the new plant? Will the estimated sales price and quality of the product make it competitive? What is the marketing and distribution plan and to whom will the product be sold? What is the nature of the plan to finance the plant? Has a realistic time schedule for construction, delivery of equipment, obtaining of materials and supplies, training of personnel and the start-up time for the plant been developed? Have arrangements been made to obtain needed materials and supplies? Are trained personnel available? Do adequate transportation, storage, power, communications, fuel, water, and other facilities exist? Has a sound plan for equipment, design, construction, and operations been developed? Have proper management controls for design, production, quality-control and other factors been developed? Will the industry fit into the development plans for the area?

Fully documented information to these and a host of additional technical questions should be available to the investor before he proceeds with implementation of an industrial project.

ORDERING INSTRUCTIONS

Copies of individual *Industry Profiles* are sold by the Clearinghouse for Federal Scientific and Technical Information at \$1.00 each. A subscription service through which all *Industry Profiles* may be received as they are produced (about 250 in 1966) is available at a cost of \$200.00.

Address orders to:

U. S. Department of Commerce
Clearinghouse for Federal Scientific
and Technical Information, 410.14
Springfield, Virginia 22151

Prepayment is required. Make check or money order payable to National Bureau of Standards—CFSTI. Clearinghouse deposit account holders may charge purchases to their accounts.

GENERAL INFORMATION

Available Profiles are listed in the *Index to the Catalog of Investment Information and Opportunities*, available on request from the Agency for International Development, DFPE, Washington, D. C. 20523

Industry Profiles are prepared for the Agency for International Development by Surveys & Research Corporation, 1030 15th Street, N. W., Washington, D. C. 20005

10.886/1

A DISCUSSION ON FUTURE HAND PUMP TUBEWELLS
IN RURAL AREAS OF BANGLADESH

by - M.A. Hussain
Chief Engineer, DPHE.

1. Introduction

Evolution is not spontaneous. It is gradual; based on the necessity and demand of better living which involves again a change of economic condition. Hence it is bound to be a slow process.

Bangladesh is using hand pump tube wells from about 50-60 years ago, but its extensive use was started only about from 1960. It was observed that the most vulnerable parts of a hand pump are the buckets and the threaded portions of the moving parts. To improve on them, some modifications in pump design were attempted from 1965 with evaluation of the results. Nothing substantial were however done for want of finance as well as motivation.

Then, when UNICEF took up the 1,60,000 hand pump tube well programme in Bangladesh, they initiated a continuous research and study programme not only on the design of the pump but also the design of the wells as a whole. The UNICEF also engaged a consultant, ' Battelle ' Columbus Laboratories, Ohio, U.S.A. who supplied the UNICEF with a hand pump design along with a technical report and guidelines to help upgrading the local foundries.

The Battelle pump was found magnificent; but it was found too sophisticated for Bangladesh in respect of cost, production methods and services. So the Battelle pump could not be accepted as such for use in Bangladesh.

Instead, the UNICEF and DPHE started remodelling of the conventional No.6 and No.4 pumps by introducing the improved facilities of the Battelle Pump. Also a Railway pump called Pitcher Pump about

1/4th weight of the Battelle pump was taken into consideration for remodelling. In this remodelling job, reduction of maintenance cost has always been kept in view and so, every endeavour was to standardise and reduce the number of movable parts and also to increase the bearing surface of such parts.

2. Comparison of Hand Pumps

The pumps which were under process of continuous remodelling, test and evaluation are shown below:

Comparison of Hand Pumps

Name of Pump	Diameter of Barrel-inches	Length of stroke - inches	Net weight lbs	Yield gpm	Approximate cost - Tk.
Conventional No.6 Pump	3½	6½	64	5-8	250
Battelle Pump	3	8	84	5-8	360
New No.6 Pump	3½	8½	66	5-8	260
Conventional No.4 Pump	3	4½	50	4-5	230
Modified No.4 Pump	3½	5½	54	4-6	240
pitcher Pump (Railway Pump) modified	3	6	40	5-6	-

* Tk.26.50 is equivalent to one pound (£)

After making limited performance tests the UNICEF ultimately selected the New No.6 Pump which is a "cross" between the Battelle Pump and the Conventional No.6 Pump (called Maya No.6 Pump).

During the research and study period other modifications and improvements made were: use of PVC bucket which lasts longer than leather bucket and design of well with PVC pipes and screen which are corrosion proof and long lasting.

3. Ultimate aim of Rural Wells

Our ultimate aim is to serve all rural people with safe drinking water. To do that and considering the geophysical conditions of Bangladesh one tube well need not serve more than 100 people. If we propose to supply tube well water at the rate of 10 gpcd (gallons per capita per day) the net yield therefore of a well need be only 1000 gpd. Allowing an equal quantity for other uses and losses, 2000 gpd yield from a well should be considered as enough for 10 working hours.

The average yield of a 1½" well with New Pump No.6 is 6 gpm (gallons per minute). Considering 6 hours total pumping period, the yield of a well is 2160 gpd. At the same time the average yield of Pump No.4 or the modified Pitcher Pump pumping 7 hours at the rate of 5 gpm is 2100 gpd. Our need is only 2000 gpd. The Pitcher Pump or No.4 Pump is then found quite efficient to meet the requirement. This pumping time difference say less than 1 minute per person or between 4 to 5 minutes per day per family is negligible but economy in price is considerable.

From the above statement, it appears that we can reduce the size of pump and even diameter of wells in our future programme of works.

4. Economical size of well

Selection of proper diameter of a well is important because it affects significantly the cost of the structure.

In Ground Water Technology and wells, length of the screen is a more important factor than its diameter in respect of specific capacity.

Other things being equal, if the diameter of a well is doubled (the well screen) it is expected to increase the specific capacity only about 10%. Specific capacity of a well is its yield per unit of drawdown, usually expressed as gpm per foot of (lowering of static water level) drawdown. This is a measure of the efficiency of a well. With same length of screen a 4 inch dia well is only 10% more efficient than a 2" dia well, though construction cost differs about 50%. Of course there are other factors and critical design criteria that determine the size of pumped well. As such we may further explore the possibility of reducing the present diameter of hand pump tubewell ~~XXXXXXXXXXXX~~ in order to reduce cost of materials of well installation in addition to reduction in cost of hand pump.

It was observed from various sources that for ease of pumping the normal length of stroke applied by a person is not to be more than 5 inches. So, in the pump design 6 inch stroke length of the barrel may be considered optimum - A pump with 6 inch stroke length and 3 inch barrel diameter capable of pumping 5 gpm may be the optimum both on considerations of economy and ease of pumping.

The new No.6 Pump is however not the means to an end for further improvement of pump design. During performance some more modifications may be required, for example the shape and length of handle, head cover etc.

5. Conclusion

In future, with the people receiving more and more doses of health education about environmental health and developing better water use habits, each family may feel the necessity of having a well of their own. This, in turn will reduce the demand of public wells. Indirectly, that situation will save lot of Govt. money spent on construction and maintenance of public wells.

It is therefore, our desire to standardize hand pump tubewells in such a manner that the cost reduces sufficiently to match the purchasing capacity of the people and spare parts are easily available in local market. That is the realistic way of serving rural people with safe drinking water.

The studies, research and development, projects, programmes etc. carried out by the IICRP, under the auspices of the D.W., Bangladesh are attached.

International Workshop on Hand Pumps.

U.N.E.P. - W.H.O. - I.R.C.

Subject : The handpumps in West Java
Indonesia.

BACKGROUND INFORMATION.

Location, geology, topography, demography, health and water supply.

West Java area is one of the 26 provinces of the Republic of Indonesia extending 105.° West to 108.7.° East longitude, 6,2 North to 7,8.° South latitude.

The total land area is some 46.200 sq.km.

The center part consists of a chain of mountains form the backbone and some 4 volcanoes are said to be still mildly active.

West Java province has a number of rivers and some of which are the cause of flood during the West seasons, the period from December to March.

The area of the South part is flat, and generally the shallow groundwater here is saline.

The salinity of shallow groundwater is more pronounced, but the water is not so salty.

In winter the rainfall from July to September most people had to travel a couple of kilometers up to a mountain just to collect some buckets of water for their household purposes.

Salinity to the depth of the ground is no problem for them during this period.

Shallow and deep well pumps are successfully installed in between the coastal and mountain areas.

Generally there is no problem in the South part regarding fresh groundwater.

Most of the mountain are covered by tropical forest where fertile soils are continually replenished by volcanic matter (eruption).

* In general the quaternary volcanic region of Indonesian archipelago consist of good aquifer material and added with the favorable climatic condition and vegetative coverage.

West Java province lies in the equator zone, has a tropical humid climate with abundant rainfall and vegetation.

The highest temperature is experienced in the plain along the coast ($30^{\circ}\text{C} - 33^{\circ}\text{C}$), but in the mountains it is pleasantly cool ($15^{\circ}\text{C} - 22^{\circ}\text{C}$).

The average annual rainfall is 1000 mm - 2000 mm.

Most Java area registering an average of 565 persons per sq. km. as per 1971 census, inhabited now by 23 million people, among them 60% live in the rural areas.

From available information it may be stated that the gastro - enteric infections are the main cause of sickness and death among the have nots. This information points out the need for much more attention and activity along environmental health especially in the field of water supply and excreta disposal for communities in the rural areas.

From the 1969 survey of 10 provinces for sanitary facilities it was noted that the population utilized the following sources of water :

Wells	45%
Springs	26%
Public	15%
Water	13%
.....	7%

Installation of hand pumps and deepwell pumps have been made since 1969. The Ministry of Health from 1969 to 1974.

One of the main reasons for this is:

The shallow handpumps were not in Java while the deepwell pumps were installed from Australia.

Long before United introduced this Japanese pump which has a not name of " Jet also known " to the country, this pump was already popular among the people of the area.

The Australian deepwell pump was very helpful for people in areas with deeper ground water level, but unfortunately the spare-parts were not available in the Indonesian market.

In the last five years plan the Government paid more attention in improving the environmental condition of the rural community, and many more handpumps have been and planned to be installed as follow :

1974 - 1975	2,500 pumps have been installed
1975 - 1976	3,374 pumps have been installed

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TECHNICAL AND ECONOMIC ASPECTS OF JOINTABLE DRAGON

Note : Since no studies nor investigations have been made regarding hand-pump, the informations and dates given below are personal opinion, based on field experience.

The Jointable Dragon :

1. is easy to install and maintain
2. have been proven of its durability in some families
3. has the advantage of convertible in its usage from an ordinary suction to pushing up water.
4. the pascalabi enameled cylinder liner prevents rusting of the pump lining.
- 5.-dimension 1 1/2 "
- suction head 30 ft.
- pushing lift 66 ft (according to the manufacture
 note). In fact Java produces a 7 1/2
 ton hand pump lift have been
 proven successfully.
 In a fact from local rule (consider
 the above the highest lifting
 heads are about 7 meter high).
- capacity 100 liter/min (according to the
 manufacture).
- weight 15 kg
- material enameled
6. In high mountainous land, only little physical effort is re-
 quired to get a maximum amount of water.
7. as a public pump a jointable dragon is hoped to serve 100 people.
8. market price \$ 67.50
9. spare-parts are easily available in the market.

Note :

An imitation of jointable dragon pumps are also available in the markets with lower price, but could not compete the original ones in quality as well as in performance.

These pumps are product of local home industries.

(4)

It is hoped that the workshop will also discuss about :

" What would be the best material being used for pump if ground-water has aggressive CO_2 , or high salinity or a low p.H. "

Those conditions are considered to be the main cause of rust.

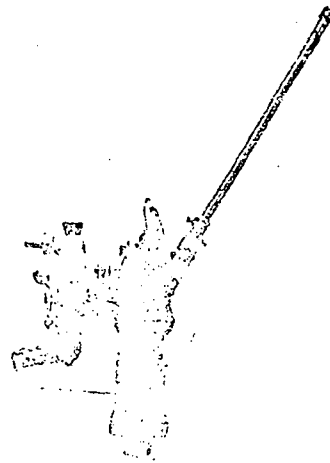
Bandung, June 28th, 1976.--

" Study, I Hodo (1973) on :

" Water Supply for Indonesian Communities."

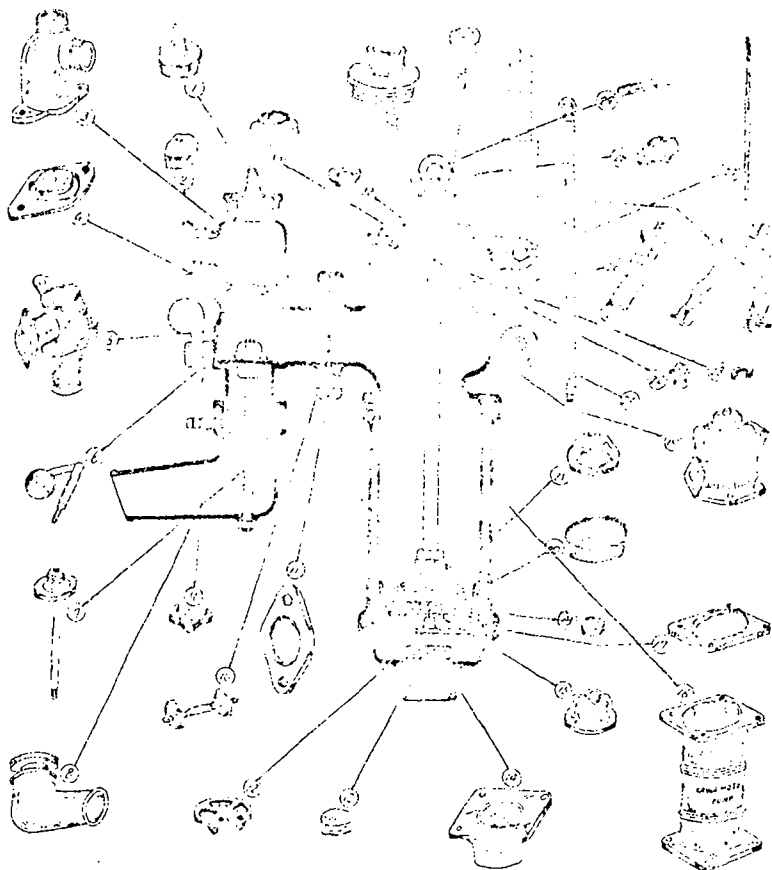
" JETMATIC - DRAGON "

Model . No. 2 (C) . -



CONSTRUCTION :

Model No. 2 (C)



No	Name of parts
1	Bone joint
2	Cap
3	3 way spout upper body
4	Check valve
5	2 way spout body
6	Change lever
7	Change valve
8	Spout
9	Hook
10	Bolt & Nut
11	3 way spout packing
12	Valve cover
13	Valve weight (Valve)
14	Valve
15	Lower plunger
16	Cylinder porcelain enameled inside
17	Rubber packing
18	Valve weight (Pump)
19	Chamber
20	Rubber cup
21	Upper plunger
22	Priming cap
23	Priming cap packing
24	Handle
25	Lever
26	Double rod
27	Shaft
28	Head
29	Pin
30	Gland
31	Packing box
32	Collar washer
33	Gland bushing

Shallow Handpump Design : Summary

General Considerations

1. Pump cost should be related to the cost of the well, and the extent to which people depend on it for their welfare.
2. Designing a handpump tubewell is like designing a more sophisticated water system. Many of the same factors should be considered:- mapping the served population, (optimum site selection, drainage considerations) ground water resources (quality and quantity), alternative sources, total population per pump, water useage patterns, gallons per capita per day, peak demands, financial status of users/ local institutions/executing authority.
3. The output of a pump can not be considered independently of the design and construction of the well. The latter depends on ground water conditions (static water level, permeability of aquifer, variation of static water level); type, diameter, slot size, open area of well screen; and type and degree of development of the aquifer.

Getting Started

4. At the outset of a new handpump tubewell programme, improving the traditional pump design or introducing a new one may have high priority if shallow well pumps are usually out of order an unacceptably high % of time, (say 30%) or deep well pumps more than 10% of the time. (The latter because people normally depend more on a deep well pump). A relatively small amount of time and money spent at the beginning of a HPTW programme to introduce or develop an improved pump should reap manifold benefits in the long run. It might even be worth consideration delaying the construction of large numbers of new wells until at least an interim design is available. ("Why is it we always have enough time (money) to do it over again, but never enough to do it right the first time?").
5. It is normally preferable to separate the construction programme from the research programme, at least to the extent that a large programme is not held up waiting for a new design. Better to introduce a modestly improved traditional design, and then introduce improved models as they become available.
6. It is usually expedient to start a programme with a single design to serve a variety of uses. As time goes on, specialized designs can be developed for specific uses.

Design Objectives

7. The primary design objective is reliability. Most traditional designs provide sufficient quantities of water-when they work. Handpump programmes most often fail because pumps are out of order too often and too long.
8. Normally, to be reliable a pump design should be simple, i.e. few bearing surfaces, few numbers of parts, few kinds of parts, locally replaceable spares.
9. If the handpump programme is rather large, and there is wide use of private handpumps and sufficient capacity for local production, it may also be desirable to develop or introduce a design which is locally reproduceable - both technically and economically. For a large public handpump programme, local reproduceability may be a major objective in order to ensure ready supply of spare parts.
10. From the economic point of view, cost should be appropriate to the investment in the well. Avoid exotic materials or sophisticated technology, unless major gains in reliability are resulted.
11. Acceptability is important. The people who use, produce, purchase, install, maintain and repair the pump should all be considered.

How to Proceed

12. In pump design work, start small. Begin with existing models. Attempt modest improvements (larger bearing surfaces; smooth, large dia. pivot pins) etc. Experience will show what is best. Do not make major commitments to unproven or inadequate designs.
13. Unsatisfactory traditional shallow well pumps can often be made quite satisfactory by simple, common sense design improvements. (For deep set well pumps, however, especially for deep water tables of say 20 meters or more, innovative departures from traditional designs may be necessary to produce a reliable, economical pump).
14. Improvements can be graded as I - Urgent, Immediate; II - as soon as practical; III - for further consideration.
 - I. Increased bearing surfaces, bigger, smoother pivots, stronger structural design.
 - II. Simpler design, fewer parts, standard size of fasteners, reduced weight, less expensive material.
 - III. More efficient, reliable valve systems, hardened bearing surfaces, bushing or roller bearings, lubrication points, preventing pin rotation.

15. Continuous observation of new or improved designs in actual field situations (both extraordinary and normal intensity) plus continuous observation of production processes will reveal design weaknesses needing further modification. Convergence towards a satisfactory design solution is a process of trial and success/error.
16. Only intensive field testing of a new design can reveal its real weaknesses. Mechanical tests conducted in laboratories often do not faithfully reproduce wear patterns produced by field use.
17. Local production problems often cannot be anticipated in the design office. They may become apparent only after large scale production is attempted.

Outline of Procedures

- (1) Define project goals, purpose, objectives, outputs, inputs
- (2) Develop pump design criteria
- (3) Estimate basic pump dimensions, capacity
- (4) Choose most appropriate materials and production process to achieve functional goals
- (5) Sketch designs
- (6) Prototype samples
- (7) Field test
 - a) Normal use
 - b) Intensive use
- (8) Evaluate wear patterns, performance, produceability
- (9) Redesign
- (10) Repeat 6-10 until design converges on acceptable solution
- (11) Working drawings
- (12) Tolerances
- (13) Specifications
- (14) Mass production
- (15) Project implementation
- (16) Refinement of design

General Observations

18. Handpump design, or redesign, is deceptively simple. One should proceed slowly, carefully. Systematically investigate effects of proposed changes on production and performance.

19. Handpump design is not really that difficult. After all, the technology is relatively simple. The primary requirement is interest, followed by perseverance, patience and a willingness to work closely with local producers and people who use and maintain the pumps.
20. Pump designs can be continuously improved. "Can we do it better? Can we do it cheaper?" Should be asked continuously.
21. Adapt the technology to the people rather than vice versa.
22. Acceptability is important. The pump should be acceptable first of all to the users, also to producers, purchasers, installing agency and maintenance personnel.

Production of New Design

23. Traditional designs tend to be institutionalized. Great energy is often needed to catalyze a design improvement programme. The prospect of large sales of the improved design may be the only force capable of starting the process.
24. Choice of pump construction - (i.e. cast iron, fabricated from standard fittings at a central workshop, or fabricated of local materials at site) will depend on available technology, materials, and skills. Local acceptability is very important.
25. Tolerances should be neither too strict nor too lenient. Impractically strict tolerances may lead to high rates of rejection, low rates of production, high costs. On the other hand, tolerances must be strict enough to assure a relatively uniform standard of good quality, and interchangeability of spares and components produced at different times and places.
26. Drawings should be produced eventually, especially if mass production by more than one supplier is intended. But it may be possible to do most of the R & D work with prototypes and sketches. The use of drawings also depends on the sophistication of the design and the general use and comprehension of drawings in factories and workshops.

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